The Human Genome Project:

An Annotated & Interactive Scholarly Guide to the Project in the United States

Editor: Kevin Davies

Cold Spring Harbor Laboratory
Library & Archives

Editor

Kevin Davies

Project Leaders

Ludmila Pollock

Judy Wieber

Production Manager

Thomas Adams

Contributors

Brian Dick

Robert Wargas

Michael Eisenstein

Victor McElheny

Stephanie Satalino

Reviewers

Jan Witkowski

Rick Myers

Robert Cook-Deegan

Acknowledgment

This project was supported by the National Library of Medicine (NLM) Grants for Scholarly Works in Biomedicine and Health (G13).

Project Title: Human Genome Project Documentary History: An Annotated Scholarly Guide to the HGP. **PI:** Ludmila Pollock

Research reported in this publication was supported by the National Library of Medicine of the National Institutes of Health under Award Number G13LM011890-01. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Researched, compiled and published by Cold Spring Harbor Laboratory Library & Archives.

All World Wide Web addresses are accurate to the best of our knowledge at the time of the printing.

ISBN 978-0-9978662-0-9

Extracted: 2016-11-22

1 INTRODUCTION

It is my great pleasure to introduce **The Human Genome Project: An Annotated & Scholarly Guide to the Project in the United States**. The idea for this annotated scholarly guide to the Human Genome Project (HGP) originated at an international meeting on the history of the HGP that was held in May of 2012 at the Cold Spring Harbor Laboratory's Banbury Center. This meeting gathered a wide range of participants, including scientists, administrators, authors, publishers, filmmakers, historians, and funders, to consider how best to present the history of the HGP to different audiences.

The HGP was the first "big science" project for biological research, and while previous big science projects, such as the Manhattan Project, were documented extensively, we recognized that formal plans to document the HGP had not made at its inception. Thus, this annotated guide is the first step in this direction. **The Human Genome Project: An Annotated & Scholarly Guide to the Project in the United States** was a natural project for us to take on because of the establishment in 2005 of the Genentech Center for the History of Molecular Biology and Biotechnology at the CSHL Library and Archives and my belief that it is critically important to document the history of these relatively new scientific areas while primary sources and people remain available.

We intend this guide as a research tool that historians of medicine and the life sciences, as well as bioethicists and public health officials, can use to locate materials for their research. Represented here is a compendium of a wide range of materials from the HGP covering the years 1977 to 2003, including: a brief history of the HGP; research methods used; ethical, legal, and social implications; grant applications; news items; scientific records, data, and notebooks; relevant meetings and publications; government documents; brief biographies of those involved in the HGP; participating academic, commercial, and governmental organizations; genome maps and sequences; as well as links to other repositories. We are presenting the guide as an e-book/pdf for ease of navigation. And while the current version covers just the United States HGP collections, a future version will be expanded to cover international resources.

We are grateful for the grant support of the National Library of Medicine Grants for Scholarly Works in Biomedicine and Health program. Such a large and complex project would not have been possible without the the significant contributions of the Cold Spring Harbor Laboratory Library and Archivies staff—Michael Eisenstein, Brian Dick, Robert Wargas, Clare Clark, and Stephanie Satalino. Co-leaders on this project were Judy Wieber, who collected much of the guide's content, and Thomas Adams, who oversaw the database and technological aspects. This immense editorial task was undertaken by Kevin Davies, founding editor of *Nature Genetics* and author of articles and books about the HGP.

I hope that scholars and historians will find this initial guide to be a useful resource in planning and completing their own HGP projects, and I look forward to hearing their comments and suggestions for future development of this extensive resource.

Ludmila Pollock, Executive Director
Genentech Center for the History of Molecular Biology and Biotechnology
CSHL Library & Archives

2 NOTE FROM EDITOR

When the Human Genome Project was officially launched back in 1990, it was envisioned as an international effort that would span 15 years with a price tag of $3 billion -- $1 for each base of the genetic code. After a journal with many twists, turns and tribulations, this extraordinary quest was marked by a White House celebration in June 2000, and the publication of the first drafts of the human genome in February 2001. The Nobel laureate David Baltimore wrote in *Nature* that he got “chills” reading the manuscript detailing the reference genome for humankind.

It is 15 years since those first drafts of the human genome were published. From a solitary reference genome, there are now hundreds of thousands of decoded genomes, thanks to astonishing advances in next-generation sequencing. Our understanding of the biology of the human genome has grown, bolstered by projects that have built upon the foundation of the Human Genome Project, including the International HapMap project, The Cancer Genome Atlas, the ENCODE Project, and many more.

There is no shortage of books, review articles, documentaries, and conferences addressing the Human genome Project and its legacy. Is there room for another scholarly effort to add to this abundance of information? We think so.

The Annotated Scholarly Guide to the Human Genome Project is a vast, online window into the Human Genome Project. It features a rich, meticulous gathering of resources, information and links to original research, articles, videos and many other materials. The scope spans not only the years bracketing the Project itself, but also the period leading to the launch and events following the Project’s completion.

The Annotated Scholarly Guide is the brainchild of Mila Pollock, librarian at the Cold Spring Harbor Laboratory. I am proud to have worked alongside Mila and her team, including contributor Michael Eisenstein, and hope this resource helps scholars and researchers learn more about the conception, history and legacy of the Human Genome Project.

Kevin Davies, PhD

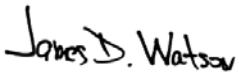
3 PREFACE

In February of 1953, Francis Crick and I proclaimed to the patrons of the Eagle pub in Cambridge that we had discovered “the secret of life”—how the structure of DNA carries genetic information. But I don’t think that Francis and I could realize then that just 50 years on, the complete sequence of the three billion base pairs of the human genome would be deciphered and the molecular basis of what it is to be human would be revealed.

Certainly, Fred Sanger’s development of the dideoxy chain-termination method of sequencing in 1977 was a critical step in moving us closer to this goal, and so his important achievement marks the starting point for the resources concerning the complex history, science, economics, and politics of the Human Genome Project contained in this extensive guide. Ending with the announcement of the completed human genome sequence in 2003, **The Human Genome Project: An Annotated & Scholarly Guide to the Project in the United States** constitutes an indispensable research tool for scientific investigators, historians of medicine and the life sciences, as well as bioethicists and public health officials worldwide.

My directorship of the National Center for Human Genome Research from 1989 through 1992 was a period in which technologies and bioinformatics approaches were being developed, the U.S. Congress was brought on board with funding, and attention was paid to the social, economic, and moral implications of knowing the sequence of the human genome. Thus, I am very pleased to see documented here the wealth of progress and information, as well as the large number of researchers and organizations involved in this enormous effort, from that nascent period for the Human Genome Project through the completion of the project.

Implicit in the information presented here are the future benefits of knowing the structural and functional details of the human genome. Already there are companies that offer consumer genome analysis, and new technologies have made the $1000 genome a reality, with personalized medicine on the near horizon. The journey of research developments and the resources compiled in this guide will most certainly spur further progress and so fulfill the Human Genome Project’s promise to provide the understanding and effective treatment of the diseases that plague the human condition.



Dr. James D. Watson

4 TABLE OF CONTENTS

4.1

Table of Contents End

Editor

Kevin Davies

Project Leaders

Ludmila Pollock

Judy Wieber

Production Manager

Thomas Adams

Contributors

Brian Dick

Robert Wargas

Michael Eisenstein

Victor McElheny

Stephanie Satalino

Reviewers

Jan Witkowski

Rick Myers

Robert Cook-Deegan

Acknowledgment

This project was supported by the National Library of Medicine (NLM) Grants for Scholarly Works in Biomedicine and Health (G13).

Project Title: Human Genome Project Documentary History: An Annotated Scholarly Guide to the HGP. **PI:** Ludmila Pollock

Research reported in this publication was supported by the National Library of Medicine of the National Institutes of Health under Award Number G13LM011890-01. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Researched, compiled and published by Cold Spring Harbor Laboratory Library & Archives.

All World Wide Web addresses are accurate to the best of our knowledge at the time of the printing.

ISBN 978-0-9978662-0-9

5 USING THIS GUIDE

This Annotated Scholarly Guide is published in two formats: as an easy to distribute E-Book in PDF format and as an online wiki. Both formats are currently maintained at the following URL:
http://library.cshl.edu/Guide-to-HGP/

5.1 PDF Version

The PDF version can be read and browsed using Adobe Acrobat or Adobe Reader. Extensive internal and external links are used within the guide. It is best to use reader platform which is able to open external webpages, allowing you to fully explore. View our Effective PDF Navigation for tips on using Acrobat Reader.

5.2 Wiki (Confluence) Version

The online wiki version of this guide, enables quick browsing and facilitates updates. To navigate, use the left hand panel to browse the page hierarchy. Expand the hierarchy tree by clicking on the right caret (">") symbol, so that it points downward. If you had instead clicked on the title, the child pages would not have been displayed.

If you would like to contribute to expanding this as a resource, please get in touch with the CSHL Archives.

6 EFFECTIVE PDF NAVIGATION

This guide makes extensive use of internal links, enabling exploration of the material in a non-linear fashion.

In it's PDF form with more than 700 pages, you might want to utilize the built-in features of Adobe Acrobat or Adobe Reader, to easily navigate to the areas of interest.

> The procedures listed below, apply to a recent version of Adobe Reader. Your version may differ,

6.1 Links

There is a visual clue if a link is internal to the document or if it links to an external resource on the web. With your mouse, hover over a link, if the mouse pointer changes to a hand with a "W" box, then the link is an external URL.

6.2 Acrobat Bookmarks

Bookmarks have been generated within the guide to facilitate navigation between different sections. It provides, in essence, an always available table-of-contents in the left hand panel of your Adobe Reader. To show the bookmarks panel, choose the Bookmarks icon or select from the top menu:

View -> Show/Hide -> Navigational Panes -> Bookmarks

Based upon your personal preference, you might want to:

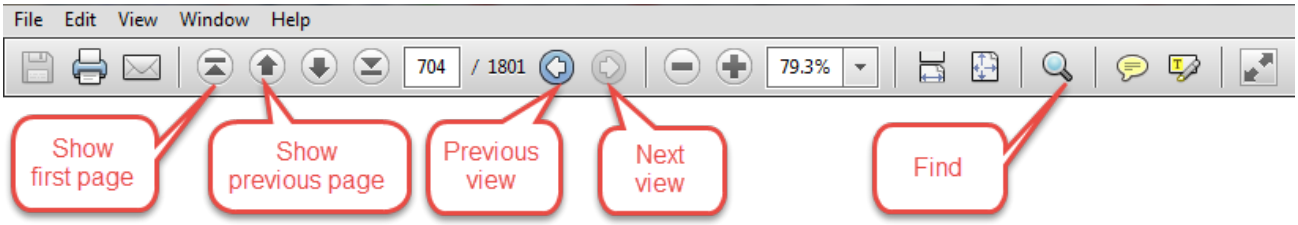
- resize the panel to 1/4 of the screen
- Uncheck **Wrap Long Bookmarks**
- Change **Text Size** to Small
- **Collapse Top-level Bookmarks**

(the above options are located in the "Options" icon near the top/left of the Bookmarks panel.)

When the **Bookmarks** are visible you are able to quickly select any chapter or section by expanding/collapsing bookmarks while drilling down. Don't forget the **Collapse Top-level Bookmarks** option.

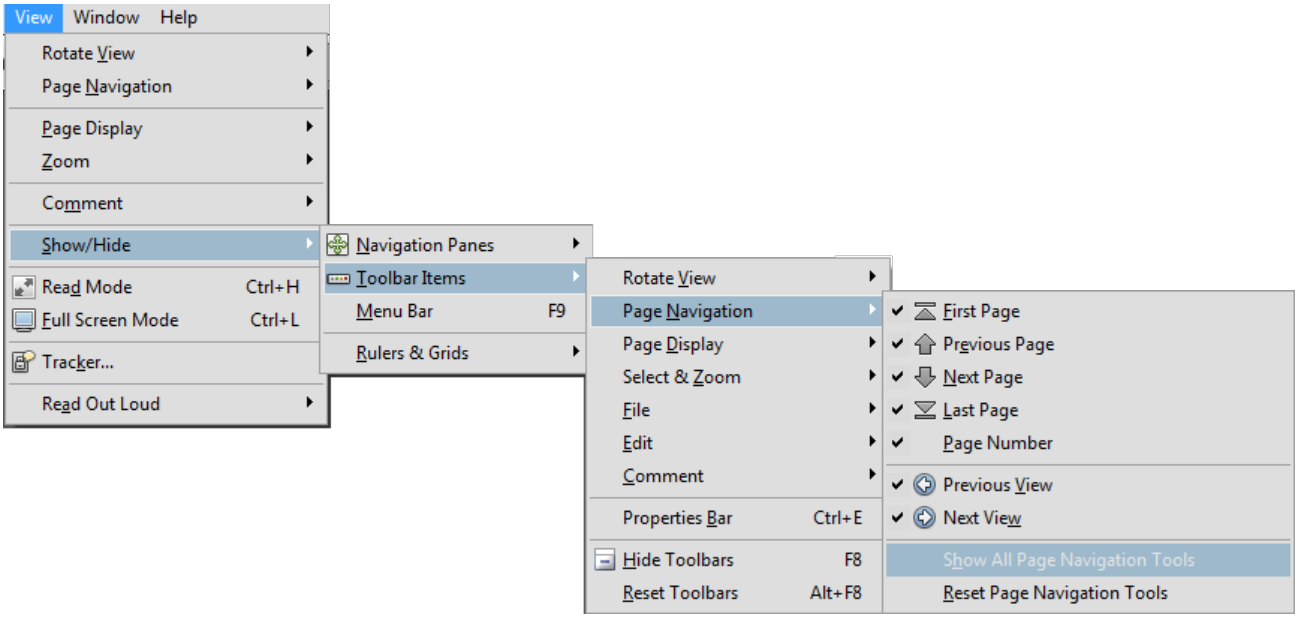
6.3 Acrobat Navigation

Here is a snapshot of Adobe Acrobat menus, with some of the navigation icons highlighted. The **Previous view icon**, will bring you back from previous links you might have traversed.



Some of these icons might be hidden by default. To display these icons, select from the top menu:

View -> Show/Hide -> Toolbar Items -> Page Navigation -> Show All Page Navigation Tools



Alternatively, you can use the keyboard shortcuts:

Command	Windows	Apple
Show First Page	Home	Home
Show Previous Page	Left Arrow	Left Arrow
Show Next Page	Right Arrow	Right Arrow
Show Last Page	End	End
Previous View	Alt + Left Arrow	Command + Left Arrow
Next View	Alt + Right Arrow	Command + Right Arrow
Find Text	Ctrl + F	Command + F

7 NARRATIVES

7.1 The Early Years 1990-1997

7.1.1 HGP Inception

In October 1990 – the start of the 1991 fiscal year – the Human Genome Project officially began, or so declared Jim Watson. Total funding to the NCHGR and DOE was over $150 million, within striking distance of the $200 million per year target set out in the NRC report. That same month, Eugene Myers (University of Arizona), David Lipman and colleagues from the National Center for Biotechnology Information (NCBI) published the Basic Local Alignment Search Tool – better known as BLAST – a powerful algorithm for aligning DNA sequences. {Altschul, S.F. *et al. J. Mol. Biol*. 1990}.

That same autumn, two important events illustrated the extraordinary potential of the HGP for diagnosing and treating disease.

University of California, Berkeley, geneticist Mary-Claire King capped a 15-year quest to prove a hereditary link to some familial cases of breast cancer. Her group successfully mapped the *BRCA1* hereditary breast and ovarian cancer gene to the long arm of chromosome 17. Because of the genetic heterogeneity of breast cancer, proving the culpability of any genetic variation was an immense undertaking. One of King's students ultimately provided the breakthrough, suggesting that families with an earlier average age-of-onset were more likely to harbor an inherited predisposing mutation. {Hall et al. *Science* 1990; Davies, K. & White, M. *Breakthrough: The Race to Find the Breast Cancer Gene,* 1995}

On the therapeutic front, a watershed moment occurred on September 14, 1990. Ashanti DeSilva, a 4-year-old girl suffering from a rare immune disease called ADA (adenosine deaminase) deficiency, was admitted to the NIH medical center to begin a course of treatment. Under the supervision of W. French Anderson and Michael Blaese, DeSilva became the first patient to receive an officially sanctioned gene therapy treatment. Years later, her treatment was declared a success. {Thompson, L. *Correcting the Code* 1994}

In the summer of 1991, Craig Venter's team at the NIH published a remarkable paper in *Science* in which they sequenced and identified by homology searches scores of genes based on sequencing randomly selected complementary DNA (cDNA) clones. Venter called the sequences "expressed sequence tags" (ESTs). In a single research paper, Venter's team had identified hundreds of human genes expressed in the human brain, including many of potential medical relevance. {Adams, M. et al. *Science* 1991} His approach was not original – Sydney Brenner had proposed a similar strategy to the MRC but lacked the resources to embark on a full-scale project. But Venter's paper highlighted the obvious implications: cDNA sequencing could prove to be a much faster and cost-effective route to sequencing the high-value regions of the genome. Not that Venter was wedded to that approach: in the first five issues of *Nature Genetics*, launched in 1992, Venter and co-workers reported on the automated DNA sequencing of large 100-kb regions of two key stretches of chromosomes 4 and 19 – candidate regions for the genes for HD and myotonic dystrophy. {McCombie, W.R. *et al. Nat Genet*. 1992; Martin-Gallardo, A. *et al. Nat Genet.* 1992}

The commercial potential of Venter's EST approach was not lost on investors – or the NIH. While Venter's employers at the NIH controversially signaled their intent to apply for patents on this new bounty of genes and gene fragments, Venter accepted a $70-million offer from venture capitalist Wallace Steinberg to set up a new non-profit research institute (The Institute of Genomic Research, TIGR), while licensing the intellectual property to a for-profit sister company, Human Genome Sciences.

7.1.2 Mapping the Foundations

In 1990, the French Muscular Dystrophy Association (AFM) and the Centre d'Etude du Polymorphisme Humain (CEPH) created Genethon, a genetics research institute in Paris, with funding provided by the annual French telethon.

In January 1992, Watson met Frederic Bourke, a Connecticut-based former college squash champion turned entrepreneur, who had decided to mount something of a hostile takeover of the early genome project. The men did not get along well. With Lee Hood serving as an advisor, Bourke had ambitions to invest $50 million in a private sequencing venture in Seattle, and was sending overtures to leading figures in the genome community, including John Sulston and Robert Waterston, the twin towers of the nematode genome project. Several senior scientists, including Watson, feared that the HGP could be derailed before it had seriously begun and lobbied UK funding organizations for help.

Intent not to lose the services of one of their key genome scientists, the Wellcome Trust stepped up to provide £50 million (~$80 million) in funding for the completion of the nematode genome sequencing project – a crucial stepping stone for the HGP. The Trust also committed to establishing a flagship genome center just south of Cambridge – the Sanger Centre – appropriately named after Fred Sanger, the double Nobel laureate.

Bourke retaliated by writing to NIH director Bernadine Healy, alleging that Watson had spearheaded "resistance" to his venture and suggesting a possible conflict of interest. As Cook-Deegan wrote, "While Bourke's torpedo may have passed wide of the mark in its first pass, it ultimately circled back and found Watson's hull." {Cook-Deegan, 1994} Healy initiated an inquiry into Watson's financial holdings, further eroding the strained relationship between the two. Watson told the *Washington Post* that he could divest most of his stock holdings, but to do so would be "pointless."

On April 10, 1992, Watson resigned via fax from his office at Cold Spring Harbor Laboratory. Healy invited molecular geneticist Michael Gottesman to serve as acting director until a permanent successor to Watson could be found. But the identity of that individual was soon apparent: the University of Michigan physician-scientist Francis Collins, who had helped identify the genes for CF and neurofibromatosis, was the consensus pick. In the New Year's Day issue of *Science* in January 1993, Collins confirmed he would take up the mantle of director of the NCHGR. His appointment was made official in April.

While the directorship drama played out, researchers took several important steps in laying the groundwork for the HGP. Venter and colleagues reported the sequencing of a 100-kb stretch of chromosome 19 in the inaugural issue of *Nature Genetics*. {Martin-Gallardo, A. *et al. Nat. Genet.* 1992}. This article signaled the feasibility of using automated DNA sequencing to sequence the human genome. Several groups also made progress in building genetic and physical maps of the genome.

Eric Lander's group at the Whitehead Institute produced a medium-resolution genetic map of the mouse, with markers 4-5 cM apart. Later that year, Lander and Jean Weissenbach (Genethon) reported in *Science* the first comprehensive genetic linkage map of the human genome, with markers spaced 5 cM apart.

At the same time, two groups – David Page at the Whitehead and Daniel Cohen at Genethon in Paris – reported advances in building the first chromosome physical maps. Page's lab produced a map of the Y chromosome, while the French team constructed a map of chromosome 21. Meanwhile, Caltech's Mel Simon reported a significant step forward in physical mapping by developing a resource called bacterial artificial chromosomes (BACs), modified *E. coli* plasmids capable of holding DNA inserts of up to 300 kb. {Shizuya, H. *et al. PNAS* 1992}. BACs would complement yeast artificial chromosomes (YACs), developed by David Burke and Maynard Olson five years earlier {Burke, D.T. *et al. Science* 1987}, which could house larger DNA inserts of 500-750 kb. YACs were the major cloning vehicle in the early years of the HGP, but as concerns about chimerism and artefacts grew, their use was phased out in favor of BACs.

1993: Ten tortuous years after the Huntington's disease gene was mapped to chromosome 4, a multi-center consortium finally identified the rogue gene. The gene encodes a neuronal protein called Huntingtin. The mutational basis of the disease was found to be an expansion of a repeated codon, like the expansion of a concertina. HD thus joined fragile X syndrome, myotonic dystrophy and several other neurological disorders as the first examples of a new class of genetic disease: Triplet repeat disorders.

In October 1993, the NIH and DOE published an updated 5-year plan for the Genome Project, spanning 1993-1998 {Collins & Galas, Science, 1993}. The authors, Collins for the NIH and DOE chief David Galas, said that the HGP was progressing on schedule and becoming truly international in scope, with "myriad interrelationships" forming "generally spontaneously," but that refinements and new priorities were needed. For example, the 2-5 cM genetic map was on schedule, but methods to enable more rapid multiplex genotyping were necessary, especially to tackle the genetics of more complex diseases. The 100-kb resolution physical map was also on target, but there the authors noted "a pressing need for clone libraries with improved stability and lower chimerism and other artifacts and a need for better technology for traveling from one STS to the next."

As for DNA sequencing itself, Collins and Galas noted that the cost per base ($0.50) was on target, but the speed and throughput of sequencing was lagging. They wrote:

> *"Substantial new technology that will allow sequencing at higher rates and lower costs is also needed: both evolutionary technology developed from improvements in current gel-based approaches and revolutionary technology based on new principles. These developments will only occur if significantly greater financial resources can be invested in this area."*

As if on cue, that same month, the Wellcome Trust and the MRC opened the Sanger Centre just outside Cambridge UK.

1994: Progress on the genome mapping front was evident when *Nature Genetics* published a large supplemental special issue containing a pair of papers on genetic maps of human and mouse from the Généthon and Whitehead Institute groups. The French researchers compiled a genetic linkage map of the human genome with an average marker spacing of 2.9 cM – comfortably within the range specified in the original 5-year plan. {Gyapay, G. *et al. Nat. Genet*. 1994} The map included some 2,000 DNA markers, more than double the number in Généthon's previous linkage report in 1992. The preliminary mapping stage of the HGP had been completed one year ahead of schedule.

Later that year, Myriad Genetics won the fierce race to isolate the *BRCA1* gene, which had been mapped by the King lab in 1990. Myriad edged half-a-dozen groups hoping to isolate the rogue gene on chromosome 17. {Kamb, A. *et al. Science* 1994} The subsequent patent resulted in a Myriad maintaining a virtual monopoly on breast cancer genetic testing until a 2013 challenge that went all the way to the U.S. Supreme Court.

7.1.3 The First Genome

The year 1995 was highlighted by two major genome announcements. The first came in July from Venter's group at TIGR, including Nobel laureate Hamilton Smith and Clare Fraser, which published the first complete bacterial genome sequence – *Haemophilus influenzae*. {Fleischmann, R.D. *et al. Science* 1995} The genome size – 1.8 Mb – was typical for a bacterium but about ten times larger than any viral genome sequenced to that point. (It should be noted that there are claims that first fully sequenced bacterial genome was actually completed in 1994, by George Church and colleagues, but that project was performed on behalf of a private biotech company, Genome Therapeutics, and not published.)

The accomplishment was notable not only for being the first publicly reported genome of a free-living organism but also for the method by which the genome was assembled. Venter's team eschewed traditional physical mapping and clone-by-clone sequencing in favor of a random or "shotgun sequencing" approach, relying on the computational assembly of the final genome sequence. The approach worked supremely well for this and many other bacterial genomes in quick succession, raising the question of whether it could be applied to larger more complex genomes, including the human genome.

In December 1995 Lander's team, led by Thomas Hudson, reported a dense complete physical map of the human genome, consisting of more than 15,000 STS markers at an average spacing of 199 kb. {Hudson, T. *et al. Science* 1995}. The map was deemed to be "an essential prerequisite for the international effort to sequence the human genome." The authors noted that the reliance on STSs had helped overcome the technical hurdles caused by the YAC chimerism problem. The new map, neatly book-ending the NIH/DOE's first 5-year plan, provided the scaffold for initiating large-scale sequencing of the human genome.

On the technology front, Perkin Elmer broke new ground with the launch of the ABI PRISM 310 Genetic Analyzer, the first commercial DNA sequencer using capillary electrophoresis. In a radical departure from the previous generation's slab gel format, the ABI 310 used narrow capillary tubes to separate the DNA samples, which were then analyzed using 4-color laser-induced fluorescence. All four reactions were loaded into a single capillary, with an initial rate of 400-450 bases sequenced in a 2-hour run. {Ahern, H. *The Scientist* 1995}

7.1.4 New Rules

In February 1996, about 50 genome leaders from NIH, DOE, Wellcome Trust and international groups met at the Princess Hotel in Hamilton, Bermuda, to discuss the public release of sequence data. (The meeting was funded by the Wellcome Trust, but organizers sought a "neutral" ground.) Scientists crafted the "Bermuda Principles," most importantly agreeing for free access to genome data within 24 hours of generation. One year later, the same group reconvened in Bermuda and established quality metrics for the genome sequence.

Two months after the Bermuda meeting, the NCHGR signaled a shift in sequencing strategy by identifying six genome centers that would be entrusted with developing high-throughput sequencing operations. Annual grants of $20 million were awarded to institutions: Baylor College of Medicine, Stanford University, The Institute for Genomic Research [TIGR], University of Washington, Washington University School of Medicine, and the Whitehead Institute for Biomedical Research—MIT Genome Center.

Nine months after Venter's coup with the first bacterial genome, an international team of researchers in the hundreds announced the completion of the full genome of baker's yeast. The work involved dozens of small independent laboratories across Europe, North America and Japan. The yeast genome, which contains about 6,000 genes encoded in 12 million basepairs, was published in October 1996. {Goffeau, A. *et al. Science* 1996}

With so much emphasis on building the scaffold for full-scale sequencing, little attention was paid at the time to speculative ideas about the next-generation of DNA sequencing technologies. David Deamer, Daniel Branton and colleagues published an intriguing method involving the passage of DNA strands (under an electric field) through nanopores (bacterial membrane proteins with a natural pore or channel). If the movement of molecules could be slowed and shifts in electrical current correlated to base sequence, then this had the makings of a powerful and accessible method for DNA sequencing. "With further improvements," the authors predicted, "the method could in principle provide direct, high-speed detection of the sequence of bases in single molecules of DNA or RNA."{Kasianowicz, J.J. *et al. Proc. Natl. Acad. Sci. USA* 1996}

1996 ended with the publication of the largest single stretch of human chromosomal sequence to date, as Lee Hood's group in Seattle reported the 685-kb sequence of the T-cell receptor locus. It was a testament to the power of physical mapping and automated DNA sequencing. {Rowen, L. *et al. Science* 1996} And yet six months earlier, Hood had teamed up with Venter and Ham Smith to co-author a commentary in which the authors projected that a random shotgun approach, using paired-end BAC sequencing, could provide a dense panorama of STS markers and accelerate human genome sequencing. {Venter, J.C. *et al. Nature* 1996}

7.1.5 Shifting Strategies

1997 began with DHHS secretary Donna Shalala renaming NCHGR the National Human Genome Research Institute, upgrading the genome hub to full institute status. The DOE opened the Joint Genome Institute (JGI) to consolidate the agency's genome research activities at its three major genome centers – the Lawrence Berkeley National Laboratory (LBNL – the lead laboratory), the Lawrence Livermore National Laboratory (LLNL), and the Los Alamos National Laboratory (LANL).

As the HGP approached the halfway mark in its planned 15-year voyage, Jim Weber and Eugene Myers published a provocative and controversial commentary in *Genome Research* proposing an alternative, less costly shotgun sequencing approach to the human genome. {Weber, J.L. & Myers, E.W. *Genome Res.* 1997}

The authors noted that despite the excellent work that had already been put into building genetic and physical maps, only a few percent of the human genome had actually been sequenced: it was not too late to change course. They concluded:

> *"About a decade ago, when the Genome Project was just being contemplated, Fred Blattner proposed whole-genome shotgun sequencing of both the E. coli and human genomes. His proposals were neglected. Today, no one considers for a moment sequencing bacterial genomes by any method other than whole-genome shotgun sequencing. Even at several dollars per finished base the human sequence is probably one of the greatest bargains in human history. We laud efforts now under way in several large sequencing centers to generate human genomic sequence. The reality, however, is that research dollars are always limited. We should sequence the human and other eukaryotic genomes using the most rapid, cost effective, and productive strategy."*

The Weber-Myers article was accompanied a rebuttal by University of Washington bioinformatician Phil Green, who countered that the physical mapping approach was not only a pre-requisite but cost effective. In short, he concluded, there was no need to switch course. {Green, P. *Genome Res*. 1997}

7.2 Biological Research/Methods Development

7.2.1 Mapping the Genome

In 1980, a quartet of esteemed geneticists sounding suspiciously like a law firm – Botstein, Davis, Skolnick and White – published a seminal paper outlining a bold strategy by which random polymorphic DNA markers could be used to map the 23 pairs of chromosomes in the human genome, just as had proved effective in creating a genetic map of yeast. {Botstein D, et al. (1980) Construction of a genetic-linkage map in man using restriction fragment length polymorphisms}. Within a couple of years, Ray White's group had isolated the first restriction fragment length polymorphism (RFLP) marker, and the human genetic map began to take shape.

The key purpose of constructing such a map was to build the framework upon which to map genes that, when mutated, are responsible for inherited diseases. Polymorphic markers were analyzed in affected families (preferably large and multi-generational) to assess the statistical odds of linkage with the disease gene in question. In 1983, James Gusella and colleagues at Massachusetts General Hospital in Boston produced a stunning result: using vast family trees of Huntington's families from villages in Venezuela studied by Nancy Wexler, Gusella's team was able to map the rough location of the Huntington's disease gene to the short arm of chromosome 4. The DNA marker, dubbed G8, in proximity to the Huntington's gene was just the 12th random marker tested by the Boston group. {Gusella JF, et al. 1983}

Two years later, three teams simultaneously reported linkage of other markers from the long arm of chromosome 7 to the gene mutated in patients with cystic fibrosis (CF). The CF gene was a prized quarry because of the disease's prevalence (affecting roughly 1 in 2,000 newborns among individuals of Northern European descent) and severity (CF patients succumbed to severe untreatable lung infections and seldom lived into their 20s). Knowlton RG, et al. (1985)

By the late 1980s, researchers succeeded in identifying the genes underlying some of the most devastating and well-known Mendelian disorders. Lou Kunkel, Tony Monaco and colleagues at Boston's Children's Hospital identified the X-linked gene mutated in Duchenne Muscular Dystrophy (DMD), the most severe form of muscular dystrophy. The gene encoded a large muscle protein dubbed dystrophin.

In 1989, Lap-Chee Tsui and Jack Riordan at the Hospital for Sick Children in Toronto, Canada, in collaboration with the University of Michigan's Francis Collins, isolated the CF gene. In a tour de force of genetic mapping and analysis, the trio reported in *Science* the structure of a membrane protein – the cystic fibrosis transmembrane regulator (CFTR) – almost certainly an ion channel, responsible for shuttling chloride ions in and out of the cells lining the airways. The most prevalent mutation, deltaF508, was the deletion of 3 consecutive nucleotides encoding a phenylalanine residue in the 508th position in the protein. Subsequent work showed that this tiny deletion interfered with the transport of the CFTR protein to the cell surface.

7.2.2 Planning the Project

During the mid-1980s, the idea and feasibility of a Human Genome Project was discussed and gained momentum during several workshops and conferences, featuring government funders and research scientists, from Santa Cruz to Cold Spring Harbor.

In December 1984, the DOE arranged a meeting of geneticists at the Alta resort , just outside Salt Lake City, to explore the mutational profile in children of survivors of the two atomic bombs dropped on Hiroshima and Nagasaki at the end of World War II. The consensus was that current genetic analysis techniques lacked precision and sophistication, but advances in technology were encouraging.

In May 1985, virologist Robert Sinsheimer, chancellor of the University of California, Santa Cruz (UCSC), convened a small workshop in Santa Cruz with leading geneticists. Sinsheimer was looking to create a "big science" biology project for UCSC to rival its expertise in astronomy and high-energy physics. He had the idea of creating a sequencing institute, but recognized that NIH would be unlikely to give UCSC a major grant without considering competing bids from more prestigious institutes.

"If NIH thought [a DNA sequencing center] was a good idea, they weren't just going to give Santa Cruz $25 million, which I figured was the minimum needed to get going," Sinsheimer recalled. "I thought what I needed to do was to raise $25 million of private money, and then we could go to NIH and we could get grants or something. But, in order to do that, I had to have more than just the idea; I had to have some validation that this was really a feasible project." {Erwin, S. Caltech Archives, 1992}

Sinsheimer invited a dozen or so leading scientists to his Santa Cruz workshop, entitled "Can we sequence the human genome?" {Sinsheimer, R. *Am J Hum Genet* 2006} Participants included leading genetics researchers from both sides of the Atlantic:

- Bart Barrell (Medical Research Council)
- David Botstein (MIT)
- George Church (University of California–San Francisco)
- Ron Davis (Stanford)
- Walter Gilbert (Harvard)
- Leroy Hood (Caltech)
- Hans Lehrach (European Molecular Biology Laboratory)
- John Sulston (MRC)
- Michael Waterman (University of Southern California)

The group considered the prospects of launching a "big science" genome project, conceived as requiring 15 years and $3 billion ($1 per nucleotide). (It is worth noting that the largest genome sequenced at that time was the Epstein-Barr virus, just 173,000 bases.) Several participants were initially skeptical of the merits of mounting a comprehensive, telomere-to-telomere sequencing project. Doubts centered on two major concerns: first, a concerted "big biology" project would inevitably draw funding from traditional investigator-driven RO1 funding. Second, scientists questioned the wisdom and expenses of sequencing the genome when the majority of the DNA was dismissed as mere "junk".

But Sinsheimer saw little merit to either worry. “To be sure, Big Science, *per se*, is not a virtue,” he admitted. But biology needed “a massive information base,” computing facilities and an understanding of the genomes of various model organisms besides humans. As for the junk DNA, only by sequencing the entire genome could the extent and function of regulatory, non-coding regions of DNA begin to be understood. Moreover, the rapid progress in building restriction maps of model organisms such as yeast and the nematode worm indicated the feasibility of building a solid framework upon which to hang the complete genome sequence.

Sinsheimer’s report of the Santa Cruz workshop was particularly well received by the DOE, which, having a much more hierarchical, top-down structure than the NIH, was accustomed to funding large-scale consortia. Only later, he said, did NIH realize that it had to get in on the act or it could lose out on what normally be thought of as its turf. “I don’t think that it would have been set up that way *a priori*, but that’s the way it’s evolved.” {Erwin, 1992}

Prominent support for sequencing the human genome came in a commentary published in *Science in* March 1986 by Nobel Prize-winning oncologist Renato Dulbecco. “We are at a turning point in the study of tumor virology and cancer in general,” he wrote. “If we wish to learn more about cancer, we must now concentrate on the cellular genome.” By concentrate, Dulbeco meant sequence in full, and the priority had to be the human genome. {Dulbecco, R. *Science* 1986}

The Dulbecco commentary coincided with a conference in Santa Fe in March 1986, organized by Charles DeLisi, to discuss the DOE’s involvement in potentially setting up a genome project. DeLisi had taken up the role of head of health and environmental research programmes at DOE, and had heard about Sinsheimer’s 1985 workshop. {DeLisi, C. *Nature* 2008} Invitees were summoned with two tantalizing questions: “Can we, through a concerted and dedicated effort, sequence the entire human genome in ten or twelve years? Should we?” {McElheney, V. *Drawing the Map of Life*, 2010}

The answer to both questions among the prominent scientists gathered at Santa Fe, including Sydney Brenner, was an enthusiastic “yes.” Questions centered more on how the project should be organized, funded and distributed. Gaining public acceptance and Congressional support would be a critical issue; geneticist David Comings argued the importance of linking the genome project to advances in medical genetics and the quest to identify disease genes for Mendelian disorders such as CF and DMD as well as more common disorders, including psychiatric diseases, of much more complex genetic provenance.

Two months after the Santa Fe conference, DeLisi advised DOE leadership to launch a genome project in two phases: the first phase would focus on creating a physical map of the genome, developing methods for automated DNA sequencing, and enhancing computing capability. That would lay the groundwork for the second phase – genome sequencing. The DOE’s funding request first appeared in the U.S. government budget for fiscal year 1986. {McElheney, V. 2010}

Over the subsequent few months, the genome project was discussed at several major conferences and symposia, beginning with the prestigious annual Cold Spring Harbor Symposium, held at the Long Island research campus where James Watson was director. Watson had chosen the title *Molecular Biology of Homo sapiens*, but received some devastating personal news on the eve of the meeting. Watson’s teenage son Rufus, who suffers from schizophrenia, had run away from a psychiatric hospital in New York. (He was found safe and returned home a short time later.) From this point, Watson’s personal interest in sequencing the genome centered on its potential to identify genes involved in complex neurological and psychiatric disorders.

The Symposium organizers devoted a session to discussion of the merits of genome sequencing, during which Walter Gilbert famously scrawled “$3 billion” on the Grace Hall blackboard. But many scientists in the packed auditorium expressed strong concern about the hefty price tag and questioned whether a lower-resolution physical map of the genome, guiding researchers to regions of interest, might not be more valuable. The divide seemed in part generational, with younger scientists particularly concerned about the impact of big biology on their research enterprise.

In October 1986, recognizing the growing DOE interest in backing a genome project, the NIH director, James Wyngaarden, arranged a two-day conference to discuss the potential role of the NIH. He left open the possibility of NIH leading the charge to map the genome, although several institute chiefs were opposed to the idea. {McElheny, V. 2010}

As the debate intensified within the scientific community, the National Research Council (NRC) decided to convene a committee to examine the merits of human genome sequencing. The committee was chaired by noted cell biologist Bruce Alberts, and consisted of a dozen high-profile scientists including Watson, Brenner, Botstein and Hood. Testimony was received from a host of similarly esteemed researchers including George Church, Jim Gusella, Ray White, and Eric Lander. The 100-page NRC report – *Mapping and Sequencing the Human Genome* -- was published in February 1988. The panel affirmed the need and feasibility of a centrally organized Human Genome Project, but only in the context of multiple model organism genome sequences, including bacteria, yeast, nematode and fruit fly. {Burris J. *et al. Nat Genet*. 1998} The report stated:

> *"Acquiring a map, a sequence, and an increased understanding of the human genome merits a special effort that should be organized and funded specifically for this purpose. Such a special effort in the next two decades will greatly enhance progress in human biology and medicine."*

The committee recommended building a series of genetic and physical maps of ever greater resolution and density until advances in DNA sequencing technology made the sequencing portion feasible. It even attached a price tag -- $200 million per year, in agreement with earlier $3 billion ballpark estimates – but made no recommendation whether the project should be run under the auspices of DOE or NIH.

Months before the NRC report was published, Watson had begun discussions with leaders on Capitol Hill. Accompanied by Nobel laureate David Baltimore and a lobbyist named Brady Metheny, Watson met with congressmen who had responsibility for setting the NIH budget. Those discussions helped facilitate start-up funds of $30 million for the NIH. In the fiscal year beginning October 1987, NIH spent $17 million, DOE $11 million. Wyngaarden chose Watson to lead the start-up program.

Two months after the release of the NRC report, the Congressional Office of Technology Assessment (OTA) held a hearing and released a report on ways to coordinate management of various genome initiatives. The chairperson of the hearing, Democratic congressman Ron Dryden, said: "The human genome holds seemingly infinite knowledge about the human body. Precise knowledge of the genome could create a remarkable biological tool." Dryden added: "The pre-eminence of this country in the life sciences is at stake."

Maynard Olson delivered important testimony about the benefits of the HGP lying not simply in the derivation of the sequence itself, but also in the "trickle-down" benefits of advanced technology and training. Similarly, Victor McKusick, the grandfather of medical genetics, predicted major benefits in cancer biology and diagnostics, which would yield "a new human anatomy." Watson drove the point home:

> *"We have at our disposal the ultimate tool for understanding ourselves at the molecular level and for fighting the genetic diseases that diminish the quality of so many of our lives. The time to act is now."*

In October 1988, Watson accepted Wyngaarden's invitation to become associate director of NIH, and head of the Office of Human Genome Research. "I would only once have the opportunity to let my scientific life encompass a path from double helix to the three billion steps of the human genome," he later reflected. {Cook-Deegan, R. *The Gene Wars* 1994} By this point, it was clear that the NIH and DOE would have a role in administering the genome project, but aside from a larger slice of the budget, Watson's fame and celebrity ensured that the NIH would be the de facto leader in the program.

Around that time, the NIH and the DOE to formalized an agreement by signing a Memorandum of Understanding to "coordinate research and technical activities related to the human genome." The following year, the budget for the genome effort grew to $59.5 million (fiscal year 1990), and the Office of Human Genome Research was renamed the National Center for Human Genome Research (NCHGR).

In April 1990, the DOE and NIH published the first 5-year framework for the HGP. The working group was co-chaired by UCSF's Sheldon Wolff (representing the DOE) and Rockefeller University's Norton Zinder for the NIH. The report, entitled *Understanding Our Genetic Inheritance*, discussed the strategy and funding needs to map the human genome and identify the location of "the estimated 100,000 genes." The two agencies "would continue their synergistic working relationship" and interact with other funding bodies. Among the first set of 5-year goals:

- Complete a genetic map with STS markers set 2-5 Centimorgans (cM) apart

- Build an STS physical map with markers spaced on average 100 kb apart
- Build a genetic map of the mouse genome
- Begin sequencing a total of 20 million bases in various model organisms to assist in sequencing technology development
- Develop software, algorithms and database tools for large-scale genome mapping

In addition, the plan called for investment in studying the ethical, legal and social (ELSI) ramifications of the HGP.

7.3 Sequencing Methods/Technology Development

7.3.1 DNA Sequencing

In the late 1970s, Fred Sanger (MRC, Cambridge UK) and Walter Gilbert (Harvard) and colleagues developed two methods for sequencing DNA.

Gilbert's method – developed along with Allan Maxam – was called the chemical method; it relied on four specific reactions to cleave DNA strands at the four respective nucleotides (Maxam, A.M. & Gilbert, W. *PNAS* 1977). Sanger, working with Alan Coulson, devised a technique known as the chain-termination or dideoxy method; it relied on using dideoxy nucleotide in low concentrations to block the extension of a newly synthesized DNA strand. The method was published in 1977, applied to the DNA of the smallest known virus, phiX174 (Sanger, F. *et al. PNAS* 1977).

In both the chemical and dideoxy methods, the radioactively labeled DNA fragments were separated by polyacrylamide gel electrophoresis and the sequence deduced by reading the pattern of bands on the resulting autoradiograph. For the first few years, there was little to choose between the two methods in terms of popularity. But the toxic nature of some of the chemical agents in the Maxam-Gilbert method and the reliability of Sanger's approach ensured the dideoxy method became the gold standard.

Gilbert, Sanger shared the 1980 Nobel Prize for Chemistry (along with Paul Berg). Sanger became just the fourth person to receive a second Nobel Prize.

7.3.1.1 Sequencing in Color

On June 12, 1986, Lloyd Smith, Lee Hood and colleagues at Caltech published a seminal paper in *Nature* describing an automated method for sequencing DNA using Fred Sanger's dideoxy chemistry. (Smith, L.M. *et al. Nature* 1986).

"This machine will automate many of the tasks involved in DNA sequencing now done laboriously by hand," Hood told the *Washington Post*. "It will allow researchers to analyze the structure of DNA molecules far more quickly and less expensively than ever before." {Mathews, J. *Washington Post* June 12, 1986} Hood predicted the $90,000 instruments would be purchased by every major medical laboratory and become the centerpiece of medical diagnostics.

The device relied on using fluorescent dyes (fluorophores), rather than radioactive nucleotides, to tag the four bases of DNA. The dye was incorporated into the oligonucleotide that primed the sequencing reaction. The reaction mixtures were electrophoresed together down a single polyacrylamide gel tube; the separated

fluorescent bands of DNA were detected at the bottom of the tube, where the dyes were activated by a laser. The DNA sequence information was fed directly into a computer.

The following year, J. Craig Venter, a neuroscientist at NIH, took delivery of one of the first Applied Biosystems automated DNA sequencer prototypes. Venter was eager to find a quicker route to isolating genes of significance in neuroscience. His group's early embrace of automated sequencing was to prove a key factor in Venter's non-profit endeavors in the 1990s.

7.3.2 Women in Sequencing

The role of women in the history of genomics and DNA sequencing cannot be overlooked. They include the following important figures:

- Jane Carlton, Professor of Biology and Director of the Center for Genomics and Systems Biology, New York University.
- Carol Churcher, former head of sequencing operations at the Wellcome Trust Sanger Institute.
- Helen Donis-Keller, studied under Walter Gilbert at Harvard; part of the group that created the first genetic linkage map of the human genome in 1987.
- Claire Fraser, former president and director of The Institute for Genomic Research.
- Kelly Frazer, director of UC San Diego Institute for Genomic Medicine; leading researcher in genomics.
- Stacey Gabriel, director of the Genomics Platform at the Broad Institute of MIT and Harvard.
- Jo Handelsman, Associate Director for Science at the White House Office of Science and Technology Policy; came up with the term "metagenomics."
- Jeannine Gocayne Illig, research assistant who got the first Applied Biosystems (ABI) sequencer working in J. Craig Venter's lab at NIH in 1987; helped scale up the sequencing operation there and then at TIGR; led the R&D group at Celera that developed and implemented all of the sample prep methods to enable up to 100,000 plasmid preps and 200,000 Sanger sequencing reactions per day; also optimized operation of the new ABI 3700 capillary sequencers.
- Mary-Claire King, of the University of Washington; identified BRCA1 gene responsible for inherited susceptibility to breast cancer.
- Lauren M. Linton, operations chief at the Whitehead Institute in the race for the first human sequence, concluding in 2000.
- Elaine R. Mardis, of the McDonnell Genome Center at Washington University, St. Louis; a leader in early cancer genomics.
- Donna Muzny, of the genome center at Baylor College of Medicine, Houston.
- Debbie Nickerson, professor of genome sciences at the University of Washington; leading genome researcher.
- Leena Peltonen, identified genes responsible for two dozen rare genetic diseases prevalent in Finland.
- Jane Rogers, formerly head of sequencing at the Wellcome Trust Sanger Institute at Hinxton, and later head of the Genome Analysis Center in Norwich; also was the author of the lead article of CSH Symposium on the human genome in 2003.
- Zhiping Weng, head of the computational consortium for ENCODE.
- Nancy Wexler, of the College of Physicians and Surgeons at Columbia University; located the gene responsible for Huntington's disease.
- Barbara Wold, of Caltech; specialist in genetics, genomics, and developmental biology; important researcher in high-throughput sequencing technologies.

7.4 Software/Database Development

Software/Database Development

The creation and deployment of software tools played a critical role in the evolution of the Human Genome Project (HGP). Indeed, software tools for physical mapping chromosomes were developed by investigators in the nematode genome project before the launch of the HGP.

A major advance came in 1990 when Eugene Myers (then at the University of Arizona), David Lipman and colleagues from the National Center for Biotechnology Information (NCBI) published a crucial algorithm called the Basic Local Alignment Search Tool (BLAST) for aligning DNA sequences. {Altschul, S.F. *et al. J. Mol. Biol*. 215, 403-10, 1990}. The article is one of the most cited and important in the history of bioinformatics. BLAST has become the most commonly used program for sequence similarity searches.

A year after the publication of BLAST, researchers at Oak Ridge National Laboratory led by Edward Uberbacher developed a leading gene-finding program called GRAIL (Uberbacher, E.C. & Mural, R.J. *Proc. Natl. Acad. Sci. USA* 88, 11261-5, 1991). In 1994, David Haussler at University of California, Santa Cruz, applied a hidden Markov model (HMM) for the first time to predict protein-coding gene locations in *Escherichia coli* (Krogh, A. *et al. Nucl. Acids Res.* 22, 4768-78, 1994). Many software tools have since been developed for the identification and predictive analysis of genes (Claverie, J-M. *Hum. Molec. Genet.* 6, 1735-44, 1997).

During the early 1990s, tools and strategies for genetic mapping also improved (see Kruglayk, L. *Nat. Rev. Genet.* Feb 2008). The classic Mendelian Inheritance in Man catalog of genetic traits was put online (OMIM), now managed by the NCBI.

Bermuda Principles

At the conclusion of the 1995 *Science* paper presenting the first bacterial genome sequence, Venter and colleagues made the following observation: “Finally, this strategy has the potential to facilitate the sequencing of the human genome.” The strategy in question was “shotgun sequencing," in which DNA fragments are reassembled by the computer without reliance on physical maps of the parent chromosome.

Shotgun sequencing

In February 1996, about 50 leading geneticists from NIH, DOE, Wellcome Trust and international groups met at the Princess Hotel in Hamilton, Bermuda, to discuss the public release of sequence data. (The meeting was funded by the Wellcome Trust, but organizers sought a "neutral" ground.) Scientists crafted the “Bermuda Principles," most importantly agreeing for free access to genome data within 24 hours of generation. One year later, the same group reconvened in Bermuda and established quality metrics for the genome sequence.

Myers and geneticist James Weber agreed. In 1997, the duo triggered a reappraisal of human genome mapping methods when they proposed that the “shotgun” method could be used to produce the assembly of the human genome, despite the daunting problems posed by repetitive DNA and the computational resources that would be required. Weber had presented this idea at the 1996 Bermuda conference, but the proposal received a cool reception by the genomics establishment.

Undeterred, Myers and Weber submitted their proposal to the major journals, *Nature* and *Science*, but were turned down. The article was accepted by *Genome Research* (Weber, J.L. & Myers, E.W. *Genome Res.* 7, 401-9, 1997) but with the proviso that a contrasting review be published. That was authored by Phil Green (University of Washington), who had served as one of the reviewers for the article, and was simply titled, “Against a whole-genome shotgun.” Green argued that Venter’s shotgun success in bacteria failed “to provide any confidence whatsoever that the same approach would work with the human genome.” He concluded: “There is no reason to switch.” (Green, P. *Genome Res.* 7, 410-7, 1997)

Myers joined Celera Genomics as head of Bioinformatics and developed an algorithm for de novo whole-genome shotgun assembly called the Celera Assembler. It was first described in the construction of the *Drosophila* genome sequence in early 2000 (Myers, E.W. *et al*. *Science* 287, 2196-2204, 2000).

Since the completion of the Human Genome Project, many de novo whole-genome shotgun assembly programs have been released, including Arachne, Phusion, and many others.

Quality Sequence

As Sanger sequencing moved to higher-throughput automated instrumentation, a software package developed by Phil Green and colleagues proved to be essential in the analysis of automated DNA sequencing data. The PHRED software package assigned a "quality score" to each nucleotide by assessing the probability that a call might be erroneous. The PHRED program allowed researchers to monitor the quality of the raw data emerging from a sequencing run and to determine whether two similar sequences truly overlap. (Ewing, B. *et al. Genome Res.* 8, 175-185, 1998). The PHRAP program systematically assembles the sequence data using quality scores assigned to each base. These scores are present in the assembly, which helps guides the finishing process. (Ewing, B. & Green, P. *Genome Res.* 8, 186-194, 1998).

Genome Databases and Browsers

Behind the scenes during the run-up to the White House declaration of the first draft of the human genome, researchers at the University of California, Santa Cruz, were working feverishly to complete the assembly of the draft sequence. The effort was led by Jim Kent, a graduate student in the lab of bioinformatician David Haussler. Kent worked for weeks to complete a computer program called GigAssembler, consisting of 10,000 lines of code. Haussler recalled Kent's efforts as follows:

"[Kent] literally worked night and day. I remember visiting him and he had to ice his wrists because he was coding so furiously! He wrote thousands of lines of code to assemble the DNA for the first draft of the genome… There were 13 different types of input that you had to solve this big constraint satisfaction problem for. Basically you had the cloned fragments, you had the genetic maps, you had the physical maps, you had RNA sequences to order and orient the fragments, all kinds of information about how the DNA should go together and much of it contradictory. You had to adjudicate those contradictions and deal with all of these different pieces of information to achieve a single assembly that made sense." {Gitschier, J. *PLOS Genet.* Jan 13, 2013).

Using a distributed network of 100 computers, Kent produced the first assembly of the draft genome sequence, four days before the White House pronouncement on June 26, 2000. Haussler says Kent had to ice his wrists at night because of the intense effort to finish the code. "Without Jim Kent, the assembly of the genome into 'the golden path' wouldn't have happened," said Francis Collins {Wade, N. *New York Times* 2001}. The UCSC team released the raw data on July 7, 2000, and Kent adapted an existing browser (INTRONERATOR) to unveil the UCSC Genome Browser a short time later. It remains a primary resource for genome annotation and analysis today.

Complementing the UCSC genome browser was the Ensembl project, launched in 1999 under the auspices of the European Bioinformatics Institute in Hinxton, UK. The goal was to provide an automatic annotation of the growing stream of genome data and provide researchers with online access to the draft human genome sequence. The Ensembl website debuted in July 2000.

Beyond the Genome

In the decade since the completion of the HGP, the importance of software tools, including cloud-based genome analysis platforms and pipelines, has grown even greater. Examples include:

- The Genome Analysis Toolkit (GATK) developed at the Broad Institute.
- Illumina developed the BaseSpace Sequence Hub for cloud-based next-generation sequence data analysis.
- Improvements in the development of de novo genome assembly programs such as ABySS, SOAPdenovo and Velvet (Salzberg, S.L. *et al. Genome Res.* 22, 557-567, 2012).
- The Exome Aggregation Consortium has compiled the ExAC Browser and database containing more than 60,000 human exomes (as of April 2016)
- ClinVar is a database that aggregates clinical sequence variant data.

A list of current genome analysis software providers can be found here.

7.5 Public vs Private: Human Genome Project 1998-2000

7.5.1 Venter's Venture

The trajectory of the HGP changed profoundly in May 1998. J. Craig Venter invited Francis Collins to meet him at Washington Dulles Airport. Venter informed Collins of his plans to launch a company dedicated to sequencing the human genome. The company (later named Celera Genomics) was a spin-out of Applied Biosystems (part of Perkin Elmer Corporation) and would provide a high-profile outlet for the sequencing instrumentation leader.

News of Venter's audacious venture was splashed on the front page of the *New York Times* in an exclusive story by Nicholas Wade on May 10, 1998. {Wade, N. 1998} Venter's plan was to employ the shotgun sequencing approach that had been used so effectively by his academic colleagues at TIGR in publishing the first microbial genome sequence in 1995. Venter's company would sequence the human genome in the space of 2-3 years for $150-200 million. Genome data would be housed in a comprehensive public database.

Venter and Perkin Elmer's chief executive, Tony White, pledged to cooperate with the HGP and argued that their effort necessitated more funding for genome research, not less. "We are trying to do this not with an in-your-face kind of attitude," Venter told the *Times*. Such a spirit of harmony, however, did not last long. Venter was later quoted as saying that the HGP should concentrate on the mouse genome.

The week after the *Times* story appeared, hundreds of genome scientists gathered at Cold Spring Harbor Laboratory for the prestigious annual *Biology of Genomes* conference. Debate focused on the likely quality and comprehensiveness of Venter's shotgun approach and the desirability of entrusting the genome sequence to a single commercial entity. The UK's leading biomedical charity, the Wellcome Trust, which funded Britain's flagship genome center – the Sanger Centre – sent a clear signal of its intentions by announcing it would double funding for genome sequencing. "To leave this to a private company, which has to make money, seems to me completely and utterly stupid," said Wellcome Trust program director Michael Morgan.

In June 1998, Venter and Collins testified in front of a U.S. House subcommittee on energy and environment, pledging cooperation. "The private and public genome sequencing efforts should not be seen as engaged in a race," said Collins. But University of Washington geneticist Maynard Olson testified that the Venter shotgun approach would "encounter catastrophic problems," leaving 100,000 gaps in the assembled sequence.

Collins, Ari Patrinos and colleagues outlined the new NIH/DOE 5-year plan in a commentary in October 1998 {Collins, F.S. *et al. Science* 1998}, with some aspects reported a month earlier by the *New York Times*. {Wade, N. *New York Times* 1998} Collins and colleagues declared that DNA sequencing would become "the project's central focus" during the subsequent five years. Against a backdrop of intensifying debate over the merits and rigor of Venter's shotgun strategy, they reiterated their commitment to producing a complete genome sequence:

> *"While partial subsets of the DNA sequence, such as expressed sequence tags (ESTs), have proven enormously valuable, experience with simpler organisms confirms that there can be no substitute for the complete genome sequence."*

But the timetable could now be moved up two years:

> *"Recent technological developments and experience with large-scale sequencing provide increasing confidence that it will be possible to complete an accurate, high-quality sequence of the human genome by the end of 2003, 2 years sooner than previously predicted. NIH and DOE*

> *expect to contribute 60 to 70% of this sequence, with the remainder coming from the effort at the Sanger Centre, funded by the Wellcome Trust, and other international partners."*

The plan's authors acknowledged that this was "a highly ambitious, even audacious goal, given that only about 6% of the human genome sequence has been completed so far. Sequence completion by the end of 2003 is a major challenge, but within reach and well worth the risks and effort."

That said, the public project had been galvanized by the Venter approach and felt it possible – if not necessary – to produce a draft sequence roughly on Venter's timetable, two years ahead of schedule. The revised plan called for the completion of one third of the finished genome sequence – 1 gigabase (Gb) – by the consortium by the end of 2001, focusing on gene-rich regions. This would be complemented by a draft sequence of 90% of the genome with at least 99% accuracy.

The new 5-year plan acknowledged the arrival of Venter's private effort to sequence the genome, stating: "The NIH and DOE welcome such initiatives and look forward to cooperating with all parties that can contribute to more rapid public availability of the human genome sequence."

Other items of note in the 5-year plan included the call to build a map of 100,000 single nucleotide polymorphisms (SNPs) at a density of 1 every 30,000 bases; and the completion of the genomes of two key model organisms, *Caenorhabditis elegans* (1998) and *Drosophila* (2002). The *C. elegans* genome sequence was indeed essentially completed by the end of 1998, and published in *Science*. {C. elegans Sequencing Consortium, *Science*, 1998} It was a triumph for the transatlantic partnership between the Sulston and Waterston labs, but with credit given to many other smaller contributing groups.

The nematode genome was 97 megabases, and contained more than 19,000 genes. "If we began again now, would we employ the same approach?" the authors asked rhetorically. "Almost certainly. The clone-based physical map was a critical factor in organizing the project between the two sites." There is no doubt that the worm project was an influential effort in technology, software and strategic development. But the authors admitted there were still gaps and imperfections: as such, "this publication marks more of a beginning than an end."

7.5.2 Come Fly With Me

Despite the demonstrable success of the physical mapping approach for model organisms such as the worm, Venter was intent and set out to prove the validity of the shotgun approach for a complex eukaryotic genome by collaborating with the community of academic scientists sequencing the genome of the fruit fly, *Drosophila melanogaster*. He extended that offer to UC Berkeley geneticist Gerry Rubin on May 12, 1998. As University of Cambridge geneticist Michael Ashburner later observed, "there was considerable skepticism in the community that [shotgun sequencing] would succeed for a large and complex genome with much repetitive DNA." {Ashburner & Bergman, 2005}

On October 4, 1999, Venter sent the *Drosophila* genome sequence to Celera's database subscribers.{Butler, D. 1999} The following month, dozens of *Drosophila* experts gathered at Celera for a two-week "annotation jamboree." This successful gathering was important, bringing together biologists, bioinformaticians and programmers to define the fly "parts list" and supply functional sequence annotation.{Ashburner & Bergman, 2005} Harvard geneticist William Gelbart called it "some of the most exciting science I've done in a long time." {Pennisi, E., 2000}

The first draft of the *Drosophila* genome was released on March 24, 2000, tied to the publication of papers in *Science* and the annual fly meeting in Pittsburgh. The article by Mark Adams and colleagues presented the sequence of most of the 120-megabase euchromatic portion of the *Drosophila* genome using a combination of Celera's shotgun sequencing strategy and more traditional clone-based sequencing, anchored by a physical map of bacterial artificial chromosomes. Although the sequence was not fully completed, it was sufficiently robust to support an initial inventory of some 13,600 genes.{Adams M.D. et al., 2000}

Michael Ashburner's *Won for All: How the Drosophila Genome was Sequenced*, tells the inside story of the controversial public-private partnership that led to the fly genome sequence.{Ashburner, M. 2005}

As 1999 came to a close, a large team led by scientists from the Sanger Centre published the sequence of chromosome 22 – the first human chromosome to be fully sequenced. It was the largest contiguous stretch of DNA sequenced to date, the analysis of which "gives a foretaste of the information that will be revealed from the remaining chromosomes." {Dunham, I. *et al. Nature* 1999} The sequence consisted of 34 megabases, 545 genes and 134 pseudogenes, leaving 11 small gaps that could not be bridged with available cloning vectors and technologies. The authors drew two central conclusions: 1) the physical map strategy formed the foundation for "the operationally complete genomic sequence of a chromosome" for the first time; and 2) the release of emerging sequence into the public database, as laid out in the Bermuda Principles, had facilitated research and contributed to several important publications in advance of the chromosome 22 article.

7.5.3 DNA Detente

Even as scientists celebrated the publication of the fruit fly genome and the unique collaboration that underpinned it, there were few signs of such cordiality among the two organizations sequencing the human genome. Representatives from both sides had met in December 1999 to discuss a possible collaboration, but there were significant disagreements on the right to make genome data publicly available and reusable without embargo and before publication. After two months of silence, Collins and Harold Varmus wrote to Venter in February 2000. Venter replied a week later, stating that Celera was still interested in some sort of collaboration with the international consortium.{Wade, N. 2000} At this point, Celera had a narrow lead in terms of the amount of the genome sequenced: it reported having sequenced 2.58 million bases in January, a threshold the HGP crossed a couple of months later.

On March 14, 2000, President Clinton and U.K. Prime Minister Tony Blair issued a joint statement that the sequence of the human genome should be made freely available. The declaration prompted a sizeable sell-off on the stock market, including many biotech and genomics stocks including Celera and rival companies such as Incyte Pharmaceuticals and Human Genome Sciences.{Berenson, A. & Wade, N. 2000}

On April 6, Venter testified before a Congressional committee that Celera had finished a first draft of the human genome and would begin assembling the sequences into a draft genome, a process that should take about 6 weeks. Venter's written testimony illustrated the lingering friction between the two groups. "Two years ago it was reported that Dr. Collins had said Celera would produce the *Mad* Magazine version of the human genome… From its formation, Celera's goal has been to produce a high-quality human genome sequence that will stand the test of time."

In May 2000, the sequence of the first and smallest human chromosome – chromosome 21 – was published in *Nature*, an impressive 15 days after acceptance.{Hatton, M. *et al.* 2000} The sequence -- produced by an international collaboration of American, European and Japanese researchers – was of high quality and largely complete, spanning some 33.5 million bases of euchromatin, with only an estimated 100 kilobases unsequenced. The gene catalogue was sparse, only 127 known genes and 98 predicted genes, indicating that the conventional wisdom on the number of human genes (frequently touted around 100,000) would have to be revised sharply lower.

7.5.4 The Golden Path

On June 26, 2000, President Bill Clinton hosted a ceremony in the East Room of the White House to formally announce the first draft of the Human Genome Project. Guests of honor were Francis Collins and Craig Venter: over the course of the preceding few weeks in secret meetings with the DOE's Ari Patrinos, Venter and Collins had agreed to a truce of sorts and participate in a joint announcement.

Nearly two centuries after President Thomas Jefferson had laid out the first map of the American continent in the presence of Meriwether Lewis, Clinton proudly remarked: "We are here to celebrate the completion of the first survey of the entire human genome. Without a doubt, this is the most important, most wondrous map ever produced by humankind."

The President continued:

> *"Today, we are learning the language in which God created life. We are gaining ever more awe for the complexity, the beauty, the wonder of God's most divine and sacred gift. With this profound new knowledge, humankind is on the verge of gaining immense, new power to heal. Genome science will have a real impact on all our lives -- and even more, on the lives of our children. It will revolutionize the diagnosis, prevention and treatment of most, if not all, human diseases."*

Clinton went out of his way to stress that biotechnology companies were essential in realizing the therapeutic potential of the HGP, but that did little to undo the unwitting damage caused by the patent announcement a few months earlier. He then welcomed British Prime Minister Tony Blair, participating via satellite from 10 Downing Street, where he was joined by Nobel laureates Fred Sanger and Max Perutz.

Blair paid tribute to the international cooperation underlying the HGP, with significant contributions from researchers in France, Germany, Japan and China, along with the British scientists who had contributed roughly 30% of the genome assembly. And he acknowledged the contribution of Celera and Craig Venter, "who in the best spirit of scientific competition, has helped accelerate today's achievement." {The White House, 2000}

Indeed, most commentators would agree that the creation of Celera hastened the completion of the first draft of the human genome. But not everybody: Sir John Sulston reflected that is "absolutely wrong." He continued: "All [the competition] did was to speed up getting this *fake* release of the draft sequence, which was 90% complete. It was a political deal. [2000] was an election year. The White House had really become unhappy about what was going on. It was a silly deal, but it meant peace."{Gitschier, J. *PLOS Genetics* 2006.}

The first draft that was celebrated in the June 2000 ceremony almost didn't happen: behind the scenes, bioinformaticians in both groups were scrambling to assemble a picture of the genome from the hundreds of thousands of sequences. On the public side, the unsung hero was Jim Kent, a graduate student in the lab of UC Santa Cruz researcher David Haussler, who worked tirelessly for 4 weeks to write a program called GigAssembler, consisting of 10,000 lines of code. Using a distributed network of 100 computers costing $250,000 that Haussler had acquired, Kent produced the first assembly of the draft genome sequence, just four days before the White House pronouncement. "He had to ice his wrists at night because of the fury with which he created this extraordinarily complex piece of code," Haussler recalled. Collins added: "Without Jim Kent, the assembly of the genome into "the golden path" wouldn't have happened." {Wade, N. *New York Times* 2001} For good measure, Kent also developed a genome web browser to view the sequence. The UCSC browser debuted on July 7, 2000, and remains a primary resource today.

7.6 Ethical, Legal, and Social Implications (ELSI) of Genome Research

7.6.1 The Origins of ELSI

James Watson's early commitment to dedicate Human Genome Project (HGP) funding to the investigation of social and ethical issues took many by surprise. He first proposed the idea at a press conference held in late September 1988 to announce his appointment as leader of the project, remarking that up to 3% of the project's budget should be designated for exploring issues related to the appropriate uses of genomic data and how to protect patients against discrimination. An article published in *Science* years later claimed that

Watson's remarks were unscripted and "off the cuff"—and by all accounts, they were made without advance consultation of his colleagues at NIH. Nevertheless, he continued to expand on this idea in subsequent talks and interviews. "You do not want a group of people labeled as genetically damned," he told the *New York Times* a few days later, adding that it must be made clear "that a person's DNA is his or her own property, not to be used without consent by government or employer."

The timing was fortuitous, as the US lacked a dedicated body for exploring bioethical concerns. The National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, which produced the seminal 'Belmont Report' on the protection of human research subjects, had dissolved in 1978. It was followed by the President's Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research, which tackled touchy subjects related to cutting-edge research, including a highly influential 1982 report on gene therapy entitled 'Splicing Life'. Unfortunately, the successors of this commission, the Biomedical Ethics Board and Biomedical Ethics Advisory Committee, became bogged down in acrimonious partisan bickering over abortion politics. The two groups dissolved in 1989; Robert Cook-Deegan, a clinician and former fellow at the US Office of Technology Assessment who served as acting executive director at the time, recalled in his book *The Gene Wars*: "As I heard the senators yelling at one another, I could vaguely sense my job disappearing and the nation's only national bioethics forum crumbling to dust."

For those taken aback to learn that the pragmatic and technocratic Watson had opted to tackle such issues head on, Cook-Deegan notes that Watson had a history of favoring such oversight. In the early 1970s, when Senator Walter Mondale was looking for backing from the scientific community for what would become the National Commission, Watson was one of the few prominent researchers who stepped forward to voice support. Others have viewed this as merely another form of pragmatism. According to policy analyst Kathi Hanna, Eric Juengst, who later led the HGP's ethics research program, described Watson's investment as an "unavoidable political tax" that he was willing to pay to gain political buy-in to the project.

Regardless of motive, the wheels turned quickly. At a January 1989 meeting, the Program Advisory Committee created what would come to be known as the Joint Working Group on Ethical, Legal and Social Implications (ELSI) of Human Genome Research, intended to coordinate the ELSI programs being respectively run by the National Institutes of Health (NIH) and the Department of Energy (DOE). The group was chaired by Nancy Wexler, a geneticist at Columbia University whose research had been instrumental in mapping the gene responsible for Huntington's disease. The Joint Working Group held its first meeting on 14 and 15 September, 1989, with members including Cook-Deegan and five others:

- Jonathan Beckwith (Harvard Medical School microbiologist)
- Patricia King (Georgetown University Law Center)
- Victor McKusick (Johns Hopkins medical geneticist)
- Robert Murray, Jr. (Howard University School of Medicine clinical researcher)
- Thomas H. Murray (Case Western Reserve University social psychologist)

That first meeting laid out the ELSI Working Group's mission. A report published the following January stated that the goal was to "anticipate and address the implications for individuals and society" and "examine the ethical, legal and social consequences" associated with the HGP, and to engage the public and develop appropriate policy options around these issues. To this end, the Working Group proposed a five-point plan:

- stimulate research on the issues through grants
- refine the research agenda through workshops, commissioned papers, and invited lectures on specific topics selected by the working group
- solicit public input from the community-at-large through town meetings and public testimony
- support the development of educational materials for all levels
- encourage international collaboration in this area.

Grants were administered by ELSI programs in both government agencies; NIH grants were overseen by bioethicist Eric Juengst, whereas the DOE grant program was managed by biologist Daniel Drell. Over the

course of the project, each project carved out its own subset of issues. According to the final report issued on the joint ELSI effort on 10 February 2000, NIH "focused primarily on clinical research and health care policy issues and on the education of health care providers, while DOE's program…primarily supported projects more broadly related to the privacy and fair use of personal genetic information in various settings and the education of the public, students and policymakers."

True to Watson's word, NIH funding for ELSI started at 3% of the budget allocated for the HGP. In 1993, when Congress established the National Center for Human Genome Research (NCHGR), this number climbed to 5%, where it remained (as specified by statute) for the duration of the project. According to Cook-Deegan, the DOE quickly came under pressure to match the NIH commitment. During a Congressional hearing in November 1989, Robert Wood, acting director of DOE's Office of Health and Environmental Research, found himself on the spot from Senator Albert Gore, Jr. after following Watson at the lectern:

"[Gore] asked if DOE had made a similar commitment of funds to study the ethical and social implications of the genome project… Wood began a reply to the effect that he believed that the NIH effort would address the necessary issues and that DOE was quite concerned about them. Gore responded by asking specifically whether DOE had made a commitment similar to NIH's. Wood said no, and Gore stepped up to the plate. He suggested quite strongly that they do so and noted that there would be future hearings on the genome project at which this issue would come up. Gore's position was reiterated by Senator John Kerry. It was as clear a congressional signal as can be made."

The DOE subsequently pledged to invest 3% of its HGP budget in the ELSI program, and continued to do so through 2000. Lori Andrews, a law professor at the Illinois Institute of Technology, assumed the leadership of the program after the conclusion of Wexler's tenure as chair in 1995, but resigned less than a year later over concerns about the oversight and autonomy of the working group. Amid considerable discord within the working group, and based on subsequent recommendations from an evaluation committee formed by the DOE and NIH, the NCHGR shifted oversight of ELSI programs to the ELSI Research, Planning and Evaluation Group (ERPEG), created in July 1997. Chaired by Georgetown University ethicist LeRoy Walters, ERPEG would administer NIH and DOE ELSI programs up until early 2000.

7.6.2 Accomplishments of the ELSI Program

Over the course of ten years, the joint ELSI program spent more than $76 million on various initiatives; the NIH supported more than 190 grants, educational programs and conferences during this period, while the DOE funded close to 100. The final report from ERPEG in February 2000 also noted that this investment "resulted in a combined total of approximately 625 peer reviewed journal articles, books, newsletters, web-sites, PBS series, radio broadcasts, museum exhibits, videos, and education curricula." These efforts were primarily focused in four major areas: privacy and fair use, clinical integration, genetic research, and education and resources.

7.6.2.1 Privacy and Fair Use

The majority of Americans are reliant on private insurance, and access to such coverage in the pre-Affordable Care Act era was jeopardized by the presence of a pre-existing medical condition. Some experts worried that disease risk factors uncovered by newly-available genetic tests, such as Alzheimer's or cancer predisposition, might put many more people in this boat. "If people are honest with insurers, they lose insurance or are not insurable," Wexler told the *New York Times* in 1990. This issue would become an early priority for the Joint Working Group, which established a Task Force on Genetic Information and Insurance in the spring of 1991, chaired by Beckwith and Murray. In addition to policy and ethics experts, this group also gathered input from representatives from patient advocacy groups and major insurers such as the Blue Cross Blue Shield Association.

In a final report published on 10 May 1993, the Task Force (predictably) advocated against denying coverage or care on the basis of genetic information and called for broad access to genetic diagnostics and coverage,

but also used the platform as an opportunity to call for universal healthcare coverage as a surer mechanism for preventing such discrimination. Equally predictably, insurers expressed concern over being compelled to cover people with an established likelihood of becoming seriously ill, and were therefore more likely to seek out insurance. Two major insurance organizations refused to endorse the final report, although Blue Cross Blue Shield did so.

The ELSI Working Group also tried to make its mark on the Americans with Disabilities Act (ADA), which had been signed into law in July 1990. In early 1991, the Equal Employment Opportunity Commission (EEOC) was collecting comments on its draft ADA-compliance regulations, and University of Houston Law Center attorney Mark Rothstein addressed the ELSI Working Group that April with serious concerns regarding the language. The group took these issues to heart, and worked its way up through the bureaucracy to persuade the co-chairs of the NIH-DOE Joint Subcommittee on the Human Genome to reach out directly to EEOC Chairman Evan Kemp. Their letter of 10 July 1991 asked that the EEOC regulations be revised to forbid genetic discrimination, prevent unnecessary medical screening of newly-hired employees and ensure confidentiality of employee medical records. Unfortunately, Kemp ignored the Subcommittee's recommendations—although the EEOC did eventually rule in 1995 that individuals with "genetic information relating to illness, disease or other disorders" classify as having a disability, and are therefore protected under ADA.

This arm of the ELSI program also funded several policy research efforts, perhaps most notably the 'Genetic Privacy Act', drafted in 1995 by Boston University law professor George Annas. This draft legislation, which established that "to effectively protect genetic privacy, unauthorized collection and analysis of individually identifiable DNA must be prohibited," never became federal law, although it did subsequently offer guidance for dozens of state-level genetic privacy laws.

7.6.2.2 Clinical Integration

The discovery of the gene associated with cystic fibrosis in the summer of 1989 offered a timely challenge for the ELSI program. The disease remains a dire prognosis today, but at the time was associated with a median life expectancy of 25 years—and geneticists suddenly found themselves with the ability to detect causative mutations in 70–75% of Caucasian carriers. This raised complex ethical issues; as a carrier test, parents would inevitably use the results to decide whether to carry a pregnancy to term. On the other hand, many causative mutations would slip the net in the first-generation test, making it a flawed tool for family planning. *Science* reported that this made the issue of pilot studies on how to conduct genetic screening a "hot potato" that nobody wanted to handle "in part because of political skittishness over abortion."

The ELSI Joint Working Group was able to help break the logjam. After a series of meetings with cystic fibrosis (CF) experts in 1990, Wexler lobbied the genome advisory committee to make these pilot studies a priority. Although initially reluctant, the importance of CF won them over, and Juengst and NCHGR Deputy Director Elke Jordan subsequently persuaded acting NIH director William Raub to put out a request for applications (RFA) to conduct pilot studies on genetic screening. In a letter to the Joint Working Group, Wexler commented that although "it is not typical for the NIH to sponsor clinical research protocols on the introduction of new tests… these are not typical times." NIH subsequently awarded eight grants in this area in September 1991. This effort culminated in April 1997 with a NIH Consensus Development Conference on 'Genetic Testing for Cystic Fibrosis', which concluded that:

> *"Genetic testing for CF should be offered to adults with a positive family history of CF, to partners of people with CF, to couples currently planning a pregnancy, and to couples seeking prenatal testing. The panel does not recommend offering CF genetic testing to the general population or newborn infants… Additionally, genetic counseling services must be accurate and provide balanced information to afford individuals the opportunity to make autonomous decisions."*

The success of the CF initiative would spur NIH to follow-up with a second RFA in September 1994, targeting another emerging challenge in genetic diagnostics: cancer. At the time, researchers were making progress in identifying cancer-causing genes that had previously only been abstract points of interest on the

chromosomal map. For example, the cloning of *BRCA1* in October of that year by Myriad Genetics would finally enable the direct detection of predisposing mutations for breast or ovarian cancer. Such results could potentially be devastating, and many were concerned that screening would be made commercially available without consideration of the psychological impact, or even a deep understanding of how to interpret the data. In early 1995, Francis Collins told the *New York Times* that he found the proliferation of such tests "alarming" and added that "unanimously, the professional genetics community… [has] stated that these tests should not now be made available." In late 1994, the NIH issued 11 grants to explore how genetic screening for cancer risk factors should be deployed, including issues related to education, informed consent and patient counseling. The funded efforts would subsequently give rise to the Cancer Genetic Screening Consortium, which published two influential sets of recommendations based on their findings—one on screening for breast and ovarian cancer, and the other for colon cancer—exploring the clinical utility of genetic testing and delineating how cancer surveillance should be implemented in the case of a known high-risk mutation.

7.6.2.3 Genetic Research

The growth of clinical genetic testing was fueled by a parallel boom in family-based genetic studies designed to home in on genetic factors associated with heritable diseases. Although the Belmont Report had delineated core principles of informed consent for human subjects, these 'pedigree' studies created new challenges—for example, understanding how subjects would handle news that they or a loved one was at increased future risk of an untreatable disorder. The Working Group was keen to ensure that participants in genomic research are made fully aware of which information is being collected and for what purpose, and that such data is used responsibly.

They took an early step in this direction with a workshop on genetic family studies in October 1992, jointly held by the NCHGR and Office of Protection from Research Risks (OPRR). Those discussions were subsequently developed into a chapter on "Protecting Human Research Subjects" in the 1993 Institutional Review Board Guidebook, a reference manual produced by the federal government to inform ethical conduct of biomedical research. These guidelines specified best practices for each step of human genetic studies, from initial recruitment and counseling to data protection and sample handling.

'Biobanked' samples, such as tumor biopsies, can also be a rich source of scientific data—but what if consent was obtained long before genetic analysis was even a possibility? The Centers for Disease Control and Prevention (CDC) were grappling with this question in 1994, and University of Iowa bioethicist Robert Weir notes that the agency was reluctant to make use of its "national treasure chest" of biological samples for reasons including:

> *"… whether the CDC scientists had adequately informed the sample population regarding the planned storage and scientific uses of their blood samples; whether the persons in the study population had understood themselves to be consenting to long-term research on their banked blood samples; and whether the CDC would need to get additional, more specific consent (at an estimated cost of $2 million) from these persons before carrying out the planned research with the stored samples."*

That July, CDC and the NCHGR ELSI program held a "Workshop on Informed Consent for Genetics Research Using Stored Tissue Samples", chaired by Vanderbilt University law professor Ellen Wright Clayton. Their views, published in the *Journal of the American Medical Association* in 1995, were not universally well-received—ERPEG's final report noted that "these recommendations were initially considered controversial and criticized as overly restrictive" but also added that they "are now becoming the standard by which informed consent for stored tissue research is obtained, and the publication is one of the most often cited ELSI products."

The dispute over whether gene sequences should be patentable was not a primary focus of the Working Group, although DOE did fund University of Michigan researcher Rebecca Eisenberg's investigations into this then-emerging controversy. Her research program, 'Private Appropriation, Public Dissemination, and Commercial Product Development in Genomics,' generated several prominent publications between 1995 and 2003, including a highly-cited 1998 *Science* article that foresaw a potential "tragedy of the anticommons"

with regard to patented genetic data, in which “multiple owners each have a right to exclude others from a scarce resource and no one has an effective privilege of use.”

This issue became a serious point of political contention within the HGP; in late 1991, the NIH began pursuing patents on hundreds of gene sequences (expressed sequence tags, ESTs) cloned by Craig Venter while he was at the National Institute for Neurological Diseases and Stroke. The news provoked outrage, and in January 1992 the HGP Advisory Committee issued a statement of concern, noting that these patents were ill-defined from a biological perspective and would “create undesirable distortions in the conduct of basic biomedical science.” James Watson was particularly infuriated—with characteristic restraint, he declared that the policy was “sheer lunacy”. This issue—alongside other conflicts with NIH head Bernadine Healy—played a major role in his decision to step down from the HGP leadership in April 1992.

7.6.2.4 Education and Resources

The HGP struggled to emerge from the shadow of the eugenics era and fears that genetic findings might be used to justify discrimination and other abuses—indeed, the ill-healed scars of Nazism would stall German genomic research until well into the 1990s. In a letter to *Science* in November 1989, Nobel-winning microbiologist Salvador Luria took the journal to task for downplaying these risks of the program, writing that “the real danger today is the possible emergence of an establishment program to invade the rights and privacy of individuals, whether in the area of sexual preference, or right to abortion, or drug addiction, under cover of beneficient eugenic intervention.” Watson acknowledged these concerns a few months later in the same journal.

Accordingly, the ELSI program engaged in numerous outreach programs to familiarize the public with the goals and priorities of the HGP, and to tackle head-on some of the moral dilemmas involved in conducting this sort of research. This included formulating genomics curricula for high school and college students, and training programs to prepare teachers on how to most effectively explore the issues surrounding this new field in the classroom. One product of this effort was a series of materials developed for the Biological Sciences Curriculum Study, a nonprofit organization committed to life sciences education, and the final ERPEG report notes that these were subsequently disseminated to more than 30,000 US teachers. The DOE and NIH programs also backed the development of a number of public radio and television programs targeted at the general public.

Judges, police and lawyers were also finding themselves compelled to bone up on human genetics after a 1988 trial in Albany, New York saw the first use of ‘DNA fingerprinting’ to secure a murder conviction. Although challenged on appeal, the use of DNA evidence was upheld and subsequently became a viable legal tool in other US states. An initiative funded by DOE, the Genetics Adjudication Resource Project (GARP), was designed to bring genetics and ELSI education into American courthouses, and ERPEG reported that by 2000, GARP had assembled a formidable collection of relevant legal resources as a reference for the judicial community and provided direct training to more than 1,200 judges.

Many minorities remained deeply mistrustful of the scientific community’s intentions—perhaps understandably, given that the horrifying revelations about the Tuskegee syphilis experiments conducted on unsuspecting African-American men had only come to light a few decades earlier. Accordingly, the ELSI program conducted numerous outreach efforts to Hispanic, Native American and African-American communities, including a 1996 meeting held at Tuskegee University entitled ‘Plain Talk about the Human Genome Project.’ This event gave students from historically black colleges and universities an opportunity to interact with leading geneticists and ethicists, including Working Group member Patricia King. King focused on two major issues in particular:

> *“The first is whether everyone will share in the expected health benefits, or just those who can afford genetic testing and possible medical intervention. Second is the real danger that simple genetic explanations will be given for human characteristics that actually involve complex social, cultural, and environmental influences.”*

The HGP grappled with this latter issue on other occasions, including when Charles Murray and Richard Herrnstein’s book *The Bell Curve* became a best-seller in 1994. The book infamously claimed that biological

differences underpinned the differences in 'success' and 'failure' among different populations. The ELSI Joint Working Group lashed out at the authors in a statement published in the *Journal of Medical Ethics*, noting that "neither Herrnstein nor Murray are geneticists, nor have they carried out studies themselves on the genetic basis of behavior" and that "simplistic claims about the inheritance of such a complex trait as cognitive ability are unjustifiable; moreover, as the history of eugenics shows, they are dangerous."

7.6.3 Questions and controversies

The ELSI program was continually dogged by concerns that it was an engine for generating publications rather than progress. In 2008, former DOE ELSI program coordinator Michael Yesley wrote that "ELSI has produced a large portfolio of academic and professional literature, but little impact on public policymaking." He—along with other critics—noted that although the program's primary orientation towards grant-making gave it flexibility, it also lacked structure and focus, "with no commission or other independent entity to determine what policy research should be conducted or what to do with the research results."

The group tackled numerous issues related to the collection and implementation of genetic data, but many scientific controversies related to the rapidly evolving field of molecular genetics would go unaddressed. Some such omissions were deliberate; the final report from ERPEG noted that ELSI programs should "should not at this time pursue the study of broader topics such as human cloning or stem-cell research." These would instead fall under the purview of the National Bioethics Advisory Commission (NBAC), formed by the Clinton administration in 1996. For example, following the 1997 announcement that Scottish scientist Ian Wilmut and colleagues had generated the first mammalian clone, Dolly the sheep, President Clinton hastily called on the NBAC to explore the ramifications of these new technological capabilities and the broader social and ethical issues surrounding human cloning. However, the ELSI program also expended relatively little effort on other relevant and important issues, including the pressing issue of gene patenting and other aspects of scientific commercialization, like researcher conflicts of interest. A 1995 critique of the program noted that:

> *"According to several members of the Working Group, these issues were "missed" for a variety of reasons, including lack of diversity in the Working Group. Another prominent reason, according to Working Group member Robert Cook-Deegan, is that the group operated on the premise that issues related to commercialization… were being handled by other staff within NCHGR."*

Although the members of the NCHGR ELSI program were not NIH personnel, the group was nevertheless under the authority of the NIH and HGP leadership, and this lack of true independence would be seen as a constraint on the ELSI program's freedom to operate and set its own agenda. In a 1996 essay, Juengst asked, "How 'objective' can ELSI grantees be about any issue that bears on genome research, when the funding is provided by the genome research community on the assumption that genome research is a good to be protected?"

ELSI often had an uneasy relationship with the rest of the HGP. Beckwith—a geneticist himself—described an attitude of "hostility" from the project's genome scientists[ME1], and Juengst recalled a senior NIH official complaining "I still don't understand why you want to spend all this money subsidizing the vacuous pronunciamentos [sic] of self-styled ethicists." Watson's tenure was generally viewed as a time of "hands-off" oversight. According to Beckwith, he attended only a handful of meetings, and made no attempt to limit funding or set the agenda[ME2]. After Collins took the reins in 1993, however, some ELSI program members noticed a distinct change. Lori Andrews, who headed the Working Group in 1995 and 1996, wrote in her memoir that[ME3] :

> *"As the months passed, I noticed a disturbing trend. The ELSI Working Group was given no budget of its own; instead we had to ask Collins and his staff for funding. Every time we planned an activity that might lead to more people getting genetic tests or participating in genetic research – such as protecting genetic privacy – we were given a blank check. But each time we planned an activity that called into question the power of genetic testing… we were told that the Genome Center didn't have enough money to fund it."*

The mid-1990s saw multiple clashes with the HGP leadership. In 1996, NCHGR cut the budget for ELSI and authorized only one annual meeting as opposed to the three or four that had occurred in previous years. Shortly after, Andrews resigned from her leadership role over a perceived lack of autonomy for the working group and the tight purse-strings of her group's parent agency. Specifically, she cited NCHGR's decision to deny $20,000 in funding for an anthology on "non-medical uses of genetic information." According to *Nature*, working group member Troy Duster claimed that the anthology "may have been squashed partly because of concern among geneticists working on behavioral issues that the working group would put together a general attack on their area of research." Another working group member, Dorothy Nelkin, subsequently told the journal that more generally, "members feel they are sometimes being used to legitimate the project." Collins disputed these allegations, but defended limiting the Working Group's autonomy "because it is not a free-standing commission."

Conversely, many scientists at NCHGR had become impatient with what they perceived as the limited impact of the ELSI group. "It was not long," says Juengst, "before the action-oriented folk in ELSI's audience – the engineers, clinicians and activists – began to complain that the program just looked like a welfare program for underemployed philosophers." Just a few years into its existence, the ELSI Working Group's activities was already being described as a steady procession of meetings "where often the same cast of characters debate the same issues," and Collins would remark to *Science* that "[it] is time to move on and produce some general policy recommendations."

Given the nature of the Joint Working Group, such criticisms are perhaps unfair—after all, the group was designed to operate as a think-tank and funding organization. In 1996, Thomas Murray, who had coordinated the investigation of genetic discrimination issues in health insurance, told *The Scientist*, "We were an *ad hoc* task force of a working group of an advisory committee of a center of NIH… we were not a group that had the authority to dictate national policy." The article draws a contrast with the newly-formed Task Force on Genetic Testing, Privacy and Public Policy at the Whitehead Institute, which met directly with legislators on several occasions to discuss challenges related to bioethics. Cook-Deegan likewise indicated [ME4] that the working group's limited influence was essentially embedded in its DNA:

> *"[Our] lack of clout was not due to the competence or intentions of NIH or DOE officials. It was an intrinsic structural problem. While ample staffing and institutional support might increase the working group's stature, nothing could substitute for a congressional charge."*

Under Collins' direction, NIH launched an independent review of the ELSI Program in 1996, headed by Rothstein and M. Anne Spence. Their final report concluded that "[the] charge of the ELSI Working Group is so broad and complex as to be confusing to various participants and observers." This led to the re-structuring of the Joint Working Group as ERPEG, which was established in late 1997 and conducted strategic planning and oversight of extramural funding of ELSI projects for the HGP until 2000.

[ME1]'Making Genes, Making Waves', p200

[ME2]'Making Genes, Making Waves', p193

[ME3]'The Clone Age', p195

[ME4]'Gene Wars', p. 275

7.6.4 Legacy of the ELSI program

Regardless of whether the ELSI program directly transformed the legal landscape with regard to bioethical issues, it nevertheless established a clear track record of stimulating provocative and influential discussions about those issues. In 1996, biomedical ethicist Jeff Botkin noted that the program "helped spawn university and corporate programs partly by raising the profile of the issues in general and by helping foster expertise from which companies can draw." As demonstrated above, these efforts helped build a foundation for longer-term policy change on many occasions—for example, legal protections for genetic privacy or against workplace discrimination, or establishing best practices for genetic screening. Juengst likewise dismissed critiques of the Working Group's limited power:

> *"To communicate public policy options, it can digest research into "reader-friendly" reports (like the Insurance Task Force Report), convey them freely to other government entities (like the White House Task Force or the EEOC), and use all of Washington's usual informal 'mechanisms' (like personal contact) to get the attention of policymakers. To embarrass industry, it can make statements to the press… From the evidence, in fact, it appears that ELSI's repertoire of 'policy mechanisms' is as robust as anybody else's inside the beltway. Certainly, for a program primarily designed to support academic research, ELSI has had a particularly active track record in the 'policy arena'."*

It is also important to note that at least one federal law can trace its roots back to the ELSI program: the Genetic Information Nondiscrimination Act (GINA), which was finally signed into law after 13 years of protracted discussion and debate in Congress. GINA provides important protections against the misuse of genetic information by employers or insurers—a belated but important triumph for the ELSI program's efforts at privacy protection.

Today, NHGRI continues to allot considerable funding to its ELSI Research Program, with a fixed allocation of no less than 5% of the institute's budget. As before, its manifest is to fund research and conferences, with a primary focus on topics related to genomic research, genomic health care, broader societal issues, and legal, regulatory and public policy issues. Over the years, the program's efforts have included the establishment of more than a dozen Centers of Excellence in ELSI Research (CEER) at universities across the country. These center have strived to "design and implement multi-faceted and multi-disciplinary investigations of particularly complex, persistent or rapidly emerging ELSI issues" and "promote intensive and sustainable interactions among basic genomic and genetic scientists, clinical and social scientists, and researchers from law, bioethics and the humanities."

Even today, demonstrating direct impact from these programs remains challenging—in a 2014 assessment, the ELSI Research Program's leadership acknowledged that "the most consequential impact of ELSI research has come about in… more subtle ways." But the message is being heard. For example, CEER researchers have given testimony to the Presidential Commission for the Study of Bioethical Issues on returning unexpected (but medically meaningful) "incidental" findings from clinical genetic testing, and engaged with the US Patent and Trademark Office on the validation of genetic diagnostic tests. A recent article from several long-time veterans of the field – including Juengst and Wylie Burke – notes that such efforts represent important progress as ELSI evolves from a discipline of abstract academic exploration to something more immediate and socially relevant: "Just as basic genomic scientists are encouraged to pursue 'translational' research that enables the creation of medically useful tools, ELSI researchers have a 'translational' mandate to pursue studies that assist in managing practical policy problems involving human genomics."

7.7 Evaluation of the HGP

7.7.1 2001 and Beyond

In February 2001, the first drafts of the human genome were published the same week in *Nature* and *Science* magazines. The International Genome Sequencing Consortium published its article in *Nature* {International Human Genome Sequencing Consortium, *Nature*, 2001}, having earlier considered publishing alongside Celera in *Science*.

"I've seen a lot of exciting biology over the past 40 years," wrote Nobel laureate David Baltimore in an accompanying News & Views article to the public genome article. "But chills still ran down my spine when I first read the paper that describes the outline of our genome." {Baltimore, D. *Nature* 2001} The report met the guidelines of the 5-year plan, with about 1 Gigabase of sequence in final, "finished" form.

With a passing nod to Crick and Watson, Lander wrote: "The sequence of the human genome is of interest in several respects." The article continued:

> *"It is the largest genome to be extensively sequenced so far, being 25 times as large as any previously sequenced genome and eight times as large as the sum of all such genomes. It is the first vertebrate genome to be extensively sequenced. And, uniquely, it is the genome of our own species."*

The Celera genome assembly, published in *Science*, was notable in part because Venter, Myers and colleagues elected to incorporate the publicly available sequence. {Venter, J.C. *et al. Science* 2001} This was entirely their right, but left open the question of whether the shotgun strategy would be sufficient to produce a quality genome sequence. Celera began sequencing the human genome on September 8, 1999. The DNA of five anonymous volunteers was selected for the Celera sequence – one of those volunteers, it later emerged, was Venter himself. Celera sequenced DNA for nine months, generating 14.8 billion bases from libraries with 2-, 10- and 50-kb inserts of sequence from more than 27 million reads. Average coverage of the genome was 5.11x, to which was added publicly available data, for an overall coverage of 8-fold.

The assembly algorithm reported in the *Science* article was not a full shotgun method, but an adapted method called compartmentalized shotgun assembly (CSA), in which sequence data were partitioned into the largest chromosomal subsets possible, reducing the computational load.

In April 2003, the NIH issued a press release declaring the completion of the Human Genome Project. Collins said the project had been completed "ahead of schedule and under budget." The release was timed not for a formal scientific publication, but to mark the golden anniversary of the 1953 publication of the classic double helix discovery by Crick and Watson in *Nature* (NHGRI press release, 2003). The "finished" assembly of the human genome was published in 2004, consisting of some 2.85 billion bases covering approximately 99 percent of the euchromatic genome (International Human Genome Sequencing Consortium, *Nature* 2004).

Despite the NIH's desire to mark the HGP as essentially complete, the participants continued to lay out their respective contributions. In 2003, a ping-pong debate played out in the pages of the *Proceedings of the National Academy of Sciences*, with the first salvo fired by John Sulston, Bob Waterston and Eric Lander, who questioned whether Celera had achieved a fully independent genome assembly. Celera countered that it had shredded the public data (to which they were fully entitled) and had not used positional information in building their own assembly. The exchange continued for two rounds (see Cozzarelli, N. *PNAS* 2001 and references therein).

7.7.1.1 Beyond the Genome Project

In many respects, the HGP is just the launching pad for a detailed analysis of human genome structure and function. In the years since the completion of the HGP, many other large-scale international projects have provided a wealth of information on the structure and function of the human genome.

A directory of human genetic variation began before the HGP concluded and continued with the International HapMap Project. Launched in October 2002 as a true public-private partnership, scientists compiled a rich catalogue of single nucleotide polymorphisms (SNPs), which can be accessed in databases such as dbSNP. A second-generation map with more than 3 million SNPs was published in 2007 (International HapMap Consortium, *Nature* 2007). By the end of 2015, more than 32 million SNPs had been submitted to dbSNP (Build 146).

Another important aspect of human genome variation that was poorly appreciated during the HGP burst into light in 2004 with two papers that revealed a surprising degree of individual genome variation (Sebat, J. *et al. Science* 2004; Iafrate, A.J. *et al. Nat. Genet.* 2004). Copy Number Variants (CNVs) are DNA segments of varying size that can differ in copy number between individuals – from a few hundred bases to hundreds of thousands of bases. In combination, these duplications and deletions of sizeable tracts of DNA contribute to a much greater level of genetic variation than SNPs alone. Approximately 5-10% of the human genome contributes to CNV, while several studies have reported 100 or more genes that can have both copies deleted without apparent effects on human phenotype.

A major international collaboration – the ENCODE (Encyclopedia of DNA Elements) project – has sought to provide detailed analysis of the functional elements of the human genome. Following a pilot project that examined 1% of the genome sequence, In 2012, the consortium published 30 papers, featuring hundreds of authors from dozens of institutions worldwide. (The cost of teleconferencing was put at about $75,000.) The main paper was published in *Nature* (ENCODE Project Consortium, *Nature* 2012). The chief conclusion of this enormous project was that about 80% of the human genome – including large amounts of non-coding DNA – was deemed to have some function, such that biochemical activities or functions could be assigned to this proportion of the genome. That includes non-coding RNA, histone modifications, DNaseI hypersensitive sites, transcription factor activity and motifs, and of course exons (coding regions). (Birney, E. 2012)

On the 10th anniversary of the original HGP publications, *Nature* invited Eric Lander to pen a commentary on the lessons learned in the subsequent decade. Lander wrote:

> *The human genome has had a certain tendency to incite passion and excess: from early jeremiads that the HGP would strangle research by consuming the NIH budget (it never rose to more than 1.5%); to frenzied coverage of a late-breaking genome race between public and private protagonists; to a White House announcement of the draft human sequence in June 2000, 8 months before scientific papers had actually been written, peer-reviewed and published; to breathless promises from Wall Street and the press about the imminence of genetic 'crystal balls' and genome-based panaceas; to a front-page news story on the tenth anniversary of the announcement that chided genome scientists for not yet having cured most diseases.*

Lander's review is a suitable place to start to contemplate the progress made and future opportunities in areas including simple and complex genetic disorders, genome physiology and variation, cancer and human history (Lander, E.S. *Nature* 2011).

7.7.1.2 Sequencing: The Next Generation

In the autumn of 2001, NHGRI convened a scientific retreat at the Airlie House in Virginia for dozens of genome leaders to discuss future research priorities following the completion of the first draft of the sequence. It was here that scientists first used and discussed the term "the $1,000 genome," noting the urgency with which new sequencing technologies were needed to build upon the reference genome.

Early in 2002, Venter quit Celera to return to academic life at the non-profit institute that he had established. Celera was repositioning itself as a biotech firm more involved in proteomics and drug discovery than genomic analysis. Months later, in September 2002, at the annual GSAC conference in Boston, Venter and Gerry Rubin chaired an opening session showcasing new DNA sequencing technologies that could lead to the $1,000 genome. Six presenters, including George Church and representatives from U.S. Genomics, Amersham, 454 Life Sciences and a British start-up called Solexa, presented various technologies that could supersede Sanger sequencing.

In February 2005, scientists at Solexa in Cambridge, UK, quietly celebrated the completion of its first viral genome sequence (PhiX174) using the reversible terminator chemistry developed by company co-founders Shankar Balasubramanian and David Klenerman (University of Cambridge). The work was not published as the company elected to focus on the commercial development of its sequencing technology. That summer, Jonathan Rothberg and colleagues at 454 Life Sciences published a landmark article in *Nature* describing the first commercial next-generation sequencing instrument, which used a pyrosequencing platform to achieve a sequencing throughput of 25 million bases in a 4-hour run (Margulies, M. *et al. Nature* 2005).

In early 2007, Illumina bought Solexa, which had previously merged with Lynx, thereby acquiring the core of its next-gen sequencing platform. The $650 million price tag has proven to be a bargain: the Solexa sequencing system, which still underpins the company's sequencing fleet today, has emerged as the market leader, outperforming or outlasting many competitors.

In May 2007, James Watson received his personal genome on a portable hard drive from Jonathan Rothberg, founder of 454 Life Sciences. The ceremony was held in Houston, where Baylor College of Medicine scientists led by Richard Gibbs, James Lupski and David Wheeler helped Watson interpret his personal genome. The results were published 12 months later (Wheeler, D.A. *et al. Nature* 2008), but not before Craig Venter and colleagues published the first report of a personal genome sequence – Venter himself -- building on the sequencing efforts initiated at Celera almost a decade earlier (Levy, S. *et al. PLOS Biol.* 2007).

Meanwhile, two important areas of human genome analysis took major steps forward. Analysis of common diseases reached a tipping point, when scientists at the Wellcome Trust Sanger Institute published a landmark GWAS (genome-wide association study) in *Nature* identifying a group of DNA variants associated with seven common diseases. The study validated the GWAS approach as a powerful method to pinpoint susceptibility genes for complex traits, limited primarily by the density of markers and the number of patients in the study (Wellcome Trust Case Control Consortium, *Nature* 2007).

2007 also marked the dawn of the consumer genetics era: In November, California's 23andMe and Iceland's deCODE Genetics launched the first consumer genomics services, offering clients a personal whole-genome genotype providing insights into genetic traits, disease risks and ancestry (Wade, N. *New York Times* 2007). In a similar vein, George Church (Harvard Medical School) launched the Personal Genome Project, in which volunteers agreed to release their complete genome data and medical records. The first ten high-profile volunteers included Church, Harvard professor Steven Pinker, Duke University professor and author Misha Angrist, and Stan Lapidus, founder of Helicos Biosciences.

At the end of 2008, Illumina signaled its emergence as the leading next-gen sequencing technology with the publication of three back-to-back genomes in *Nature*, all performed using Illumina/Solexa instruments. These were the first reported genomes of Asian (Wang, J. *et al. Nature* 2008) and African (Bentley, D.R. *et al. Nature* 2008) descent, plus the first cancer genome (Ley, T.J. *et al. Nature* 2008).

Several start-ups launched alternative sequencing technologies, including two featuring single-molecule approaches. Following an early proof-of-principle in 2003, Steve Quake (Stanford University) co-founded Helicos Biosciences and published a paper claiming to sequence his personal genome for $50,000 (Pushkarev, D. *et al. Nat Biotech.* 2009). Meanwhile, Pacific Biosciences introduced the first commercial single-molecule sequencing technology using single-mode wave guides, based on nanotechnology developed at Cornell University (Eid, J. *et al. Science* 2009). Pacific Biosciences' SMRT sequencing features long read lengths (tens of kilobases) suitable for de novo assembly, and has the potential to detect epigenetic DNA modifications.

In January 2014, Illumina CEO Jay Flatley unveiled the company's new sequencing instrument, the HiSeq-X 10, which he claimed could deliver – at last – the $1,000 human genome. The HiSeq-X 10 (actually a cluster of ten instruments) is the mainstay of most public and private sequencing centers. Among the organizations queuing up to install the HiSeq-X 10 was Craig Venter's new company, Human Longevity, which aims to discover genes for longevity and wellness by conducting high-throughput sequencing. Venter vows to sequence 1 million human genomes by 2020.

7.7.1.3 Into the Clinic

The first detailed clinical interpretation of a complete genome sequence was published by Euan Ashley and colleagues at Stanford in 2010. The subject was their colleague Steven Quake ("patient zero") (Ashley, E. *et al. Lancet* 2010). Howard Jacob's team at the Medical College of Wisconsin, collaborating with 454, sequenced the exome of a young severely ill Wisconsin patient named Nicholas Volker, identifying a rare X-linked trait that provisionally ended the boy's "diagnostic odyssey" and resulted in a successful treatment (Worthey, E. *et al. Genet. Med.* 2011). Volker became something of a poster child for clinical genome sequencing and was featured in a Pulitzer Prize-winning series in the *Milwaukee Journal Sentinel* by Mark Johnson and Kathleen Gallagher.

Many more diagnostic odyssey stories were reported including Jim Lupski's dissection of his own family history with Charcot-Marie-Tooth disorder (Lupski, J.R. *et al. New Engl. J. Med.* 2010). An extreme example of a full omic profile of an individual, including genomic and RNA profiling with medical implications, was reported by Stanford's Mike Snyder (Chen, R. *et al. Cell* 2012). Eric Topol hailed the study as "a landmark for personalized medicine."

Baylor College of Medicine physicians published their initial results and observations on the clinical sequencing of 250 undiagnosed patients in the *New England Journal Medicine*. Positive diagnoses were made in about 1 in 4 cases (Yang, Y. *et al. New Engl. J. Med.* 2013). Other medical centers such as UCLA are rapidly adopting similar workflows (Lee, H. *et al. JAMA* 2014).

The Exome Aggregation Consortium (ExAC), led by Daniel MacArthur (Massachusetts General Hospital) has compiled, analyzed and made publicly available more than 60,000 exomes (Exome Aggregation Consortium, BioRxiv, 2016). The repository has been accessed millions of times since its launch in 2014 and, according to the investigators, "has become the default reference data set for many clinical diagnostic labs."

It is widely assumed that databases of anonymous DNA data preserve genetic privacy, but that is not necessarily the case. Yaniv Erlich, then at the Whitehead Institute, gave new meaning to genome hacking by using genotypic and surname data to identify presumed "anonymous" individuals in public DNA databases (Gymrek, M. *et al. Science* 2013).

In a major ruling, the U.S. Supreme Court ruled against Myriad Genetics in a lawsuit brought by the American Civil Liberties Union on behalf of two plaintiffs. The Court ruled that human genes cannot be patented, dealing a fatal blow to Myriad's controversial *BRCA1* patent. 23andMe received a cease-and-desist letter from the U.S Food and Drug Administration banning (temporarily) the company from offering interpretation of customers' health data. The company has begun working with the agency to gain approval for individual tests.

7.7.2 Economic

It is difficult to quantify the economic impact of the HGP and the international investment in the decade-long project. Many multi-billion-dollar biotech companies besides Celera thrived in the run up to the completion of the HGP, including Incyte Pharmaceuticals, Millennium Pharmaceuticals, Sequana Therapeutics, CuraGen and Human Genome Sciences. While many of these companies no longer exist, many more are building on the foundation laid by the HGP, including firms servicing consumer genomics, genetic diagnostics, genome interpretation, and countless therapeutic companies.

The best known report on the economic impact of the HGP was published by Battelle in 2011 and mentioned by President Barack Obama in the State of the Union address. The report calculated that the economic impact of the HGP between 1998-2010 was a stunning $796 billion – in other words, every $1 invested by the U.S. Government generated a return of $141.

The Battelle report also found that the field of genomics directly or indirectly supported hundreds of thousands of jobs, adding more than $65 billion a year to the economy. Moreover, total tax revenues in 2010 amounted to $6 billion, more than repaying the government for its decade of investment (Gitlin, J.M. NHGRI 2011).

However, analyses such as these have been criticized by economists such as Robert Topel (University of Chicago), who points out that the benefits of the HGP – and health research in general – should not be measured in terms of employment, tax returns or productivity. Says Topel: "The question is: what health benefits have people got out of it, and what will they get in the future?" (Wadman, M. *Nature* 2013).

8 TIMELINE

8.1 1950s

8.1.1 1951

- Sanger F, Tuppy H (1951) The amino-acid sequence in the phenylalanyl chain of insulin. I. The identification of lower peptides from partial hydrolysates
- Sanger F, Tuppy H (1951) The amino-acid sequence in the phenylalanyl chain of insulin. 2. The investigation of peptides from enzymic hydrolysates

8.1.2 1953

- Watson JD, Crick FH (1953) Molecular structure of nucleic acids; a structure for deoxyribose nucleic acid
- Double helix, structure of DNA

8.1.3 1956

- Prenatal genetic testing using RFLP markers

8.1.4 1958

- Human leukocyte antigen (HLA) markers
- Kendrew JC, et al (1958) A Three-dimensional model of the myoglobin molecule obtained by x-ray analysis
- The X-ray structure of myoglobin

8.2 1960s

8.2.1 1961

- Nirenberg M, Matthaei JH (1961) Dependence of cell-free protein synthesis in E. coli upon naturally occurring or synthetic polyribonucleotides

8.2.2 1962

- Pharmacogenetics

8.2.3 1964

- Cold Spring Harbor Symposia on Quantitative Biology: Human Genetics, Vol. XXIX (1964)

8.2.4 1965

- Holley RW, et al. (1965) Structure of an Alanine transfer RNA
- Holley RW, et al. (1965) Nucleotide sequences in the yeast alanine transfer ribonucleic acid

8.2.5 1966

Content by label

There is no content with the specified labels

8.2.6 1967

Content by label

There is no content with the specified labels

8.2.7 1968

- Meselson M, Yuan R (1968) DNA restriction enzyme from E. Coli

8.3 1970s

8.3.1 1970

- Banding technique for chromosomes
- Mizutani S, Temin HM (1970) An RNA-dependent DNA polymerase in virions of Rous sarcoma virus
- Smith HO, Wilcox KW (1970) A restriction enzyme from Hemophilus influenzae. I. Purification and general properties
- Kelly TJ, Smith HO (1970) A restriction enzyme from Hemophilus-influenzae 2. Base sequence of recognition site
- Protein sequencing

8.3.2 1972

- Cloning
- cDNA
- Junk DNA

8.3.3 1973

- Genetic engineering

8.3.4 1975

- Southern EM (1975) Detection of specific sequences among DNA fragments separated by gel-electrophoresis

8.3.5 1976

- Workshop on Functional Properties of Tumors of T and B Lymphocytes (1976)
- Stehelin D, et al. (1976) DNA related to the transforming gene(s) of avian sarcoma viruses is present in normal avian DNA

8.3.6 1977

- Rogers J (1977) Atomic Structure of a Living Organism
- Sanger DNA sequencing method
- Sanger F, Nicklen S, Coulson AR. (1977) DNA sequencing with chain-terminating inhibitors
- Sanger F, et al. (1977) DNA sequencing with chain-terminating inhibitors
- Chow LC, et al (1977) An amazing sequence arrangement at the 5' ends of adenovirus 2 messenger RNA
- Maxam AM, Gilbert W (1977) A new method for sequencing DNA
- Sanger F, et al. (1977) Nucleotide sequence of bacteriophage φX174 DNA

8.3.7 1978

- In vitro fertilization, first live birth
- Edwards RG, Steptoe PC (1978) Birth after the reimplantation of a human embryo
- Crea R, et al. (1978) Chemical synthesis of genes for human insulin
- Structure of telomeres
- Berget SM,et al. (1978) Spliced segments at the 5' termini of adenovirus-2 late mRNA: a role for heterogeneous nuclear RNA in mammalian cells
- Broker TR, et al. (1978) Adenovirus-2 messengers--an example of baroque molecular architecture

- Kan YW, Dozy AM (1978) Antenatal diagnosis of sickle-cell anemia by DNA analysis of amniotic-fluid cells

8.3.8 1979

- Shotgun sequencing strategy described
- Goeddel DV, et al. (1979) Expression in Escherichia coli of chemically synthesized genes for human insulin
- Los Alamos sequence database
- Smith HO (1979) Nucleotide sequence specificity of restriction endonucleases
- Solomon E, Bodmer WF (1979) Evolution of sickle variant gene
- Goad W (1979) Proposal to establish a national center for collection, and computer storage and analysis of nucleic acid sequences

8.4 1980s

8.4.1 1980

- Botstein D, et al. (1980) Construction of a genetic-linkage map in man using restriction fragment length polymorphisms

8.4.2 1981

- Miesfeld R, et al. (1981) A member of a new repeated sequence family which is conserved throughout eukaryotic evolution is found between the human delta-globin and beta-globin genes
- Gilbert W (1981) DNA sequencing and gene structure Nobel lecture
- Sanger F (1981) Determination of nucleotide sequences in DNA

8.4.3 1982

- Model 470A Protein Sequencer, first commercial instrument
- Jordan E, Carrico C (1982) DNA database
- Shih C, Weinberg RA (1982) Isolation of a transforming sequence from a human bladder carcinoma cell line

8.4.4 1983

- Cosmid cloning vector
- Gusella JF, et al. (1983) A polymorphic DNA marker genetically linked to Huntington's disease

8.4.5 1984

- International Workshop on the Applications of Genetic Engineering to Basic Biology (1984)
- Hartley, D A, et al. (1984) A cytological map of the human X chromosome--evidence for non-random recombination
- Polymerase chain reaction (PCR)
- DNA fingerprinting/DNA forensics
- Schwartz DC, Cantor CR (1984) Separation of yeast chromosome-sized DNAs by pulsed field gradient gel electrophoresis
- Positional cloning method described by Collins and Weissman
- Alta Summit (1984)
- Baer R, et al. (1984) DNA sequence and expression of the b95-8 Epstein-Barr virus genome

8.4.6 1985

- Santa Cruz 1985 Meeting (1985)
- Wainwright BJ, et al. (1985) Localization of cystic fibrosis locus to human chromosome 7cen-q22
- Jeffreys AJ, et al. (1985) Hypervariable 'minisatellite' regions in human DNA
- Knowlton RG, et al. (1985) A polymorphic DNA marker linked to cystic fibrosis is located on chromosome 7.
- Monaco AP, et al. (1985) Detection of deletions spanning the Duchenne muscular dystrophy locus using a tightly linked DNA segment
- Saiki RK, et al. (1985) Enzymatic amplification of beta-globin genomic sequences and restriction site analysis for diagnosis of sickle cell anemia
- White R, et al. (1985) A closely linked genetic marker for cystic fibrosis
- Online Mendelian Inheritance in Man (OMIM)
- Tsui LC, et al. (1985) Cystic fibrosis locus defined by a genetically linked polymorphic DNA marker
- Smith LM, et al. (1985) The synthesis of oligonucleotides containing an aliphatic amino group at the 5' terminus: synthesis of fluorescent DNA primers for use in DNA-sequence analysis

8.4.7 1986

- Cold Spring Harbor Symposia on Quantitative Biology LI: Molecular Biology of Homo Sapiens (1986)
- Santa Fe Meeting (1986)
- Meeting on human genome sequencing (1986)
- HHMI Meeting on Human Genome Sequencing (1986)
- Department of Energy (DOE) genome studies begin (1986)
- Sydney Brenner starts a small genome initiative at MRC (1986)
- Smith LM, et al. (1986) Fluorescence detection in automated DNA sequence analysis
- ABI 370 (373) DNA sequencing instruments
- Sydney Brenner urges the EU to undertake a concerted program to map and sequence the human genome (1986)

- Dulbecco R. (1986) A turning point in cancer research: sequencing the human genome
- Kunkel LM, et al. (1986) Analysis of deletions in DNA from patients with Becker and Duchenne muscular dystrophy
- Maugh II TH (1986) Caltech scientists develop super-fast DNA analyzer

8.4.8 1987

- Advisory panel suggests DOE spend $200 million per year on mapping and sequencing the human genome (1987)
- Health and Environmental Research Advisory Committee (HERAC) recommends 15-year undertaking to map and sequence the human genome (1987)
- Burke DT, et al. (1987) Cloning of large segments of exogenous DNA into yeast by means of artificial chromosome vectors
- Donis-Keller H, et al. (1987) A genetic linkage map of the human genome

8.4.9 1988

- NRC endorses the Human Genome Project (HGP) (1988)
- NIH-DOE sign MOU and agree to collaborate on the HGP and genome research (1988)
- The Human Genome Projects: Issues, Goals, and California's Participation (1988)
- First annual CSHL meeting on human genome mapping and sequencing (1988)
- Human Gene Mapping Workshop (HGM 9.5) (1988)
- Chromosome paints introduced for cytogenetics
- Committee on Mapping and Sequencing the Human Genome; Commission on Life Sciences; Division on Earth and Life Studies; National Research Council (1988) Mapping and Sequencing the Human Genome
- Congress of the United States, Office of Technology Assessment (1988) Mapping Our Genes - Genome Projects: How Big, How Fast?
- Moyzis RK, et al. (1988) A highly conserved repetitive DNA-sequence, (TTAGGG)n, present at the telomeres of human-chromosomes
- NIH and DOE (1988) Memorandum of Understanding between the National Institutes of Health and the Department of Energy
- NIH becomes major player in HGP, seizing lead from DOE (1988)
- Ad Hoc Program Advisory Committee on Complex Genomes (1988)
- Physical mapping
- Cohen AS, et al. (1988) Rapid separation and purification of oligonucleotides by high-performance capillary gel electrophoresis

8.4.10 1989

- Human Gene Mapping Workshop (HGM-10) (1989)
- Genetic Mapping Workshop (1989)

- Human Genome Conference (1989)
- STEPP - Sequencing the Human Genome: Biology Meets Big Science (1989)
- Human Genome Planning Retreat (1989)
- Rommens JM, et al. (1989) Identification of the cystic fibrosis gene: chromosome walking and jumping
- DOE-NIH joint committee on ethical, legal, and social implications of HGP is formed: Joint ELSI Working Group (1989)
- "The Human Genome Project" (1989)
- Meeting to plan the future of the U.S. genome project (1989)
- Riordan JR, et al. (1989) Identification of the cystic fibrosis gene: cloning and characterization of complementary DNA
- AAAS Annual Meeting - The Lawrence Livermore National Laboratory Human Genome Project (1989)
- Smithsonian Institution Lecture, "Mapping the Human Genome" (1989)
- DOE Human Genome Program Contractor-Grantee Workshop I (1989)
- First DOE Human Genome Program Contractor-Grantee Workshop (1989)
- International conference on status of HGP (1989)
- HUGO founded (1989)
- Kerem B, et al. (1989) Identification of the cystic fibrosis gene: genetic analysis
- Olson M, et al. (1989) A common language for physical mapping of the human genome

8.5 1990s

8.5.1 1990

- Genome Database (GDB) launched
- Council of Scientific Society Presidents - "Mapping the Human Genome" (1990)
- Genetics and Society Silver Jubilee Symposium - "The Human Genome Initiative" (1990)
- Implementing the Human Genome Project Meeting (1990)
- Second Genome Sequencing Conference (1990)
- NIH and DOE restart clock, declaring official beginning of HGP (1990)
- Decade of the Brain Symposium - "The Brain Frontier Beyond the Human Genome" (1990)
- DOE-NIH joint 5-year U.S. HGP plan (1990)
- Fluorescence in situ hybridization (FISH)
- Genome Sequencing Meeting - "Human Genome Initiative" (1990)
- Symposium on Human Genome Research, UNESCO (1990)
- Gene therapy, first approved clinical trial
- Preimplantation genetic diagnosis
- FBI Combined DNA Index System (CODIS) for DNA fingerprinting

- NIH-DOE (1990) Understanding Our Genetic Inheritance. The U.S. Human Genome Project: The First Five Years FY 1991-1995
- Altschul SF, et al. (1990) Basic local alignment search tool
- Roberts L (1990) Large-scale sequencing trials begin
- FBI (2015) CODIS Brochure
- Hall JM, et al. (1990) Linkage of early-onset familial breast cancer to chromosome 17q21
- Capillary sequencing

8.5.2 1991

- UK Human Genome Program Users Meetings (1991)
- The Human Genome Project: The Formation of Federal Policies in the United States
- NCHGR Workshop (1991)
- Genome Sequencing Conference III (1991)
- DOE Human Genome Program Contractor-Grantee Workshop II (1991)
- First Annual Center Director's Meeting (1991)
- Our Genes Our Health: Implications of the Human Genome Project for the Future of Medicine (1991)
- Rice genome sequencing effort, Japan (1991)
- NIH Conference on International Aspects of Ethical and Social Issues in Human Genome Research (1991)
- Pearson PL (1991) The genome data base (GDB)--a human gene mapping repository
- GRAIL gene-finding program
- The Genetic Revolution: Scientific Prospects and Public Perceptions
- Uberbacher EC, Mural RJ (1991) Locating protein-coding regions in human DNA sequences by a multiple sensor-neural network approach
- Watson JD, Cook-Deegan RM (1991) Origins of the Human Genome Project
- Hearing on Possible Uses and Misuses of Genetic Information Before the House Government Operations Subcommittee on Government Information, Justice, and Agriculture (1991)
- ESTs (Expressed Sequence Tags)
- Hunkapiller T, et al. (1991) Large-scale and automated DNA sequence determination
- Adams MD, et al. (1991) Complementary DNA sequencing: Expressed sequence tags and human genome project

8.5.3 1992

- Chromosome 21, physical map of
- DOE Human Genetics and Genome Analysis Meeting (1992)
- Breneman Lecture - "The Human Genome Project" (1992)
- Gene Mapping: Using Law and Ethics as Guides
- HGP Center Grants Meeting (1992)

- Guidelines for HGP data release and resource sharing announced (1992)
- BACs (Bacterial Artificial Chromosomes)
- Uberbacher, E, et al. (1992) Gene recognition and assembly in the GRAIL system: Progress and challenges
- Shizuya H, et al. (1992) Cloning and stable maintenance of 300-kilobase-pair fragments of human DNA in Escherichia coli using an f-factor-based vector
- James D. Watson resigns as head of NCHGR (1992)
- The Code of Codes: Scientific and Social Issues in the Human Genome Project
- Vollrath D, et al. (1992) The human Y chromosome: A 43-interval map based on naturally occurring deletions
- Dietrich W, et al. (1992) A genetic map of the mouse suitable for typing intraspecific crosses
- NIH/CEPH Collaborative Mapping Group (1992) A comprehensive genetic-linkage map of the human genome
- Martin-Gallardo A, et al. (1992) Automated DNA sequencing and analysis of 106 kilobases from human chromosome 19q13.3
- McCombie WR, et al. (1992) Expressed genes, Alu repeats and polymorphisms in cosmids sequenced from chromosome 4p16.3
- J. Craig Venter leaves NIH to set up The Institute for Genomic Research (TIGR) (1992)

8.5.4 1993

- GenBank database officially moves from Los Alamos to NCBI (1993)
- Sequencing by hybridization (SBH)
- From the Double Helix to the Human Genome (1993)
- NIH-DOE revised U.S. HGP plan (1993)
- DOE Human Genome Program Contractor-Grantee Workshop III (1993)
- International IMAGE Consortium established (1993)
- 17th International Congress of Genetics - "Genetics and Understanding of Life" (1993)
- DOE-NIH ELSI Working Group's Task Force on Genetic and Insurance Information release recommendations (1994)
- Wellcome Trust-MRC Sanger Centre (1993)
- MacDonald ME, et al. (1993) A novel gene containing a trinucleotide repeat that is expanded and unstable on Huntingtons-disease chromosomes

8.5.5 1994

- Genetic Privacy Act (1994)
- DOE Human Genome Program Contractor-Grantee Workshop IV (1994)
- Sylvia and Herbert Berger Lecture - "The Ethical Consequences of the Human Genome Project" (1994)
- Genetic-mapping 5-year goal achieved (1994)
- DOE Microbial Genome Project launched (1994)

- Ten Nobels for the Future Talk - "Ethical Implications of the Human Genome Project" (1994)
- Ioannou PA, et al. (1994) A new bacteriophage P1-derived vector for the propagation of large human DNA fragments
- Miki Y, et al. (1994) A strong candidate for the breast and ovarian cancer susceptibility gene BRCA1
- Gene Wars: Science, Politics, and the Human Genome
- Gyapay G, et al. (1994) The 1993-94 Genethon human genetic linkage map
- Kevles DJ (1994) Ananda Chakrabarty wins a patent: Biotechnology, law, and society, 1972-1980

8.5.6 1995

- Historical Considerations and Sequencing the Entire Human Genome (The Human Genome Initiative) (1995)
- Quackenbush J, et al. (1995) An STS content map of human chromosome 11: Localization of 910 YAC clones and 109 islands
- The Ethical Implications of the Human Genome Project (1995)
- Louis S.B. Leakey Symposium: Genetics and Human Evolution - "An Historical Perspective and Outlook for the Future" (1995)
- Introduction of ABI 377 sequencing machine
- Japanese government funding of sequencing groups (1995)
- Krauter K, et al. (1995) A second-generation YAC contig map of human chromosome 12
- Schena M, et al. (1995) Quantitative monitoring of gene expression patterns with a complementary DNA microarray
- Mycoplasma genitalium, DNA sequence of
- James Watson Lecture: The Genome Action Coalition (1995)
- Polymerase, thermostable
- Bork P, et al. (1995) Exploring the mycoplasma capricolum genome: A minimal cell reveals its physiology
- Doggett NA, et al. (1995) An integrated physical map of human chromosome 16
- Gemmill RM, et al. (1995) An integrated YAC contig map for human-chromosome-3
- Hudson TJ, et al. (1995) An STS-based map of the human genome
- Ashworth LK, et al. (1995) An integrated metric physical map of human chromosome 19
- Nature (1995) The Genome Directory
- Bell CJ, et al. (1995) Integration of physical, breakpoint and genetic maps of chromosome 22. Localization of 587 yeast artificial chromosomes with 238 mapped markers
- Fleischmann RD, et al. (1995) Whole-genome random sequencing and assembly of Haemophilus influenzae rd
- Fraser CM, et al. (1995) The minimal gene complement of Mycoplasma genitalium

8.5.7 1996

- BAC clones, ends, sequences of

- Chromosome 3, moderate-resolution map
- DNA chips
- Human T-cell receptor region sequence
- ABI 310, first capillary DNA sequencer
- Commercial Implications of Genomics Research (1996)
- Final European Conference on the Yeast Genome Sequencing Network (1996)
- DOE Human Genome Program Contractor-Grantee Workshop V (1996)
- Wellcome Trust Bermuda Principles
- DOE funding of pilot projects to sequence ends of BAC clones (1996)
- Carninci P, et al. (1996) High-efficiency full-length cDNA cloning by biotinylated CAP trapper
- Kasianowicz JJ, et al. (1996) Characterization of individual polynucleotide molecules using a membrane channel
- Rowen L, et al. (1996) The complete 685-kilobase DNA sequence of the human beta t cell receptor locus
- International Strategy Meeting on Human Genome Sequencing (policy) (1996)
- PHRAP
- Advances in Genetics Research and Technologies: Challenges for Public Policy, to the Senate Committee on Labor and Human Resources (1996)
- Goffeau A, et al. (1996) Life with 6000 genes
- International Strategy Meeting on Human Genome Sequencing (1996-1999)
- Bult CJ, et al. (1996) Complete genome sequence of the methanogenic archaeon, methanococcus jannaschii

8.5.8 1997

- Chromosome 7, high-resolution physical map
- Bermuda Genome Meeting (1997)
- Universal Declaration on the Human Genome and Human Rights (1997)
- DOE Human Genome Program Contractor-Grantee Workshop VI (1997)
- The Arabidopsis Genome: From Sequence to Function (1997)
- GENSCAN program released
- MegaBACE sequencing machine, Molecular Dynamics
- Blattner FR, et al. (1997) The complete genome sequence of escherichia coli k-12
- Burge C, Karlin S. (1997) Prediction of complete gene structures in human genomic DNA
- Nagaraja R, et al. (1997) X chromosome map at 75-Kb STS resolution, revealing extremes of recombination and GC content
- Escherichia coli, DNA sequence of
- Polymeropoulos MH, et al. (1997) Mutation in the alpha-synuclein gene identified in families with parkinson's disease
- Congressional Task Force on Health Records and Genetic Privacy Preventing Genetic Discrimination in Health Insurance (1997)

- Bouffard GG, et al. (1997) A physical map of human chromosome 7: An integrated YAC contig map with average STS spacing of 79 kb
- International Strategy Meeting on Human Genome Sequencing (1996-1999)

8.5.9 1998

- ABI Prism 3100 Genetic Analyzer
- GeneMap'98
- Forum on Genetic Testing and its Use and Misuse in the Workplace (1998)
- Genome Action Coalition Meeting (1998)
- Third International Meeting on Human Genome Sequencing (1998)
- Wellcome Trust Genome Campus Inaugural Symposium - "From the Double Helix to the Human Genome" (1998)
- DOE funding of production BAC end sequencing (1998)
- Draft NIH-DOE 5-year plan (1998)
- The Arabidopsis Genome: A Model for Crop Plants (1998)
- NIH and DOE announce new goal of creating a “working draft” of the human genome by 2001, move completion date for finished draft from 2005 to 2003 (1998)
- Largest-ever ELSI meeting attended by over 800 from diverse disciplines (1998)
- The Hospital for Sick Children (1998) SicKKids improves access to global genome database
- Meeting to form the International Rice Genome Sequencing Project (1998)
- Amersham Pharmacia Biotech - Agreement to Acquire Molecular Dynamics
- NHGRI Principal Investigator Meeting (1998)
- NIH Methods for Discovering and Scoring Single Nucleotide Polymorphisms.
- Rice genome sequence
- Mycobacterium tuberculosis, DNA sequence of
- Genome Mapping, Sequencing, and Biology (1998)
- C. elegans Sequencing Consortium (1998) Genome sequence of the nematode C. elegans: A platform for investigating biology
- Burris J, et al. (1998) The Human Genome Project after a decade: policy issues
- Collins FS, et al. (1998) A DNA polymorphism discovery resource for research on human genetic variation
- Ewing B, et al. (1998) Base-calling of automated sequencer traces using phred
- Wade N (1998) Scientist's plan: Map all DNA within 3 years
- International Strategy Meeting on Human Genome Sequencing (1996-1999)
- Cole ST, et al. (1998) Deciphering the biology of mycobacterium tuberculosis from the complete genome sequence
- Collins FS, et al. (1998) New goals for the U.S. Human Genome Project: 1998-2003
- Deloukas P, et al. (1998) A physical map of 30,000 human genes

8.5.10 1999

- Mouse genome projects (1999)
- Genome Directory (LocusLink)
- HHS Secretary Shalala Lauds First Complete Sequencing of a Human Chromosome (1999)
- Informatics Meets Genomics at the White House event (1999)
- Ten companies and the Wellcome Trust launch the SNP consortium (1999)
- Genomics: The Science and Technology Behind the Human Genome Project
- DOE Joint Genome Institute performance sequencing facility opens (1999)
- DOE Human Genome Program Contractor-Grantee Workshop VII (1999)
- Pruitt K, et al. (1999) RefSeq and LocusLink: NCBI's new curated resources for human genes
- Biotechnology at 25 Symposium - From the Double Helix to the Human (1999)
- Butler D. (1999) 'Finishing' success marks major genome sequencing milestone...as researchers pounce on glut of data
- Butler D. (1999) Venter's Drosophila 'success' set to boost human genome efforts
- Pennisi E. (1999) Fruit fly researchers sign pact with Celera
- Multiplex (Polony) sequencing
- Genome: The Autobiography of a Species in 23 Chapters
- The Biotech Century: Harnessing the Gene and Remaking the World
- Kelley JM et al. (1999) High throughput direct end sequencing of BAC clones
- Hutchison CA, et al. (1999) Global transposon mutagenesis and a minimal mycoplasma genome
- International Strategy Meeting on Human Genome Sequencing (1996-1999)
- Dunham I, et al (1999) The DNA sequence of human chromosome 22

8.6 2000s

8.6.1 2000

- Chromosome 5, draft sequence
- Controlling Our Destinies: Historical, Philosophical, Ethical, Theological Perspectives on the Human Genome Project
- Sasaki T, Burr B (2000) International rice genome sequencing project: The effort to completely sequence the rice genome
- DOE Human Genome Program Contractor-Grantee Workshop VIII (2000)
- NHGRI Video Archive (GenomeTV)
- Human Genome First Draft Announcement at the White House (June 26, 2000)
- DOE-MRC Fugu rubripes genome collaborative project (2000)
- ELSI Research Planning and Evaluation Group (ERPEG) releases its final report (2000)

- Berenson, Alex and Wade, Nicholas. (2000) A Call for Sharing of Research Causes Gene Stocks to Plunge
- Hattori M, et al. (2000) The DNA sequence of human chromosome 21
- Maglott DR, et al. (2000) NCBI's LocusLink and RefSeq
- ABI Prism 3700 DNA Analyzer
- Executive order regarding use of genetic information (2000)
- HGP leaders and President Clinton announce the completion of a "working draft" (2000)
- Drosophila melanogaster genome sequence
- Clinton, W. and Blair, T. (2000) Joint Statement by President Clinton and Prime Minister Tony Blair of the United Kingdom on Availability of Human Genome Data
- Hamosh A, et al. (2000) Online Mendelian inheritance in man (OMIM)
- Wade N (2000) Scientists Complete Rough Draft of Human Genome
- Kaul S, et al. (2000) Analysis of the genome sequence of the flowering plant arabidopsis thaliana
- Adams MD, et al. (2000) The genome sequence of Drosophila melanogaster

8.6.2 2001

- Chromosome 20, sequence
- Computational Biology: Integrating Genome Sequence, Sequence Variation, and Gene Expression (2001)
- Human Genome Project and the Private Sector: A Working Partnership (2001)
- Cracking the Code of Life, PBS documentary
- Symposium entitled "Biomedical Sciences and Human Experimentation at Kaiser Wilhelm Institutes - The Auschwitz Connection" (2001)
- Wade, Nicholas. (2001) Genome's Riddle: Few Genes, Much Complexity
- Venter JC, et al. (2001) The sequence of the human genome
- Wade, Nicholas. (2001) The Other Secrets of the Genome
- AAAS Meeting (2001)
- Cracking the Genome: Inside the Race to Unlock Human DNA - first popular science book on the Human Genome Project
- Nirenberg M, Matthaei JH (1961) Dependence of cell-free protein synthesis in E. coli upon naturally occurring or synthetic polyribonucleotides
- Lander ES, et al. (2001) Initial sequencing and analysis of the human genome

8.6.3 2002

- The Genomic Revolution: Unveiling the Unity of Life
- Yu J, et al. (2002) A draft sequence of the rice genome (oryza sativa l. Ssp. Indica)
- DOE Human Genome Program Contractor-Grantee Workshop IX (2002)
- International HapMap Project begins (2002)
- NIH News Release (2002) International consortium launches genetic variation mapping project

- The Genome of Homo Sapiens, CSHL Symposium Vol. LXVIII
- High-throughput sequencing
- The Common Thread: A Story of Science, Politics, Ethics, and the Human Genome - John Sulston's inside account of the Human Genome Project
- Hamosh A, et al. (2002) Online Mendelian Inheritance in Man (OMIM), a knowledgebase of human genes and genetic disorders
- Aparicio S, et al. (2002) Whole-genome shotgun assembly and analysis of the genome of Fugu rubripes
- Waterston RH, et al. (2002) Initial sequencing and comparative analysis of the mouse genome

8.6.4 2003

- Gene-based designer drugs
- Systems Biology: Genomic Approaches to Transcriptional Regulation (2003)
- From Double Helix to the Human Sequence and Beyond (2003)
- NIH/NHGRI (2003) Beyond genes: Scientists venture deeper into the human genome
- Wade N (2003) Once Again, Scientists Say Human Genome Is Complete
- The Genome of Homo Sapiens, CSHL Symposium Vol. LXVIII
- Gene count, human - settling a science wager on the gene tally in the human genome
- Heilig R, et al. (2003) The DNA sequence and analysis of human chromosome 14
- Skaletsky H, et al. (2003) The male-specific region of the human Y chromosome is a mosaic of discrete sequence classes
- Mungall AJ, et al. (2003) The DNA sequence and analysis of human chromosome 6
- Hillier LW, et al (2003) The DNA sequence of human chromosome 7

8.6.5 2004

- Chromosome 19, sequence
- Jacob's Ladder: The History of the Human Genome Project
- Race to the Finish: Identity and Governance in an Age of Genomics
- Identification of Functional Elements in Mammalian Genomes (2004)
- The Genome War: How Craig Venter Tried to Capture the Code of Life and Save the World
- Dunham A, et al (2004) The DNA sequence and analysis of human chromosome 13
- Deloukas P, et al. (2004) The DNA sequence and comparative analysis of human chromosome 10
- Martin J, et al. (2004) The sequence and analysis of duplication-rich human chromosome 16
- Collins FS, et al. (2004) Finishing the euchromatic sequence of the human genome
- Schmutz J, et al. (2004) The DNA sequence and comparative analysis of human chromosome 5
- Grimwood J, et al. (2004) The DNA sequence and biology of human chromosome 19
- Humphray SJ, et al. (2004) DNA sequence and analysis of human chromosome 9

8.6.6 2005

- Chromosome 4, sequence
- National Geographic-IBM Genographic Project is launched (2005)
- Ashburner M, Bergman CM. (2005) Drosophila melanogaster: a case study of a model genomic sequence and its consequences
- Goff SA (2005) A draft sequence of the rice genome (oryza sativa l. Ssp. Japonica)
- Shendure J, et al. (2005) Accurate multiplex polony sequencing of an evolved bacterial genome
- Genome Sequencer GS20, 454 Life Sciences next-generation sequencer unveiled
- Nusbaum C, et al. (2005) DNA sequence and analysis of human chromosome 18
- Hillier LW, et al. (2005) Generation and annotation of the DNA sequences of human chromosomes 2 and 4
- Ross MT, et al. (2005) The DNA sequence of the human X chromosome

8.6.7 2006

- Chromosome 17, sequence
- Springer M (2006) Applied Biosystems: Celebrating 25 Years of Advancing Science
- Schneiderman RM (2006) Illumina Buys Solexa
- Living with the Genome: Ethical and Social Aspects of Human Genetics
- Solexa (Illumina) next-generation sequencer introduced
- Haga SB, Willard HF (2006) Defining the spectrum of genome policy
- Sinsheimer, Robert L. (2006) To Reveal the Genomes
- Muzny DM, et al. (2006) The DNA sequence, annotation and analysis of human chromosome 3
- Nusbaum C, et al. (2006) DNA sequence and analysis of human chromosome 8
- Taylor TD, et al. (2006) Human chromosome 11 DNA sequence and analysis including novel gene identification
- Zody MC, et al. (2006) Analysis of the DNA sequence and duplication history of human chromosome 15
- Zody MC, et al. (2006) DNA sequence of human chromosome 17 and analysis of rearrangement in the human lineage
- Scherer SE, et al. (2006) The finished DNA sequence of human chromosome 12
- Gregory SG, et al. (2006) The DNA sequence and biological annotation of human chromosome 1
- 454 Life Sciences (2005) 454 Life Sciences and Roche Announce commercial launch of the GS20 System and reagents

8.6.8 2007

- Garcia-Sancho M (2007) Mapping and sequencing information: The social context for the genomics revolution
- SOLiD sequencer (Life Technologies)
- NIH (2007) Reference Epigenome Mapping Center (REMC) as part of the NIH Roadmap Epigenomics Program

- Turnbaugh PJ, et al. (2007) The human microbiome project

8.6.9 2008

- The Human Genome Project in College Curriculum: Ethical Issues and Practical Strategies
- Structural variation from eight human genomes
- Double Helix Awards - "First Lessons from My Personal Genome" (2008)
- Personal Genomes conference launched at CSHL (2008, 2009, 2011)
- NIH Staff (2008) 'Working Draft' of Human Genome Announced at White House
- Genetic Information Nondiscrimination Act (GINA) becomes law (2008)
- Wang J, et al. (2008) The diploid genome sequence of an Asian individual
- Bentley DR, et al. (2008) Accurate whole human genome sequencing using reversible terminator chemistry
- DeLisi C. (2008) Meetings that changed the world: Santa Fe 1986: Human genome baby-steps
- Kidd JM, et al. (2008) Mapping and sequencing of structural variation from eight human genomes
- Ley TJ, et al. (2008) DNA sequencing of a cytogenetically normal acute myeloid leukaemia genome
- Zwart H (2008) Understanding the Human Genome Project: A biographical approach

8.6.10 2009

- The Bovine Genome (2009)
- Adamson A, et al. (2009) Genome Management Information System: A Multifaceted Approach to DOE Systems Biology Research Communication and Facilitation
- Peterson J, et al. (2009) The NIH human microbiome project
- Pig, genome sequence

8.7 2010s

8.7.1 2010

- A Century of Eugenics in America: From the Indiana Experiment to the Human Genome Era
- Celebrating a 'decade of discovery' since the Human Genome Project, A film by the Wellcome Trust
- The Human Genome: A Decade of Discovery, Creating a Healthy Future (AM Session - Part 1)
- Human genome variation from population-scale sequencing (2010)
- DNA - The Next Generation (NHGRI video hosted by Robert Krulwich)
- Drawing the Map of Life: Inside the Human Genome Project
- The Language of Life: DNA and the Revolution in Personalized Medicine
- Transformational Impact of Human Genome Project

- Altshuler D, et al. (2010) A map of human genome variation from population-scale sequencing

8.7.2 2011

- Myriad gene patent is upheld (2011)
- The Human Genome: Book of Essential Knowledge
- Capitol Hill Briefing on Gene Patents, 15 Sept 2011
- Gene Patenting: The Economic Legal and Health Dilemma
- Tripp S, Grueber M (2011) Economic Impact of the Human Genome Project
- Drake N (2011) What is the human genome worth?
- Mycoplasma capricolum, DNA sequence of
- The Human Genome at 10: An Overview, Eric Lander
- Mardis, ER. (2011) A decade's perspective on DNA sequencing technology

8.7.3 2012

- MyGenome app
- Biology, Computing, and the History of Molecular Sequencing: from Proteins to DNA, 1945-2000
- The Science of Human Perfection: How Genes Became the Heart of American Medicine
- Personal Genomes & Medical Genomics (2012)
- Decoding Our DNA: Craig Venter vs the Human Genome Project
- Kaye J, et al. (2012) ELSI 2.0 for genomics and society
- Dunham I, et al (2012) An integrated encyclopedia of DNA elements in the human genome

8.7.4 2013

- U.S. Supreme Court ruling regarding warrantless collection of DNA (2013)
- Life out of Sequence: A Data-Driven History of Bioinformatics
- HGP10: Conceptualization of the Human Genome Project & Development of Data Release Principles
- Smithsonian opens human genome exhibit: Unlocking Life's Code (2013)
- U.S. Supreme Court ruling regarding gene patenting (2013)
- The $1,000 Genome... The $1,000,000 Interpretation

8.7.5 2014

Content by label

There is no content with the specified labels

8.7.6 2015

- The Evolution of Sequencing Technology (2015)
- Gudbjartsson DF, et al. (2015) Large-scale whole-genome sequencing of the Icelandic population
- Loman N, et al. (2015) A complete bacterial genome assembled de novo using only nanopore sequencing data
- FBI (2015) CODIS Brochure
- Green ED, et al. (2015) Human Genome Project: Twenty-five years of big biology
- Kundaje A, et al. (2015) Integrative analysis of 111 reference human epigenomes

9 ORGANIZATIONS

9.1 Companies

9.1.1 454 Life Sciences

454 Life Sciences was established as a subsidiary of CuraGen in 2000. 454 refers to the code used by CuraGen to classify its sequencing effort. It was acquired by Roche Diagnostics in 2007 for $154.9 million. In 2013, the parent company, Roche Applied Science, said it would shut down 454 and stop supporting the platform by mid-2016.

Time Period	2000-2007
Founders	Jonathan Rothberg
Public or Private	Private
Location	Branford, CT
Acquisition History	Roche Diagnostics (2007)
Subsidiaries & Spin-offs	Established as a CuraGen subsidiary (2000)
Technologies and Products	GS20, the first next generation DNA sequencer, in 2005; a bench top version released in 2009
Glossary	Sequencing, large-scale parallel pyrosequencing
Links	http://454.com/ https://www.linkedin.com/in/jonathanrothberg

9.1.2 Acadia Pharmaceuticals Inc.

Founded as Receptor Technologies by Mark Brann, a professor at the University of Vermont, the company initially worked with major pharmaceutical companies to perform high throughput screening based on its proprietary functional genomics platform, R-SAT. Acadia Pharmaceuticals changed its name when it moved to California and began developing its own pipeline of innovative medicines for unmet needs in central nervous system disorders. It also has clinical-stage collaborations with Allergan in glaucoma and chronic pain.

Alternate Names	Receptor Technologies Inc. (name changed in 1997 when company moved from Vermont to San Diego)
Time Period	1993 - present
Founders	Mark R. Brann (professor at U. Vermont)
Other Top Management	Mark R. Brann (CEO and CSO in 2000; and now CEO of Abbey Pharmaceuticals); Stephen R. Davis (current president and CEO)
Public or Private	Public in 2004 under Nasdaq symbol ACAD
Type of Firm	Biopharmaceutical
Location	San Diego, California

Subsidiaries & Spin-offs	Abbey Pharmaceuticals (launched 10/23/2006 to focus on substance abuse therapeutics)
Collaborations & Partnerships	March 2012 collaboration with Allergan for two product candidates, one in glaucoma and one in chronic pain
Technologies and Products	NUPLAZID™ (pimavanserin) under FDA Priority Review for Parkinson's disease psychosis
Glossary	Functional genomics; combinatorial chemistry
Links	http://www.acadia-pharm.com/about/history/ https://en.wikipedia.org/wiki/Acadia_Pharmaceuticals http://www.zoominfo.com/p/Mark-Brann/4434827 http://www.zoominfo.com/p/Mark-Brann/4434827 http://jbx.sagepub.com/content/1/1/43.abstract

9.1.3 Affymetrix

Affymetrix was founded as a subsidiary of Affymax in 1991 to make the GeneChip® microarrays invented by Stephen Fodor's research team using semiconductor manufacturing techniques (photolithography). Its first product, for HIV genotyping, was introduced in 1994, and the company went public in June 1996. Affymetrix was acquired by Thermo Fisher Scientific in 2016.

Time Period	1991 to present
Founders	Stephen P.A. Fodor
Other Top Management	Alejandro Zaffaroni; Frank Witney (current president and CEO)
Public or Private	Public - Nasdaq:AFFX
Type of Firm	Tools and Technology
Location	Santa Clara, CA
Mergers & Acquisitions	2000: Genetic MicroSystems, Inc. and Neomorphic, Inc. 2005: ParAllele BioScience, Inc. 2007: USB Corporation 2008: True Materials Inc. and Panomics Inc. 2012: eBioscience Holding Company, Inc.
Subsidiaries & Spin-offs	Subsidiary of Affymax (1991); Perlegen Sciences spun out in 2000
Technologies and Products	GeneChip system, DNA probe arrays
Glossary	Microarray technology; genomics analysis; gene chips; bioinformatics
Connections	http://www.affymetrix.com/estore/about_affymetrix/home.affx#1_3

9.1.4 Agilent

Agilent Technologies was spun out of Hewlett Packard's Medical Products and Instrument Group in 1999 to develop and market its testing and measurement instruments. It's $2.1 billion IPO, in November of that year, was the largest IPO in Silicon Valley history at that time. Originally focused on instruments for many industries, the company separated into two entities in 2013, with the life sciences-focused unit retaining the Agilent name.

Alternate	Agilent Technologies
Time Period	1999-

Founders	Bill Hewlett and David Packard
Other Top Management	Mike McCullen (current president and CEO)
Public or Private	Public
Type of firm	Tools and Technology
Location	Santa Clara, CA
Acquisition History	2001: Philips acquires its Healthcare Solutions Group 2005: KKR and Silver Lake Partners acquire its Semiconductor Products Group
Mergers & Acquisitions	2004: Silicon Genetics, a provider of software solutions for life sciences discovery and genomics data analysis 2006: Yokogawa Analytical Systems 2007: Strategene, Velocity11, Adaptif, Kalabie, NetworkFab 2010: Varian for its nuclear magnetic resonance products 2012: Dako (Danish cancer diagnostics company)
Subsidiaries & Spin-offs	Three subsidiaries: Life Sciences, Chemical Analysis, Electronic Measurement 2005: Expands to China with JV - Chengdu Instruments Division, and a holding company based in Shanghai 2013: separates into two entities: Agilent encompassing its life sciences-focused divisions, and Keysight Technologies for its electronic measurement business.
Collaborations & Partnerships	2010: National Center for Food Safety and Technology 2011: first industry member of Synthetic Biology Institute at UC Berkeley 2012: 1,000,000 Genome Project, a five-year collaboration with UC Davis and US FDA to improve food safety
Technologies and Products	2003: first whole human genome on single microarray; Mass spectrometry instruments; gas chromatography
Glossary	Analytical instruments, software, diagnostics, chromatography
Links	http://www.agilent.com/about/companyinfo/history/timeline_1999.html http://historycenter.agilent.com/category/oral-history-collection

9.1.5 AlphaGene, Inc.

Founded in 2003 by Dr. George A. Scheele, AlphaGene continues to offer genomics and proteomics services focused on the discovery of genes associated with neurological diseases and cancer. Its technologies allow for rapid, high-throughput identification of full-length genes and produces gene libraries with large quantities of full-length cDNAs, including complete protein encoding sequences.

Time Period	1993 - present
Founders	Dr. George A. Scheele, MD
Other Top Management	Peter Schad (CSO and previously at National Center for Genome Resources), Donald J. McCarren (current president and CEO)
Public or Private	Private
Type of Firm	Contract research organization
Location	Woburn, Massachusetts
Collaborations & Partnerships	1998: Genetics Institute granted exclusive license to AlphaGene's full length human genes for use with its protein development platform 1998: NEN Life Science Products to fund development and market the Micromax gene expression system
Technologies and Products	Gene expression microarray technology (MicroMax System); biochips for drug discovery; gene libraries
Keywords	Functional genomics; gene libraries; cDNA

Links	http://flockhart.virtualave.net/alphagene/AboutUs.htm http://www.drgeorgescheele.com/HTML/AlphaGene.htm

9.1.6 Amersham Pharmacia Biotech

Amersham Pharmacia Biotech arose when the biotech division of Pharmacia Biotech (itself a division of the Swedish pharmaceutical Pharmacia created when Pharmacia Fine Chemicals acquired LKB-produkter AB in 1986) merged with Amersham Life Science (UK) in 1997. The company provides equipment and supplies for genomics research. In 1998, Amersham Pharmacia acquired the instrumentation and software company, Molecular Dynamics. The company changed its name to Amersham Biosciences in 2001 and was acquired by GE Healthcare in 2004.

Alternate Names	Amersham Pharmacia, Amersham Biosciences (2001)
Time Period	1997-2004
Public or Private	Private
Type of Firm	Tools and Technology
Location	Amersham, UK
Acquisition History	Acquired by GE Healthcare (2004)
Mergers & Acquisitions	Established by merger of Pharmacia Biotech and Amersham Life science; acquires Molecular Dynamics (1998)
Glossary	Supplies, equipment
Links	http://www.fundinguniverse.com/company-histories/amersham-plc-history/ http://www.gelifesciences.com/webapp/wcs/stores/servlet/Home/en/GELifeSciences-us/

9.1.7 Amgen

Founded in 1980, the company's name is a contraction of Applied Molecular Genetics. Perhaps best known for producing recombinant eryhtyropoietin. In 2013, Amgen acquired the Icelandic genomics firm deCODE Genetics.

Name	Amgen
Alternate	Applied Molecular Genetics (original name, used until official name change in 1983)
History of the Company	Amgen was one of the major biotechnology companies created in the decade following the discovery of recombinant DNA. The company completed an IPO in June 1983 worth almost $40 million.
Historic Period	1980-present
Founders	George Rathmann
Place	Thousand Oaks, CA
Organization Type	Biotechnology company
Connections	http://investors.amgen.com/phoenix.zhtml?c=61656&p=irol-IRHome http://www.amgenhistory.com/ deCODE Genetics

9.1.8 Ani Pharmaceuticals

In 2013, Ani Pharmaceuticals merged with BioSante Pharmaceuticals, which had merged with Cell Genesys Inc., which had acquired Genetic Therapy Inc.

Name	Ani Pharmaceuticals
Historic Period	1996-present
Place	Baudette, MN
Organization Type	Pharmaceutical company
Connections	http://www.anipharmaceuticals.com/ BioSante Pharmaceuticals Cell Genesys Inc. Genetic Therapy Inc.

9.1.9 Applera Corporation

Applera emerged out of the Perkin-Elmer Corporation. Perkin-Elmer acquired Applied Biosystems in 1993 and it established Celera Genomics in 1998. Perkin-Elmer split in 1999, selling off the traditional side of its business (the Analytical Instruments Division) to EG&G and EG&G took on the name PerkinElmer. The Life Sciences Division of Perkin-Elmer became the PE Corporation. In 2000, the company was renamed Applera, with two major groups with publicly traded stocks: Applera Corp-Applied Biosystems Group and Applera Corp-Celera Genomics. The name 'Applera' is a combination of its two component groups, appl(iedCel)ara. In 2006, Applera spun off Celera Genomics and changed its name to Applied Biosystems. In 2008, Applied Biosystems merged with Invitrogen to form Life Technologies. In 2014, Thermo Fisher Scientific acquired Life Technologies.

Alternate	PE Corporation (1999-2000); Applera Corporation (2000-2006); Applied Biosystems (2006-2008)
Time Period	1999-2006
Public or Private	Public
Location	Foster, CA (Applied Biosystems) and Rockville, MD (Celera Genomics)
Acquisition History	Applera changes name to Applied Biosystems (2006); Applied Biosystems merges with Invitrogen to form Life Technologies (2008); Life Technologies acquired by Thermo Fisher (2014)
Mergers & Acquisitions	Perkin-Elmer acquires Applied Biosystems (1993); Applied Biosystems merges with Invitrogen to form Life Technologies (2014)
Subsidiaries & Spin-offs	Perkin-Elmer establishes Celera Genomics (1998); Applera spins off Celera Genomics (2006)
Glossary	Instruments, sequencing
Links	http://ir.thermofisher.com/investors/Investor-Overview/default.aspx

9.1.10 Applied Biosystems

Applied Biosystems was founded in 1981 in Foster City, California. It was initially known as GeneCo (Genetic Systems Company). The company manufactured automated devices for sequencing and synthesizing DNA and proteins. In 1993, it formed Lynx Therapeutics as a subsidiary focused on antisense DNA research. Applied Biosystems was acquired by Perkin-Elmer Corporation in 1993 and became a part of the company's Life Sciences Division. In 1998, it was consolidated with other companies acquired by Perkin-Elmer to form PE Biosystems. In 1999, the Life Sciences Division of Perkin-Elmer was renamed Applera, with Applied Biosystems being one of the two groups. In 2006, Applera spun off Celera Genomics and changed its name to Applied Biosystems. In 2008, Applied Biosystems merged with Invitrogen to form Life Technologies and in 2014 Thermo Fisher acquired Life Technologies.

Alternate Names	GeneCo (initial); Applied Biosystmes (1981-1993); PE Biosystems (1998-1999); Applera Corporation (1999-2006); Applied Biosystems (2006-2008)
Time Period	1981-1993
Founders	Sam Eletr and Andre Marion (both from Hewlett Packard)
Public or Private	Public
Location	Foster City, CA
Acquisition History	Acquired by Perkin-Elmer Corporation (1993); PE Biosystems (1998); Life Technologies (2008); Thermo Fisher (2014)
Subsidiaries & Spin-offs	Lynx Therapeutics (1993)
Technologies and Products	DNA sequencing machines used in the HGP
Glossary	Instruments, sequencing
Other Notes	http://www.nytimes.com/2008/06/13/business/13drug.html?_r=0
Links	http://ir.thermofisher.com/investors/Investor-Overview/default.aspx

9.1.11 ARCA Biopharma

ARCA Biopharma acquired Nuvelo, HySeq.

Name	ARCA Biopharma
Historic Period	2004-present
Connections	http://www.arcabiopharma.com/39/Corporate%20Profile/index.html Nuvelo HySeq

9.1.12 Arcaris/Ventana Genetics

Arcaris' function-based assays use "perturbagens," proprietary molecules that disrupt the physiological functions of critical proteins in human cells, to identify novel targets for drug discovery.

Alternate Names	Ventana Genetics (-1999)
Time Period	1996-2003
Founders	Alexander (Sasha) Kamb (now SVP and head of discovery research at Amgen)
Other Top Management	M. Scott Salka; Dennis B. Farrar
Public or Private	Private
Type of Firm	Drug Discovery
Location	Salt Lake City, UT
Acquisition History	Sold in 2003 to Deltagen
Technologies and Products	Drug discovery; perturbagen libraries
Glossary	Functional proteomics; somatic cell genetics
Links	http://www.mede.caltech.edu/seminar_series/kamb https://www.genomeweb.com/deltagen-acquires-functional-proteomics-company-arcaris https://www.genomeweb.com/deltagen-acquires-functional-proteomics-company-arcaris

9.1.13 ARIAD (Ariad Pharmaceuticals Inc)

Ariad Pharmaceuticals is an oncology company developing small molecule drugs using computational technology to understand the structure of targets in order to attack them efficiently and effectively. Its name comes from the Greek myth in which Theseus enters a labyrinth and slays the Minotaur. Ariadne, gave Theseus a spool of thread to unravel as he made his way into the labyrinth so that he could find his way out. In 1997 it formed a joint venture with Hoechst to identify and analyze genes. Currently, its main partner is Merck & Co. In 2015, activist investors forced the retirement of founder, chairman, and CEO Harvey Berger.

Name	ARIAD Pharmaceuticals, Inc.
Time Period	1991 - present
Founders	Harvey Berger (Chairman and CEO - retired in 2015)
Other Top Management	David C. Dalgarno; Shirsh Hirani; Ronald Knickerbocker
Public or Private	Public
Type of Firm	Cancer Therapeutics
Location	Cambridge, MA
Acquisition History	Sells stake in Hoeschst JV to partner (2000)
Mergers & Acquisitions	Mitotix Inc. (1997)
Collaborations & Partnerships	JV with Hoeschst Marion Roussel (1997-2000); Currently partnered with Merck on the development of ridaforolimus
Technologies and Products	Ponatinig (Iclusig)
Glossary	Oncology, structure-based drug discovery
Links	www.ariad.com

9.1.14 Array BioPharma

Array BioPharma Inc. is a biopharmaceutical company focused on the discovery, development, and commercialization of targeted small molecule drugs to treat patients afflicted with cancer. Array was first known for its small molecule libraries and drug discovery platform, which formed the backbone of many partnerships with pharmaceutical and biotech companies, and enabled it to build a strong pipeline of clinical-stage compounds including three in late-stage development.

Time Period	1998 - present
Founders	Kevin Koch; David L. Snitman
Other Top Management	Ron Squarer (CEO)
Public or Private	Public (IPO in November 2000)
Type of Firm	Biopharmaceuticals
Location	Boulder, CO
Collaborations & Partnerships	Icos, Tularik, and Neurocrine in 1999; Asahi Chemical, Eli Lilly, Merck, Amgen, and Immunex in 2000; Takeda Chemical (2001); Pfizer, Japan Tobacco, and Intermune in 2002; AstraZeneca and Genentech in 2003; and more recently Loxo Oncology (July 2013), Celgene (July 2013), and Biogen (May 2014)
Technologies and Products	Binimetinib; small molecule drugs targeting cancer, asthma
Glossary	Computational chemistry; structural biology

Links	http://www.arraybiopharma.com/

9.1.15 Artemis Pharmaceuticals

Artemis Pharmaceuticals researches, develops, and commercializes vertebrate model genetic systems such as genetically engineered mice and zebrafish for use in drug discovery and academic research. It entered into a strategic alliance with its US biotech founder, Exelixis. Exelixis acquired the company in 2001, and continued to operate it as a separate division. In 2007, Exelixis sold 80 percent of Artemis to US-based Taconic Farms, which had a strategic alliance with Artemis for the development and commercialization of genetically engineered mice and rats.

Alternate Names	TaconicArtemis GmbH (2007)
TIme Period	1998-2001 (Still in operation as TaconicArtemis GmbH)
Founders	Nobel laureate Christiane Nusslein-Volhard, Klaus Rajewsky, Peter Stadtler (CEO), and Exelixis
Public or Private	Private
Type of Firm	Tools and Technology
Location	Cologne, Germany
Acquisition History	Exelixis (2001); Taconic Farms acquires 80% stake in 2007
Collaborations & Partnerships	Exelixis (1998) Merck (2002) Taconic Farms (2005) - strategic alliance
Technologies and Products	Model system genetics for target validation Mouse genetics and genomics platform
Glossary	Functional genomics; genetic screens
Links	http://www.biocentury.com/companies/artemis_pharmaceuticals_gmbh

9.1.16 AstraZeneca Group

One of the top ten largest pharmaceutical companies in the world. MedImmune is a member of AstraZeneca Group.

Name	AstraZeneca Group
Alternate	AstraZeneca
History of the Company	Astra AB, a Swedish company, merged with British-based Zeneca in April 1999 to form AstraZeneca.
Historic Period	1999-present
Place	London
Organization Type	Pharmaceutical company
Glossary/Keywords	biologics, immunotherapies, cancer
Connections	http://www.astrazeneca.com/Home http://www.bbc.com/news/health-31010031 MedImmune

9.1.17 Atugen

Atugen was created as a spin-off from Ribozyme Pharmaceuticals (later Sirna Therapeutics) to focus on target discovery and validation collaborations with pharmaceutical companies using proprietary antisense and delivery technologies. It filed its first RNAi patent application in Germany in 2002. In 2005, Atugen became a public company by reverse merging with SR Pharma, a company listed on London's AIM exchange. Two years later, the company changed its name to Silence Therapeutics.

Alternate Names	Atugen AG; present name: Silence Therapeutics
Time Period	1998 - present
Founders	Ribozyme Pharmaceuticals spin-out
Other Top Management	Klaus Giese (VP of Research), Peter Buckel (CEO), Michael Steinmetz (MPM Capital)
Public or Private	Public
Type of Firm	Antisense, Tools and Technology
Location	Berlin-Buch, Germany
Acquisition History	SR Pharma plc (2005) [name changed to Silence Therapeutics plc (2007)]
Mergers & Acquisitions	Transgenic berlin-Buch GmbH (1999-as part of formation of Atugen)
Collaborations & Partnerships	AstraZeneca (1999) GPC AG, Axys Pharmaceuticals, Boehringer Ingelheim, Roche, Bayer (2000) Genta, Serono, Altana AG, Oxford GlycoSciences (2001) Novo Nordisk, UCSF, Schering (2002) Sankyo, Eisai Labs London, Sanofi-Aventis (2004)
Technologies and Products	AtuRNAi platform
Links	http://www.biocentury.com/companies/atugen_ag http://www.evaluategroup.com/Universal/View.aspx?type=Story&id=165

9.1.18 Aurora Biosciences

Founded in 1996 in San Diego, California, Aurora Biosciences focused on assay development and ultra high-throughput mammalian cell screening. It was acquired by Vertex Pharmaceuticals in 2001 in a stock transaction valued at $592 million.

Alternate Names	Aurora Biotechnologies (founded by Roger Tsien to commercialize the instrumentation of Aurora Biosciences)
Time Period	1996-2001
Founders	Roger Tsien (Nobel laureate and co-founder); Avalon Ventures
Other Top Management	Timothy J. Rink (CEO)
Public or Private	Public
Type of Firm	Tools and Technology
Location	San Diego, CA
Acquisition History	Acquired by Vertex (2001)
Collaborations & Partnerships	Collaborations with Wyeth Ayerst, Glaxo Wellcome, Merck & Co., Elli Lilly and Co., Cystic Fibrosis Foundation, Exelexis Pharmaceuticals, Genentech, Bristol-Myers Squibb, Merck & Co., AntiCancer, National Cancer Institute, Pfizer, Becton Dickinson and Co., Clonetech Laboratories, Becton Dickson, F. Hoffman-La Roche, Pharmacia & Upjohn, Parke-Davis,

	Acacia Biosciences, Packard Instrument, Cytovia, Xenometrix, OSI Pharmaceuticals, Systems Integration Drug Discovery Company, University of California, Sibia Neurosciences, Allelix Biopharmaceuticals, Alanex Corp., ArQule Inc., Axys (Senequa) Therapeutics
Glossary	Assays, high-throughput screening
Links	http://www.xconomy.com/san-diego/2009/12/07/tools-company-nexus-biosystems-acquires-aurora-biotechnologies/ http://www.vrtx.com/

9.1.19 AVI BioPharma

AVI BioPharma, Inc. was founded in 1980 as AntiVirals, Inc. to develop agents for specifically modulating the activity of selected genes. By the mid-1990s, the company's "Morpholino antisense oligos" were ready to be used as tools for genetic research. In 1996, the company completed an IPO, changed its name to AVI BioPharma. In 1997, it spun off its tools business as Gene Tools LLC to focus on the development of RNA-based therapeutics for unmet medical needs. Its clinical stage pipeline includes treatments for Duchenne muscular dystrophy, infectious diseases such as Marburg virus, influenza, Ebola virus, and tuberculosis.

Alternate Names	AntiVirals, Inc (Sarepta Pharmaceuticals (2012 - current)
Time Period	1980 - present
Founders	James Summerton
Other Top Management	Chris Garabedian (former CEO of Sarepta)
Public or Private	Public
Type of Firm	RNA-based therapeutics
Location	Cambridge, MA (maintains lab at original location in Corvallis, OR)
Mergers & Acquisitions	ImmunoTherapy Corp. (1997) Ercole Biotech (2008)
Subsidiaries & Spin-offs	Gene Tools LLC (1997)
Collaborations & Partnerships	Lorus Therapeutics (2000) Exelixis, Medtronic (2001) US Department of Defense
Technologies and Products	Avicine (cancer vaccine); Neugene (antisense compounds)
Keywords	RNA, antisense
Connections	https://www.gene-tools.com/ http://www.biocentury.com/companies/sarepta_therapeutics_inc https://www.sarepta.com/our-company

9.1.20 Axys Pharmaceuticals

Axys Pharmaceuticals was acquired by Celera Genomics in 2001.

Name	Axys Pharmaceuticals
Time Period	1998 - 2001
Founders	Christopher Gabrieli (Arris)
Other Top Management	John Walker (Chairman and CEO); Michael Venuti (SVP of research)

Public or Private	Public
Location	San Francisco, CA
Acquisition History	Acquired by Celera Genomics (2001)
Mergers & Acquisitions	Established when Arris Pharmaceuticals acquired Sequana Therapeutics (1998)
Subsidiaries & Spin-offs	Xyris Corp (agbio spinoff)
Collaborations & Partnerships	1998: Boehringer Mannheim, Glaxo Wellcome, Roche Bioscience; Warner-Lambert; Signal Pharmaceuticals; Wyeth-Ayerst; Bristol-Myers; Rhone Poulenc Rorer; Merck 1999: PPD; Protein Design Labs; Novalon Pharmaceutical; Daiichi Pharmaceutical; Signal Pharmaceuticals 2000: Cephalon; Searle; Novartis Research Foundation; Celera Genomics; Discovery Partners
Technologies and Products	Delta technology
Glossary	Microarray, disease gene finding, hereditary melanoma, TULP1 gene (tubby), ProteomeBank
Links	http://www.biocentury.com/archives/Results2.aspx?archivesearch=%252baxys%2b%252bpharmaceuticals https://www.celera.com/celera/about

9.1.21 Baker Hughes

Baker Hughes was formed from merger of Summa Corporation and Baker International.

Name	Baker Hughes
Connections	http://www.bakerhughes.com/ Baker International Summa Corporation

9.1.22 Baker International

Baker Hughes was formed from merger of Summa Corporation and Baker International.

Name	Baker International
Connections	http://www.bakerhughes.com/ Baker Corporation Summa Corporation

9.1.23 Beckman-Coulter

Beckman Coulter develops, manufactures, and markets products for complex biomedical testing. It was founded in 1935 as National Technical Laboratories in Pasadena, CA by Arnold Beckman, a professor at Caltech, to make and sell pH meters. In 1950 it changed its name to Beckman Instruments, and went public two years later. The company grew both geographically and organically through acquisitions, and merged with SmithKline in 1982, which spun it out as a publicly listed company in 1988. In 1997 it acquired Coulter Corp., a manufacturer of blood and cell analysis systems, changing its name to Beckman Coulter, Inc. in 1998. Today, the company operates under two segments, Diagnostics and Life Sciences. In 2011, Beckman Coulter was acquired by Danaher Corp.

Alternate Names	National Technical Laboratories (1935); Beckman Instruments (1950); Beckman Coulter (1998)
Time Period	1935 - present
Founders	Arnold O. Beckman (Caltech); Wallace H. Coulter
Other Top Management	Arnd Kaldowski (Dx); Jennifer Honeycutt (Life Sciences)
Public or Private	Private – unit of Danaher (Public)
Type of Firm	Tools and Technology; Diagnostics
Location	Brea, CA
Acquisition History	Acquired by Danaher Corporation in 2011.
Mergers & Acquisitions	Merged with SmithKline (1982-1988) to form SmithKline Beckman Hybritech (1995 from Eli Lilly) Sanofi portion of Sanofi Pasteur Diagnostics (1996) Coulter Corporaton (1998) Lumigen and Agencourt Bioscience (2006) Flow Cytometry unit of Dako N. America (2007) Lab-based diagnostics unit of Olympus Corp (2009)
Subsidiaries & Spin-offs	Helipot (1943-1952); Shockley Semiconduction Laboratory (1955-1960);
Technologies and Products	Lab tools, diagnostic tests
Glossary	Scientific instruments; genomics; immunoassay
Connections	http://www.beckmancoulter.com https://en.wikipedia.org/wiki/Beckman_Coulter

9.1.24 Biacore AB

Biocore AB was born as Pharmacia Biosnesor AB by experts from Swedish academia, industry, and government, who came together to develop new instruments for studying biomolecular interactions. The result was the Biacore® platform, which combined surface chemistry, flow systems, and optical detection methods in one analytical research tool for measuring protein-protein interactions and binding affinities. It was commercialized in 1990 and followed by improved versions. The company expanded both organically and through acquisitions and was acquired by GE Healthcare in 2006 for $390 million.

Alternate Names	Pharmacia Biosensor AB (1984-1996)
Time Period	1984 - 2006
Founders	Pharmacia, Linköping Institute of Technology, Swedish National Defense Research Institute
Other Top Management	Erik Walldén
Public or Private	Private
Type of Firm	Tools and Technology
Location	Uppsala, Sweden
Acquisition History	Acquired by GE Healthcare in 2006
Mergers & Acquisitions	HTS Biosystems (2005)
Collaborations & Partnerships	Boehringer Ingelheim (1999)

Technologies and Products	Surface Plasmon Resonance (SPR)-based instruments; automated research systems
Glossary	Biosensors, protein-protein interactions; chemical kinetics
Links	https://www.biacore.com/lifesciences/history/index.html

9.1.25 Biogen

Biogen's first CEO was co-founder Walter Gilbert, who devised one of the original methods of sequencing DNA. He shared a Nobel Prize in Chemistry with Frederick Sanger for this work. Gilbert also came up with the idea of Genome Corporation, originally conceived as a private firm to sequence the human genome.

Name	Biogen
Alternate	Biogen Idec
History of the Company	Biogen was one of the first biotechnology companies to come out of the recombinant DNA revolution in the 1970s. It was founded in 1978 by Philip Sharp, Charles Weissmann, and Walter Gilbert in Geneva, Switzerland. In 2003, Biogen merged with Idec Pharmaceticals to become Biogen Idec. In 2015, however, after over ten years of using that name, they once again go by just Biogen.
Historic Period	1978-present
Founders	Philip Sharp, Charles Weissmann, Walter Gilbert
Place	Cambridge, MA
Organization Type	Biotechnology company
Glossary/Keywords	Biologics, gene therapy, precision medicine, neurology
Connections	https://www.biogen.com/ http://www.wsj.com/articles/biogen-drops-idec-from-name-1427113639 Biogen Idec

9.1.26 Biogen Idec

Idec Pharmaceuticals was a company based in San Diego, California. In 2003, they merged with Biogen to become Biogen Idec. In 2015, the company went back to being known simply as Biogen.

Name	Biogen Idec
Alternate	Biogen (after 2015)
Historic Period	2003-present (company changed name back to Biogen in 2015)
Place	Cambridge, MA
Organization Type	Biotechnology company
Connections	http://www.biogenidec.com/investors.aspx?ID=5494 http://www.nytimes.com/2003/06/24/business/idec-to-merge-with-biogen-in-6.8-billion-deal.html?pagewanted=all http://www.wsj.com/articles/biogen-drops-idec-from-name-1427113639 Biogen

9.1.27 BioSante Pharmaceuticals

In 2013, Ani Pharmaceuticals merged with BioSante Pharmaceuticals, which had merged with Cell Genesys Inc., which had acquired Genetic Therapy Inc.

Name	BioSante Pharmaceuticals
Alternate	Ben-Abraham Technologies
History of the Company	BioSante Pharmaceuticals was founded as Ben-Abraham Technologies and changed its name in 1999.
Historic Period	1996-present
Founders	Avi Ben-Abraham
Place	Lincolnshire, Illinois
Organization Type	Pharmaceutical company
Connections	http://www.anipharmaceuticals.com/ http://www.businesswire.com/news/home/20130620005348/en/BioSante-Pharmaceuticals-ANI-Pharmaceuticals-Announce-Completion-Merger http://www.prnewswire.com/news-releases/ben-abraham-technologies-proposes-name-change-76940762.html Ani Pharmaceuticals Cell Genesys Inc. Genetic Therapy Inc.

9.1.28 Boehringer Ingelheim

In 2003, Boehringer Ingelheim partnered with Sagres Discovery, a functional genomics company that specialized in creating a database of oncogenes, to study cancer drug targets.

Name	Boehringer Ingelheim
History of the Company	Boehringer Ingelheim
Historic Period	1885-present
Founders	Albert Boehringer
Place	Ingelheim am Rhein, Germany
Organization Type	Pharmaceutical company
Glossary/Keywords	Oncology, cardiovascular disease, respiratory disease, central nervous system
Connections	http://www.boehringer-ingelheim.com/corporate_profile.html https://www.genomeweb.com/informatics/sagres-lands-boehringer-ingelheim-deal-it-assembles-oncogenome

9.1.29 Bolt, Beranek & Newman (BBN)

In 1982, Bolt, Beranek & Newman was awarded a 5-year contract by the National Institutes of Health to develop the DNA sequence database GenBank.

Raytheon BBN Technologies was originally Bolt, Beranek & Newman (BBN).

Name	Bolt, Beranek & Newman
Alternate	BBN
History of the Company	Originally formed in the post-war years as a consulting firm specializing in acoustics, Bolt, Beranek & Newman evolved into an important computer research company that was integral in forming the technology that eventually became the Internet. They were also involved in developing the database technology to store sequencing information from the Human Genome Project.

Historic Period	1948
Founders	Leo Beranek and Richard Bolt
Place	Cambridge, MA
Organization Type	Research and consulting firm
Connections	http://www.raytheon.com/ourcompany/bbn/ http://www.nih.gov/news-events/news-releases/genbank-celebrates-25-years-service-two-day-conference-leading-scientists-will-discuss-dna-database-april-7-8-meeting http://web.mit.edu/6.933/www/Fall2001/BBN.pdf Raytheon BBN Technologies

9.1.30 Bruker Biosciences

Bruker was started by Günther Laukien, a German academic who saw the potential of high-resolution nuclear magnetic resonance spectroscopy for life sciences research. During the 1970s, the company grew quickly, establishing a presence around the world, and expanding into new technologies and divisions. In 1997 it launched Bruker AXS after acquiring the X-ray spectroscopy division of Siemens AG. In 2003, it combined its Bruker AXS unit with its mass spectrometry unit, Bruker Daltonics, to form Bruker Biosciences, a public company. In 2008, all the Bruker business (Bioscience, BioOptics, and BioSpin) were unified under one corporate parent: Bruker.

Alternate Names	Bruker Corporation (2008)
Time Period	2003 - present (Bruker: 1960 – present)
Founders	Günther Laukien (founded in Germany)
Other Top Management	Frank Laukien (president and CEO)
Public or Private	Public
Type of Firm	Tools and Technology
Location	Global; Billerica, MA
Mergers & Acquisitions	X-ray spectroscopy unit of Siemens AG (1997) Roentec AG (2005) Bruker Optics (2006) Bruker BioSpin (2007)
Collaborations & Partnerships	Spectrospin AG (1965-1970) Discovery Partners, SurroMed (2003)
Technologies and Products	Analytical instruments
Glossary	NMR – nuclear magnetic resonance, x-ray diffraction, spectroscopy, mass spectrometry, surface analysis, proteomics, high-throuput screening
Links	https://www.bruker.com/about-us/who-we-are/whoweare/history.html http://www.biocentury.com/Archives/Results2.aspx?archivesearch=%252b%2522bruker%2bbiosciences%2522

9.1.31 Caliper Life Sciences Corporation

Caliper Life Sciences was founded as Caliper Technologies in 1995 with a focus on microfluidics technology. It went public in 1999 in an IPO that raised $75 million. After spending several years refining its technology, in 2003, it acquired Zymark, a company focused on laboratory automation and robotics, and soon changed its name to Caliper Life Sciences. Caliper continued to grow through acquisitions and actively partnered with

pharmaceutical and biotech companies to avail them of its automated systems. In November 2011, Perkin Elmer acquired Caliper for $600 million.

Alternate Names	Caliper Technologies (1995-2003)
Time Period	1995-2011
Founders	Larry Bock, Michael Knapp, Michael Ramsey, Andrea Manz
Other Top Management	Kevin Hrusovsky (CEO at time of PerkinElmer acquisition)
Public or Private	Public
Type of Firm	Tools and Technology
Location	Hopkinton, MA
Acquisition History	PerkinElmer (2011)
Mergers & Acquisitions	Zymark (2003); NovaScreen Biosciences (2005); Xenogen (2006); Cambridge Research & Instrumentation (2010)
Collaborations & Partnerships	Roche (1996); Amgen, Eli Lilly (1999); Millenium; SmithKline (2000); Ambion (2002); Affymetrix, Sigma-Aldrich (2004); Agilent, Bio-Rad (2005); Wyeth, Schering-Plough, Invitrogen (2006)
Technologies and Products	Automated lab tools; LabChip 3000 drug discovery system
Glossary	Microfluidics; lab-on-a-chip; optical imaging; genomics
Links	https://en.wikipedia.org/wiki/Caliper_Life_Sciences http://www.biocentury.com/Archives/

9.1.32 Celera Genomics

Celera Genomics was founded in 1998 as a joint venture between The Institute for Genomic Research (TIGR) and Perkin-Elmer Corporation. Its goal was to sequence human genome more quickly than the Human Genome Project effort using the “shotgun” sequencing method. In 1999, it acquired 49 percent of Agrogene, and in 2000, 47.5 percent of Shanghai GeneCore BioTechnologies. In 1999, it became one of two groups of Applera, which emerged from the Life Sciences Division of Perkin-Elmer. In 2008, Applera spun off Celera Genomics as an independent company. In 2011, it was acquired by Quest Diagnostics.

Alternate Names	Celera
Time Period	1998 - 2011
Other Top Management	J. Craig Venter, Mark Adams
Public or Private	Public
Type of Firm	Tools and Technology
Location	Rockville, MD
Acquisition History	Acquired by Quest Diagnostics (2011)
Mergers & Acquisitions	Agrogen (1999); Shanghai GeneCore BioTechnologies (2000); Paracel (2000)
Subsidiaries & Spin-offs	Founded as joint venture between TIGR and Perkin-Elmer
Collaborations & Partnerships	PE Biosystems, Gemini Holdings plc, Rhone-Poulenc Rorer (1999); Geron, Life Technologies, AHP, Immunex (2000); Applied Biosystems, Axys Pharmaceuticals (2001)
Technologies and Products	Databases, bioinformatics

Glossary	Shotgun sequencing, *Drosophila* genome, human genome
Connections	http://www.biocentury.com/Archives/Results2.aspx?archivesearch=%252bcelera

9.1.33 Celldex Therapeutics

In 2009, Celldex Therapeutics acquired CuraGen, which during the 1990s contributed essential DNA analysis technology to the Whitehead Institute as part of their effort to sequence the human genome.

Name	Celldex Therapeutics
History of the Company	Celldex was formed in 2005 as a spin off of Medarex, a company now owned by Bristol-Myers Squibb.
Historic Period	2005-present
Founders	Anthony Marucci
Place	Hampton, NJ
Organization Type	Biotechnology company
GlossaryKeywords	antibodies, immunotherapies
Connections	http://ir.celldex.com/index.cfm http://seekingalpha.com/article/318748-celldex-therapeutics-a-potential-triple-with-data-on-the-way http://www.fiercebiotech.com/story/celldex-acquires-curagen-94-5m/2009-05-29 http://www.thefreelibrary.com/CuraGen+enables+final+phase+of+Human+Genome+Project.-a018204556 CuraGen

9.1.34 Cell Genesys Inc.

Ani Pharmaceuticals merged with BioSante Pharmaceuticals, which had merged with Cell Genesys Inc., which had acquired Genetic Therapy Inc.

In March 1993, scientists at Cell Genesys announced they had discovered a way to put large stretches of human DNA into mice. This was part of the company's strategy to develop human monoclonal antibodies.

Name	Cell Genesys Inc.
Historic Period	1988-2009
Other Top Management	Stephen Sherwin
Place	San Francisco, CA
Organization Type	Biotechnology company
Glossary/Keywords	gene therapy, monoclonal antibodies
Connections	http://www.anipharmaceuticals.com/ http://www.thefreelibrary.com/CELL+GENESYS+SCIENTISTS+DEVELOP+METHOD+FOR+INTRODUCING+LA a013128951 https://biotechhistory.org/timeline/cell-genesys/ Ani Pharmaceuticals BioSante Pharmaceuticals Genetic Therapy Inc.

9.1.35 Cepheid

Cepheid is a molecular diagnostics company that develops, manufactures, and markets fully integrated rapid diagnostic systems based on DNA analysis for the identification of infection-causing organisms and genetic-based diseases. The company refined testing methods developed by the US Department of Energy 's Lawrence Livermore National Laboratory, and was one of a few companies able to accurately detect biothreats following the 20021 anthrax attacks. In 2014, during the Ebola crisis in West Africa, the US FDA granted emergency authorization for the use of Cepheid Xpert Ebola assay.

Time Period	1996 - present
Founders	Thomas Gutshall (CEO), Bill McMillan, Kurt Petersen, Greg Kovacs, Steven Young, and Allen Northrup
Other Top Management	John L. Bishop (CEO from 2002 on)
Public or Private	Public (2001)
Type of firm	Diagnostics
Location	Sunnyvale, CA
Mergers & Acquisitions	Actigenics (2006); Nycomed unit (2007)
Subsidiaries & Spin-offs	Aridia Corp (2000 JV with Infectio Diagnostic based in Canada)
Collaborations & Partnerships	Innogenetics NV (1998); PE Biosystems (2000); Environmental Technologies Group (2001); Applied Biosystems (2002); bioMerieux, Applera (2004); Novartis (2010); Foundation for Innovative New Diagnostics (2011)
Technologies and Products	GeneXpert System
Glossary	Genetic testing, in vitro diagnostics, biodetection, DNA analysis
Connections	http://www.cepheid.com/ https://en.wikipedia.org/wiki/Cepheid_Inc

9.1.36 Cetus Corporation

While working at Cetus, the biochemist Kary Mullis developed the polymerase chain reaction (PCR), a revolutionary laboratory technique used to amplify DNA. PCR would become essential to the sequencing of the human genome.

Cetus was acquired by Chiron Corporation in 1991.

Name	Cetus Corporation
Alternate	Cetus
History of the Company	Cetus was founded in 1971 and was the first modern biotechnology company. Over the years, Cetus saw much capital come its way, especially with its massive IPO in 1981 for well over $100 million. Despite all these resources, Cetus was not able to translate its research into marketable therapies, and the company was bought by Chiron in 1991.
Historic Period	1971-1991
Founders	Peter Farley, Donald Glaser, Ronald Cape
Place	Emeryville, CA
Organization Type	Biotechnology company
Connections	http://www.novartis.com/investors/index.shtml http://www.nytimes.com/1991/07/23/business/2-biotech-pioneers-to-merge.html

	http://ethw.org/First-Hand:Starting_Up_Cetus,_the_First_Biotechnology_Company_-_1973_to_1982 http://www.the-scientist.com/?articles.view/articleNo/12113/title/Cetus--A-Collision-Course-With-Failure/

9.1.37 ChemGenex Pharmaceuticals

Based in Melbourne, Australia, and Menlo Park, California, ChemGenex Pharmaceuticals uses genomics to discover and validate individualized therapeutic candidates in oncology. In 2004, AGT Biosciences acquired the company for $10.5 million, but kept the name for the new merged entity. In June 2011, US biotech Cephalon acquired 75 percent of ChemGenex, valuing the company at $231 million. Five months later, Cephalon was acquired by Israeli pharmaceutical company Teva. It continues to operate in Menlo Park as a unit of Teva.

Time Period	1999-2011
Other Top Management	Greg Collier (CEO), James Campbell (CFO and COO)
Public or Private	Public
Type of Firm	Biopharmaceuticals
Locations	Melbourne, Australia and Menlo Park, CA
Acquisition History	AGT Biosciences (2004); Cephalon (6/2011) [Teva Pharmaceuticals acquires Cephalon (10/2011)]
Subsidiaries & Spin-offs	Verva Pharmaceuticals (2008)
Collaborations & Partnerships	Vernalis (2004); MolecularMD (2006); Hospira (2009)
Technologies and Products	Omapro (treatment for CML)
Links	http://www.biocentury.com/Archives/

9.1.38 Chiron

Chiron bought Cetus Corporation in 1991.

Novartis International acquired Chiron in 2006.

Name	Chiron
Alternate	Chiron Corporation
History of the Company	Founded in 1981, Chiron was named for a figure in Greek mythology who taught medicine. The company sought to break new paths in genetic engineering, and they went on to create a vaccine for Hepatitis B that was the world's first vaccine created using recombinant DNA methods. Chiron also the first group of scientists to clone the HIV genome, in 1984.
Historic Period	1981-2006
Founders	William Rutter, Edward Penhoet, Pablo Valenzuela
Place	Emeryville, CA
Organization Type	Biopharmaceutical company
Glossary/Keywords	Hepatitis B, HIV, vaccines, oncology
Connections	http://www.novartis.com/investors/index.shtml http://www.bizjournals.com/sanfrancisco/stories/2001/07/16/newscolumn9.html

	Novartis International

9.1.39 Chondrogene Limited

ChondroGene was founded by two doctors, an orthopedic surgeon and an expert in tissue-specific functional genomics, to identify novel therapeutic targets for osteoarthritis. It focused on gene expression of cartilage cells called chondrocytes. In 2003, it acquired privately held GeneNews Limited, also founded by Dr. Liew, to broaden its focus past one disease. In 2006, the company changed its name to GeneNews to reflect its focus on a broader range of diagnostic tests.

Alternate Names	GeneNews Ltd (2006 - present)
Time Period	1998 - present
Founders	Dr K. Wayne Marshall and Dr C.C. Liew
Other Top Management	James R. Howard-Tripp (executive chairman)
Public or Private	Public
Type of Firm	Diagnostic
Location	Toronto, Ontario, Canada
Collaborations & Partnerships	Genzyme Biosurgery (2001), Pfizer (2002, 2003), J&J (2008), Shanghai Biochip Co. Ltd (2012)
Technologies and Products	ChondroChip™ (cartilage-specific microarray, ColonSentry (colon cancer diagnostic)
Glossary	Functional genomics, biomarkers
Links	http://www.genenews.com/history.html http://www.biocentury.com/Archives/Results2.aspx?archivesearch=%252bgenenews

9.1.40 Ciphergen Biosystems

Ciphergen Biosystems was founded in 1996 to develop protein chips that could enable rapid protein discovery and assay development on a single platform. Its ProteinChip system combined affinity chromatography and time-of-flight mass-spectrometry. The company raised $88 million in an IPO in 2000. In 2007 the company changed its name to Vermillion Inc.

The company had IPO in 2000 worth $88 million.

Alternate Names	Vermillion (2007- present
Time Period	1993 - present
Other Top Management	Christopher Pohl (VP of R&D); William Rich (CEO)
Public or Private	Public
Type of Firm	Diagnostic
Locations	Fremont, CA; moved to Austin, TX in 2010
Acquisition History	Pall buys Ciphergen's chromatography unit (2004) Bio-Rad Labs buys Ciphergen's proteomics instrument unit
Mergers & Acquisitions	Invitrogen's chromatography unit (2001) Correlogic (2012)
Subsidiaries & Spin-offs	Aspira Labs

Collaborations & Partnerships	MediGene, Johns Hopkins (2000); Pfizer, Europrteome (2001); Beckman Coulter (2002); Biosite, bioMerieux (2003); Bayer, Quest Diagnostics (2005)
Technologies and Products	ProteinChip Biomarker System; ovarian cancer risk tests
Glossary	Proteomics, protein chips, biomarkers
Links	http://www.biocentury.com/Archives/ http://www.biocentury.com/companies/vermillion_inc

9.1.41 Cogent Neuroscience

Cogent Neuroscience used functional genomics to discover and develop treatments for central nervous system diseases. The company's screening process was carried out in living, intact brain tissue, rather than cell culture, and it had developed technology to maintain the tissue's viability for at least seven days, according to the company. Though Cogent had two ongoing collaborations with Elan Corp. and had planned to develop a bioinformatics system, it filed for bankruptcy and went out of business in 2002.

Time Period	1998 - 2002
Founders	Lawrence Katz, Donald Lo, and Max Wallace (CEO)
Public or Private	Private
Type of Firm	Biotechnology
Place	Durham, NC
Collaborations & Partnerships	Elan Corp (2001); reQ Therapeutics (2001)
Glossary	Functional genomics
Links	http://www.biocentury.com/companies/cogent_neuroscience_inc

9.1.42 Collaborative Research, Inc. (Genome Therapeutics; Oscient Pharmaceuticals)

Thermo Fisher Scientific acquired Life Technologies and, in effect, Invitrogen, Applera, Applied Biosystems, Genome Therapeutics, Collaborative Research.

Alternate Names	Genome Therapeutics (1994); Oscient Pharmaceuticals (2004)
Time Period	1961 - 2010
Founders	Orrie Friedman
Other Top Management	Helen Donis-Keller
Public or Private	Public
Location	Waltham, MA
Acquisition History	Agencourt Bioscience buys Oscient's sequencing division (2003)
Mergers & Acquistions	Genesoft (2003)
Collaborations & Partnerships	Astra AB (1995); Schering-Plough (1995); Merck (1996); Versicor , Bayer (1997); ArQule (1998); Cambridge Antibody, Biogen, CuraGen, bioMerieux (1999); Wyeth-Ayerst, Bristol Myers (2000); AHP, Cetek, Aventis (2001); Amgen (2003)
Technologies and Products	GTC Sequencing Center; first commercial genome sequence (Helicobacter pylori); PathoGenome database

Glossary	Functional genomics, drug discovery, high-throughput sequencing of pathogen genomes, identification of human disease genes
Links	https://en.wikipedia.org/wiki/Genome_Therapeutics_Corporation http://ir.thermofisher.com/investors/Investor-Overview/default.aspx http://www.biocentury.com/archives/

9.1.43 Commonwealth Biotechnologies

Commonwealth Biotechnologies, Inc., is a contract research organization founded in 1992 to provide drug discovery services to the global biotechnology and pharmaceutical industry. Since 2004, CBI has pursued a strategy of acquiring or merging with complementary companies that extend its drug discovery capabilities and earnings potential. Commonwealth Biotechnologies emerged from bankruptcy by merging with HedgePath Pharmaceuticals in 2013.

Alternate Names	HedgePath Pharmaceuticals (2013-)
Time Period	1992 - present
Founders	Four Virginia Commonwealth University scientists
Other Top Management	Nicholas J. Virca (current president and CEO)
Public or Private	Public
Type of Firm	Contract research organization; supplies and services
Location	Richmond, VA
Acquisition History	Bostwick buys two CBI units (2009); Leadtec acquires Mimotopes (2010); HedgePath Pharmaceuticals (2013)
Mergers & Acquisitions	Mimotopes (2006); Tripos' Discovery Research unit (2007); GL Biochem (2013)
Subsidiaries & Spin-offs	RCNET-chemicals; EuroChemicals; Mimotopes, PTY (Australia and China)
Collaborations & Partnerships	Prism Pharmaceuticals (2006); JV Venturepharm Asia (2008)
Technologies and Products	AccuTrac DNA sequencing reagents
Glossary	CRO
Links	http://www.biocentury.com/companies/commonwealth_biotechnologies_inc http://www.cbi-biotech.com/

9.1.44 Compaq

Hewlett Packard spun out Agilent; they also acquired Compaq in 2002.

During the Human Genome Project, Compaq's technology was used to handle the large amounts of data generated by scientists' sequencing work. Beginning in 1998, Compaq partnered with Celera Genomics to help Celera with their information technology.

Name	Compaq
Historic Period	1982-2002
Organization Type	Computer manufacturer
Connections	http://h30261.www3.hp.com/ http://www.taborcommunications.com/sponsors/compaq/celera2.html

	Agilent Hewlett Packard

9.1.45 Complete Genomics

Complete Genomics was founded in 2006 to sequence genomes. In February 2009, it sequenced its first human genome. By the end of that year, it had sequenced fifty genomes. It has now sequenced more than 20,000 genomes. The genomic data is used to study genomic variation and identify gene-related diseases. Its technology platform uses DNA nanoball sequencing to assemble sequences and variation files using lower volumes and concentrations of reagents, and attain a greater number of base reads per image. The 69 Genomes Data project provides 69 DNA samples sequenced using the company's Standard Sequencing Service. Complete Genomics was acquired by BGI-Shenzhen in 2012. In 2015, it introduced its Revolocity system, for whole genome sequencing and whole exome sequencing.

Name	Complete Genomics Inc.
Time Period	2005-2013 (now operates as a unit of BGI)
Founders	Clifford Reid, Radoje (Rade) Drmanac, and John Curson
Public or Private	Public (IPO in 2010)
Type of Firm	Tools and Technology
Location	Mountain View, CA
Acquisition History	Acquired by BGI-Shenzhen
Collaborations & Partnerships	Institute for Systems Biology (2008); GATC Biotech (2009); Inova Health System (2011); Mayo Clinic (2012)
Technologies and Products	69 Genomes Data, DNA nanoball sequencing, Revolocity system
Keywords	Genomic variation, sequencing, instruments
Links	http://www.completegenomics.com/about-us/ https://en.wikipedia.org/wiki/Complete_Genomics http://www.biocentury.com/companies/complete_genomics_inc

9.1.46 Compugen

Compugen is a drug discovery company that uses predictive computational biochemistry to advance a therapeutic pipeline of immuno-oncology programs for unmet medical needs. It was started to develop more powerful computers able to handle increased data being produced by DNA sequencing; in 2001, it shifted focus to providing bioinformatics and diagnostic services; and in 2010, to the discovery and development of immune-oncology therapeutic candidates. The company went public in the US in 2000, in Israel in 2001, and established a US presence in South San Francisco, California, in 2012. In 2014, Compugen made headlines when it announced a collaboration with German pharmaceutical Bayer to research and develop two of its preclinical immune checkpoint regulators as cancer therapies.

Time Period	1993 - present
Founders	Eli Mintz, Simchon Faigler, Amir Natan
Other Top Management	Martin Gerstel (Chairman), Anat Cohen-Dayag (CEO)
Public or Private	Public
Type of Firm	Therapeutics, computational biochemistry
Location	Tel Aviv, Israel

Mergers & Acquisitions	Metafore (2015)
Subsidiaries & Spin-offs	Evogene (1998-2002); Agro-Leads (2002); Neviah Genomics, an Israeli biomarker JV with Merck Serono (2012)
Collaborations & Partnerships	Warner-Lambert, Pfizer (1998); Genzyme Molecular, Human Genome Sciences, Genome Therapeutics, MediGene (2000); Novartis (2001); Gene Logic (2002); Abbott (2003); Biosite, J&J (2005); Medarex, Teva (2007); Merck, Merck KGaA (2008); Seattle Genetics (2010); Bayer (2013)
Technologies & Partnerships	Bioccelerator (faster computer); LEADS (1997)
Glossary	Computational biochemistry, cancer, checkpoint regulators
Links	https://en.wikipedia.org/wiki/Compugen_(Israeli_company) http://www.cgen.com/about-us/overview http://www.biocentury.com/companies/compugen_ltd

9.1.47 CuraGen

CuraGen was founded in 1993 in New Haven, Connecticut, to discover disease genes by analyzing gene expression patterns in cells of abnormal tissues. Celldex Therapeutics acquired CuraGen in 2009.

In the mid-1990s, CuraGen contributed to the Human Genome Project with the DNA analysis technology it had developed. A collaboration with the Whitehead Institute, beginning in 1996, allowed the researchers there to make use of CuraGen's Niagara technology, which significantly sped up sequencing and expression analysis.

Name	CuraGen
Time Period	1993 - 2009
Founders	Jonathan M. Rothberg
Public or Private	Public
Type of Firm	Tools and Technology
Location	New Haven, CT
Acquisition History	Acquired by Celldex Therapeutics (2009)
Subsidiaries & Spin-offs	454 Life Sciences (2000)
Collaborations & Partnerships	Pioneer Hi-Bred, Biogen, Genentech (1997); ArQule, DuPont, Glaxo Wellcome (1998); Roche, COR Therapeutics, Abgenix (1999); Gemini Genomics, Biogen, Ono Pharmaceutical (2000); Immunex, Monsanto, Bayer (2001), Sequenom, Alexion (2002); Pfizer (2003)
Technologies and Products	GeneCalling (gene expression), PathCalling (biological pathways), HitCalling (potential drugs), CuraTox, and CuraMode pharmacogenomics databases, GeneScape Portal (database for data mining), CuraTools (genomics data analysis software)
Keywords	Databases, gene expression, drug discovery, software, SNP's
Links	http://ir.celldex.com/index.cfm http://www.biocentury.com/companies/curagen_corp http://www.thefreelibrary.com/CuraGen+enables+final+phase+of+Human+Genome+Project.-a018204556

9.1.48 Cytomyx Holdings plc

Cytomyx provided cells expressing human ion channels and offered a compound profiling service based on its extensive collection of cell lines, in particular hERG and other cardiac channels using automated

electrophysiology. The company completed an IPO in 2001. In 2006, Cytomyx was acquired by Serologicals, which was then acquired by Millipore.

Alternate Names	Cambridge BioScience Ltd (1996-2001)
Time Period	1996 - 2006
Founders	Michael Kerins (CEO); Umesh Patel
Public or Private	Public
Type of Firm	Tools and Technology
Locations	Cambridge, UK
Acquisition History	Serologicals (2006); Millipore (2006)
Mergers & Acquisitions	Clinomics Biosciences (2003); Ardais' biorepository unit (2005)
Subsidiaries & Spin-offs	Cytocell Technologies
Collaborations & Partnerships	Exalpha Biologicals (2002); AstraZeneca (2004); Biomoda, Wyeth, OriGene (2005)
Technologies and Products	TissueScan (PCR biomarker validation); IonScreen
Glossary	Genomics, Proteomics, High throughput screening
Links	http://www.biocentury.com/companies/cytomyx_holdings_plc

9.1.49 Cytrx

CytRx Corporation uses a proprietary copolymer technology to research and develop cancer therapeutics. Its lead compound, aldoxorubicin, an improved version of the chemotherapeutic agent doxorubicin, is in late-stage testing. It was founded in 1985 and completed an IPO one year later. It set up a subsidiary, Vaxcel, in 1993 to develop its vaccine adjuvant technology. In 2002, the company merged with Global Genomics Capital, and though it said it would change its name to Global Genomics, it did not.

CytRx's subsidiary and eventual spin out, RXi Pharmaceuticals, is focused on RNAi-based therapeutics.

Time Period	1985 - present
Founders	Robert Hunter
Other Top Management	Jack Luchese (CEO in 1993); Steven A Kriegsman (chairman and CEO)
Public or Private	Public (1986)
Type of Firm	Biopharmaceuticals
Location	Los Angeles, CA
Mergers & Acquisitions	Global Genomics Capital (2002); Innovive Pharmaceuticals (2008)
Subsidiaries & Spin-offs	Vaxcel; VetLife; Araios; RXi Pharmaceuticals Corp.
Collaborations & Partnerships	Corixa (1996); Nycomed (1999); Merck (2000); Vical (2001); Millenium (2003); Thermo Fisher (2007)
Technologies and Products	OncoScint (1993); Aldoxorubicin (phase 3)
Links	http://www.cytrx.com/ http://www.biocentury.com/companies/cytrx_corp

9.1.50 deCODE Genetics

deCODE Genetics was founded in Iceland in 1996 to discover disease genes based on Iceland's population, which is characterized by a high degree of homogeneity and comprehensive family histories and medical records. deCODE was Iceland's first biotech company. It established a major partnership with Hoffmann-La Roche in 1998, and gained access to Affymetrix's GeneChip technology in 1999. The company filed for chapter 11 bankruptcy in 2009 and sold most of its assets to Saga Investments in 2010. Amgen acquired deCODE Genetics in 2012. In October 2013, Amgen spun off deCode Genetics' systems and database into a new company, NextCODE Health, which was acquired by WuXi PharmaTech in January 2015.

Time Period	1996 - 2012
Founders	Kári Stefansson
Public or Private	Private as of 2000
Type of Firm	Tools and Technology, Genomics
Location	Reykjavik, Iceland
Acquisition History	Saga Investments (2010) Acquired by Amgen (2012)
Collaborations & Partnerships	Hoffman-La Roche; Affymetrix
Technologies and Products	Personal genome scans
Keywords	Disease genes, pre-eclampsia
Links	https://en.wikipedia.org/wiki/DeCODE_genetics http://www.decode.com/company/

9.1.51 Deltagen Inc.

Deltagen focuses on functional analysis of gene families using knockout mice for drug discovery, and offers target validation data in the areas of immunology and metabolic diseases. It went public in 2000 and licensed Affymetrix's GeneChip.

Name	Deltagen Inc.
Time Period	1997- present
Founders	William Matthews, Mark Moore (CEO until 2003)
Other Top Management	Robert J Driscoll (current CEO)
Public or Private	Public
Type of Firm	Tools and Technology
Location	1900 S. Norfolk St, San Mateo, CA 94403
Mergers & Acquisitions	Arcaris (2001); BMY's Pharma Research Labs (2002); Benten BioServices (2009)
Collaborations & Partnerships	Tularik (1998); Roche, Merck, Pfizer (1999); Affymetrix, J&J, Glaxo Wellcome (2000), Aurora, Vertex, Lilly, Hyseq (2001)
Technologies and Products	DeltaBase
Glossary	Knockout mice, gene function
Connections	http://www.deltagen.com/ http://www.biocentury.com/Archives/Results2.aspx?archivesearch=%252bdeltagen

9.1.52 DevGen N.V.

DevGen was founded in 1997 as a spin-off of Ghent University and The Flemish Institute for Biotechnology to commercialize IP on the use of RNAi in nematodes for drug and target discovery company. It quickly struck R&D deals with Janssen Pharmaceutica, Merck & Co., and Genentech. In 1999 it partnered with the Agricultural Products Group of FMC Corp to discover novel pesticides. Soon it was collaborating with agbiotech companies such as Syngenta, Pioneer Hi-Bred, and, in 2005, with Monsanto. DevGen soon became known for its improved hybrid rice varieties, molecular breeding technologies, and RNAi-based insect control technology. In 2012, Switzerland-based Syngenta acquired DevGen for $523 million.

Name	DevGen N.V.
Time Period	1997 - 2012
Founders	Thierry Bogaert
Other Top Management	Remi Vermeiren, Wim Goemaere
Public or Private	Public (NYSE Euronext Brussels - 2005)
Type of Firm	Agricultural Biotech
Location	Agricultural Biotech
Acquisition History	Syngenta (2012)
Mergers & Acquisitions	Monsanto's subsidiaries in India, Pakistan, Philippines (2007)
Collaborations & Partnerships	Janssen Pharmaceutica, Genentech, Merck (1998); FMC Corp (1999); Monsanto (2005)
Glossary	Functional genomics; RNAi; molecular breeding
Connections	https://en.wikipedia.org/wiki/DevGen

9.1.53 Digene Corporation

Digene Corporation was a molecular diagnostics company best known for developing an in vitro test for detecting the human papillomavirus, approved by the FDA in 1997.

An attempted merger with Cytyc in 2002 was stopped by the FTC. In 2007, German biotech Qiagen acquired Digene for $1.6 billion.

Name	Digene Corporation
Alternate Names	Digene Diagnostics Inc.
Time Period	1984 - 2007
Founders	Floyd Taub
Public or Private	Public
Type of Firm	Molecular diagnostics
Location	Gaithersburg, MD
Acquisition History	Qiagen (2007)
Mergers & Acquisitions	Viropath (1998)
Collaborations & Partnerships	Cytyc (1996); Perkin-Elmer, MedImmune (1998); Luminex (2005)
Technologies and Products	HC2 HPV DNA Test , in vitro DNA tests
Keywords	Molecular diagnostics, in vitro diagnostics

Connections	https://en.wikipedia.org/wiki/Digene

9.1.54 Digital Gene Technologies

Digital Gene Technologies combines its patented Total Gene Expression Analysis (TOGA) technology with bioinformatics to identify expression patterns of genes in tissue samples. In 2000, it formed a gene discovery partnership with Elan to discover and develop therapeutics for Alzheimer's and Parkinson's diseases. In 2004, it was acquired by Neurome, another La Jolla, CA-based biotech company conducting genetic research in neurodegenerative diseases.

Name	Digital Gene Technologies
Time Period	1995 - 2004
Founders	J. Gregor Sutcliffe (Scripps) and Robert Sutcliffe (CEO)
Other Top Management	Paul Freiman (Chairman)
Public or Private	(Private as of 2000)
Type of Firm	Tools and Technology
Location	11149 North Torrey Pines Road La Jolla, CA 92037
Acquisition History	Acquired by Neurome (2004)
Subsidiaries & Spin-offs	Recordati, Immunex (1997); Scripps, Salk Institute (1998); Elan (2000-2003)
Technologies and Products	Total Gene Expression Analysis (TOGA), Netscape format TOGA browser intranet
Glossary	Total Gene Expression Analysis (TOGA), Netscape format TOGA browser intranet
Connections	http://www.lilly.com/about/Pages/default.aspx Lilly Neurome

9.1.55 Discovery Partners International

eDPII was originally IRORI Quantum Microchemistry, a combinatorial chemistry company that developed and provided libraries of drug-like compounds, drug discovery services, computational tools to generate compound libraries, and testing and screening services to optimize potential drugs. In 1998, CEO Riccardo Pigliucci brought IRORI into an umbrella company, changed its name to Discovery Partners International, and relocated it to San Diego. The company completed an IPO in 2000. In 2006, the privately held Infinity Pharmaceuticals acquired Discovery Partners in a reverse merger deal that made Infinity Pharmaceuticals, Inc. a public company.

Name	Discovery Partners International Inc.
Alternate Names	IRORI Quantum Microchemistry (1995-1998)
Time Period	1995-2006
Founders	K.C. Nicolaou and Michael Philip Nova
Other Top Management	Riccardo Pigliucci
Private or Public	Public (2000)
Type of Firm	Tools and Technology

Location	San Diego, CA
Acquisition History	Infinity Pharmaceuticals (reverse merger in 2006)
Mergers & Acquisitions	Discovery Technologies, Axys unit, Structural Proteomics (2000); Systems Integration (2001); Xenometrix (2001); Biofrontera Discovery (2005)
Subsidiaries & Spin-offs	ChemRx (1998)
Collaborations & Partnerships	Bristol-Myers Squibb, Aventis (1998); DuPont, Kirin Brewery, Pharmacia & Upjohn (1999); Merck, Takeda Chemical, Pfizer (2001); Novartis, Actelion, AstraZeneca, Inspire Pharma, Allergan (2003); Vertex (2004); Galapagos, MedImmune (2006)
Technologies and Products	AccuTag Combinatorial Chemistry Systems
Glossary	Chemistry, high throughput screening, bioinformatics
Connections	http://www.biocentury.com/companies/discovery_partners_international_inc http://www.referenceforbusiness.com/history2/38/Discovery-Partners-International-Inc.html

9.1.56 Diversa

Diversa Corporation was founded as Recombinant BioCatalysis Inc. in 1987, offering combinatorial biology, genomics, and high throughput screening services to the biopharmaceutical industry. In 1997, it changed its name to Diversa Corp., and raised $200 million in an IPO in 2000. Diversa identified genetic material from microbes found in nature in order to discover commercially valuable enzymes and biologically active small molecules. In 2007, Diversa merged with Celunol to create a new company, Verenium. In 2013, Verenium was acquired by Germany's BASF.

Name	Diversa Corporation
Alternate Names	Recombinant BioCatalysis Inc (1987-1997)
Time Period	1987-2007
Founders	Jay M. Short (also founder of BioAtla)
Other Top Management	Terrance Bruggeman
Public or Private	Public
Type of firm	Tools and Technology
Location	10665 Sorrento Valley Road San Diego, CA 92121
Mergers & Acquisitions	Merges with Celunol to form Verenium (2007)
Collaborations & Partnerships	Dow Chemical, Boehringer Mannheim (1997); Invitrogen, Rhone-Poulenc, Novartis Seeds (1999); Celera Genomics, Glaxo Wellcome (2000); Syngenta Seeds, Dow, P&G (2001); Degussa, Givaudan, DuPont (2002); Medarex, BASF (2003); Xoma, Bayer, Cellectis (2004)
Technologies and Products	CloneZyme (kit of recombinant enzymes)
Glossary	Microbial genetics, drug discovery, enzymes; gene libraries
Connections	http://www.verenium.com/ Verenium Corporation

9.1.57 DNAPrint Genomics

Incorporated in 1983 as a pharmaceutical company, DNAPrint Genomics provided sequencing and genotyping services. Revenue mainly derived from its geneology test, AncestryByDNA. It ceased operations in 2009.

Name	DNAPrint Genomics
Time Period	1983 - 2009
Founders	Tony Frudakis (former CEO); Lou Charlton
Private or Public	Public
Type of Firm	Tools and Technology
Location	Sarasota, FL
Subsidiaries & Spin-offs	Trace Genetics (Richmond, CA); Ellipsis Biotherapeutics
Technologies and Products	AncestryByDNA
Glossary	Genomics, forensic science, genotyping, geneology
Connections	Reuters company Profile DNAG.PK

9.1.58 DuPont

In 1987, DuPont developed a new method using fluorescent dyes for DNA sequencing, marketing the Genesis 2000 instrument in 1988. (DuPont acquired Danisco A/S in 2011, including its Genencor division.

Name	E. I. du Pont de Nemours and Company
Alternate Names	DuPont
Time Period	1802-
Founders	Éleuthère Irénée du Pont
Other Top Management	Edward D. Breen (Chairman and CEO)
Public or Private	Public
Type of Firm	Chemicals, plastics, biosciences, energy
Location	1007 Market St, Wilmington, DE 19898
Mergers & Acquisitions	Pioneer Hi-Bred (1999); Danisco (including Genencor) (2011); Solae (2012)
Collaborations & Partnerships	Bayer and Monsanto (2009); Monsanto (2013)
Technologies and Products	Genesis 2000 (instrument for DNA sequencing using fluorescent dyes)
Glossary	Biorenewables, bioenergy, GMOs, biopesticides
Connections	http://biosciences.dupont.com/duponttm-genencorr-science/ Genencor

9.1.59 EG&G Biomolecular

Edgerton, Germeshausen, and Grier, Inc., later known as EG&G, was incorporated in 1947. In the late 1980s, EG&G Biomolecular developed a sequencing machine that employed radioactive phosphors and was

cheaper than the fluorescent instruments developed at DuPont, the Genesis 2000. The non-government side of EG&G took over the traditional side of Perkin-Elmer's business (the Analytical Instruments Division) in 1999, and took on the name PerkinElmer. In 1999, EG&G was wholly-owned by The Carlyle Group, and was acquired by the defense corporation URS in 2002. In 2009, URS eliminated the EG&G division name.

Name	EG&G Biomolecular
Alternate Names	Edgerton, Germeshausen, and Grier, Inc.; EG&G
Time Period	Late 1980s; 1947-2002
Founders	Spun out of MIT
Public or Private	Private
Acquisition History	Wholly-owned by Carlyle Group (1999); acquired by URS (2002)
Mergers & Acquisitions	Perkin-Elmer (Analytical Instruments Division) (1999)
Technologies and Products	Perkin-Elmer (Analytical Instruments Division) (1999)
Glossary	Instruments, radioactive phosphorous DNA sequencer
Connections	http://www.urs.com/ URS

9.1.59.1 Ecopia Biosciences Inc.

Canadian biotech Theratechnologies started Ecopia BioSciences to comb through microbial genomes to identify potential drug candidates that could be synthesized into antibiotics against resistant bacteria. Theratechnologies owned one third of the biotech. In 2007, Ecopia merged with privately held infectious diseases and cancer biotech Caprion Pharmaceuticals to form Thallion Pharmaceuticals. Thallion Pharmaceuticals was acquired by Bellus Health in 2013.

Name	Ecopia Biosciences Inc.
Alternate Names	Thallion Pharmaceuticals
Time Period	1998 - 2007
Founders	Chris Farnet (COO) and Eric Cohen
Public or Private	Public
Type of Firm	Tools and Technology
Location	Montreal, Quebec, Canada
Acquisition History	Bellus Health Inc. (2013)
Collaborations & Partnerships	Kosan, Merck (2000)
Glossary	Applied genomics, high throughput screening
Connections	http://www.biocentury.com/companies/ecopia_biosciences_inc

9.1.60 Eli Lilly

Eli Lilly was in a joint venture with Neurome, which had acquired Digital Gene Technologies.

Name	Eli Lilly
Alternate	Eli Lilly and Company

History of the Company	Eli Lilly was established in 1876 by a veteran of the Civil War who wanted to develop more effective medicines. Throughout the twentieth century, Lilly became known for its reputation as a provider of insulin, making available the first insulin product in 1923 and eventually becoming the first company to market synthetic human insulin in the 1980s. Lilly became a public company in 1952.
Historic Period	1876-present
Founders	Colonel Eli Lilly
Place	Indianapolis, IN
Organization Type	Pharmaceutical company
Connections	http://www.lilly.com/about/Pages/default.aspx Digital Gene Technologies Neurome

9.1.61 EOS Biotechnology

Eos Biotechnology, Inc. used its proprietary genomic platform to identify novel disease targets in cancer, cardiovascular and autoimmune diseases and to develop highly specific antibodies against them. Protein Design Labs acquired Eos in 2003 for $37.5 million.

Name	EOS Biotechnology Inc.
Time Period	1997-2003
Founders	David Martin (CEO)
Public or Private	Private
Type of Firm	Biopharmaceuticals
Location	South San Francisco, CA
Collaborations & Partnerships	Affymetrix (1998); Medarex, Aventis Pasteur, MorphoSys, Biogen (2000); Avanir Pharma, Seattle Genetics (2001); Icos (2002)
Glossary	DNA microarrays; genomics
Connections	http://www.biocentury.com/companies/eos_biotechnology_inc

9.1.62 Epigenomics

Epigenomics was founded in Germany to develop blood-based tests for the early detection of cancers using its proprietary DNA methylation technology. At the end of 1999, it joined several European research centers to launch the Human Epigenome Consortium, which hopes to effect a better understanding of epigenetic effects by developing a complete human epigenotype within ten years. Epigenomics completed an IPO in 2004 and trades on the Frankfurt Stock Exchange. The company focuses on pharmacogenomics tests and cancer companion diagnostics.

Name	Epigenomics AG
Alternate Names	Epigenomics GmbH
Founders	Kurt Berlin (CSO)
Other Top Management	Thomas Taapken (CEO/CFO)
Public or Private	Public
Type of Firm	Molecular Diagnostics
Location	Geneststrafe 5, 10829 Berlin, Germany

Mergers & Acquisitions	ORCA Biosciences (Seattle) (2000)
Subsidiaries & Spin-offs	Epigenomics Inc (US)
Collaborations & Partnerships	MethylGene (2001); Roche, Wyeth (2003); AstraZeneca, Biogen Idec (2004); Qiagen (2005); Myriad Genetics, Abbott (2007); Quest Diagnostics (2009); Life Technologies (2011)
Technologies and Products	Epi proColon®, Epi proLung®; companion diagnostics
Glossary	DNA methylation, bioinformatics, pharmacogenomics
Connections	http://www.epigenomics.com/en/contact.html www.biocentury.com/Archives

9.1.63 Epoch Biosciences

Epoch Biosciences began doing business as MicroProbe, which developed DNA-based microbial identification systems for pathogen detection. In 1995 the company changed its name to Epoch Pharmaceuticals, and in 2000 it changed it again to Epoch Biosciences. Nanogen acquired Epoch in December, 2004; Nanogen was acquired by Elitech Group (France) in July 2009.

Name	Epoch Biosciences Inc.
Alternate Names	MicroProbe (1985-1995), Epoch Pharmaceuticals (1995-2000)
Time Period	1985 - 2004
Founders	Martin Bak
Public or Private	Public (EBIO)
Type of Firm	Tools and Technology
Location	Bothell, WA
Acquisition History	Nanogen (2004)
Mergers & Acquisitions	Synthetic Genetics (2000)
Collaborations & Partnerships	Proctor & Gamble (1995); Perkin-Elmer (1999); Applied Biosystems, Third Wave Technologies (2000); Incyte Genomics (2001); Qiagen (2002); Amersham, Millenium (2003)
Technologies and Products	Microbial ID tests, DNA probe-based assays
Glossary	Genomics, oligonucleotides
Connections	http://www.biocentury.com/companies/microprobe_corp

9.1.64 Eurogentec S.A.

Founded in 1985 as a spin-off from the University of Liège in Belgium, Eurogentec develops genomics and proteomics tools and services for life sciences companies. The company's first goal was to use genetic engineering to develop a vaccine for fish breeding. It soon started offering oligonucleotides and contract research services, and by 2002 it established a US facility in San Diego. In 2009, it acquired US proteomics specialist AnaSpec. In 2010, the Japanese chemical company Kaneka acquired a majority stake in Eurogentec.

Name	Eurogentec S. A.
Time Period	1985- present

Founders	Joseph Martial and Andre Renard
Other Top Management	J-P Delwart (CEO)
Public or Private	Private
Type of Firm	Tools and Technology
Location	Tools and Technology
Acquisition History	Kaneka Corp (2010)
Mergers & Acquisitions	Oswel Research Product (1999); Wita Proteomics (2002); AnaSpec (2009)
Technologies and Products	Proteins, plasmids, vaccines, oligonucleotides, qPCR reagents, antibodies, peptides, and Fluorophores Dyes & Quenchers
Glossary	Proteomics, CRO, research tools, diagnostics
Connections	http://www.eurogentec.com/us-home.html https://en.wikipedia.org/wiki/Eurogentec

9.1.65 EXACT Sciences Corporation

EXACT Sciences is a molecular diagnostic company focused on DNA-based non-invasive cancer detection tests. It's first test had a rocky path to approval. A pivotal trial was begun in 2002 but it wasn't until 2014 that the company won FDA marketing approval for the non-invasive stool test for the detection of colorectal cancer.

Name	EXACT Sciences Corporation
Time Period	1995-present
Other Top Management	Kevin Conroy (Chairman and CEO)
Public or Private	Public (2001)
Type of Firm	Diagnostics
Location	441 Charmany Dr; Madison, WI 53719
Collaborations & Partnerships	OncoMethylome (2003); Genzyme (2009)
Technologies and Products	Cologuard (sDNA-based cancer detection test)
Glossary	DNA-based assays, molecular diagnostics, genomics, DNA methylation
Connections	http://www.exactsciences.com/about https://en.wikipedia.org/wiki/Exact_Sciences_(company) http://www.biocentury.com/companies/exact_sciences_corp

9.1.66 Exelixis Pharmaceuticals

Before the Human Genome Project was completed, Exelixis had begun conducting new research on small worms and fruit flies, following up on genetic discoveries about those organisms.

Name	Exelixis, Inc.
Time Period	1994 - present
Founders	Stelios Papadopoulos, Corey Goodman, Sherry Reynolds, Spyridon Artaavanis-Tsakonas, Gerald Rubin, Charles Cohen

Other Top Management	Michael M. Morrissey (president and CEO)
Public or Private	Public (2000)
Type of Firm	Biopharmaceuticals
Location	210 East Grand Ave; South San Francisco, CA 94080
Mergers & Acquisitions	MetaXen (1999); Artemis Pharmaceuticals (2001); Genomica (2001); X-Ceptor Therapeutics (2004)
Collaborations & Partnerships	Bayer (1998); Pharmacia & Upjohn, Bristol-Myers Squibb (1999), Dow Agrosciences (2000), Elan, AVI BioPharma (2001); GlaxoSmithKline, Galapagos (2002); Genentech, Wyeth (2005); Daiichi Sankyo (2006); Boehringer Ingelheim, Sanofi Aventis (2009)
Technologies and Products	Cometriq; Cottelic
Glossary	Functional genomics, drug discovery, proteomics, model system genetics technologies; gene expression software
Connections	http://www.exelixis.com/about http://www.biocentury.com/Archives/ AP Archive

9.1.67 ExonHit Therapeutics

ExonHit Therapeutics was founded by researchers from Rhone-Poulenc Rorer to study alternative splicing for rapid target identification. The company's Differential Analysis of Transcripts with Alternative Splicing technology analyzes differences between expressed genes to identify functionally distinct RNA variants. The company completed an IPO in 2005. At the end of 2012, it acquired in vitro diagnostics company InGen BioSciences, and changed its name to Diaxonhit to focus on specialty diagnostics.

Name	Diaxonhit (2013-present)
Alternate Names	Exonhit Therapeutics
Time Period	1997 - present
Other top Management	Bruno Tocque (CEO at founding)
Public or Private	Public
Type of Firm	Diagnostics
Location	In US: Diaxonhit: One Research Court, Ste 450 Rockville, MD 20850
Mergers & Acquisitions	InGen BioSciences (2012)
Collaborations & Partnerships	Rhone-Poulenc Rorer (1998); bioMerieux, Idec (2001); Roche, Allergan (2002); Agilent (2004); Affymetrix (2005); Genmab (2010); Pfizer (2010)
Technologies and Products	SpliceArray™
Glossary	Microarrays, in vitro diagnostics, gene profiling, alternative RNA splicing
Connections	http://www.biocentury.com/companies/diaxonhit http://www.exonhit.com/about-us/history

9.1.68 Fujifilm Global

Fujifilm Global was formed from Fuji Photo.

Name	Fujifilm Global
Connections	http://www.fujifilm.com/ Fuji Photo

9.1.69 Fuji Photo

Fuji Photo sponsored a DNA sequencing project in Japan (also sponsored by Seiko, Toyo, Soda, Hitachi, and Matsui Knowledge Industries) in the early 1980s that was housed at the RIKEN in Tsukuba Science City (Gene Wars, pp. 71, 215). "Seiko developed a DNA purification system and another microchemical robot, Fuji began to mass-produce its gel, and Hitachi developed a prototype DNA sequencing machine" (Gene Wars, p. 215). While Fuji's gels were test-marketed, they were eventually withdrawn as the Japanese project wound down (p. 217).

Name	Fuji Photo
Time Period	Early 1980s
Location	Japan
Technologies and Products	Gels for DNA purification system
Glossary	Materials and equipment
Connections	http://www.fujifilm.com/ Fujifilm Global

9.1.70 Galapagos Genomics B.V.

Galapagos Genomics was created as a 50-50 functional genomics joint venture between IntroGene (the Netherlands) and Tibotec (Belgium), marrying Tibotec's bioinformatics with IntroGene's gene therapy technology. It expanded into a drug discovery and services company through several acquisitions to become Galapagos. In 2007, it became a public company in Europe, and in 2015 it completed an IPO in the US. Partnerships with pharmaceutical companies, including MorphoSys, Servier, and AbbVie, are advancing several therapeutic candidates targeting inflammatory diseases, osteoarthritis, and cystic fibrosis.

Name	Galapagos Genomics B.V.
Alternate Names	Galapagos
Time Period	1999 - present
Founders	IntroGene B.V. and Tibotech N.V.
Other Top Management	Helmuth van Es (project leader R&D); Dinko Valerio (IntroGene CEO)
Public or Private	Public
Type of Firm	Therapeutics, Tools and Technology
Location	Industriepark Mechelen Noord Generaal De Wittelaan L11 A3 2800 Mechelen, Belgium
Acquisition History	BioFocus and Agenta sold to Charles River Labs (2014)
Mergers & Acquisitions	BioFocus (2005); Discovery Partners' drug discovery unit, Inpharmatica, ProSkelia (2006); Sareum Holdings' drug discovery unit (2008); GSK's Zagreb research (2010)

Subsidiaries & Spin-offs	Galadeno (2004)
Collaborations & Partnerships	InCyte Genomics (2000); Bayer, Vertex, Procter & Gamble, Pharmacia (2001); Boehringer, Wyeth (2003); Celgene (2004); J&J, Allergan, Morphosys (2008); Servier (2010); AbbVie (2013) [select list - too many to list all]
Technologies and Products	Gene libraries; adenovirus services
Glossary	High throughput screening, functional genomics
Connections	http://www.glpg.com/history http://www.biocentury.com/companies/galapagos_nv

9.1.71 GE Healthcare Life Sciences

In 2003, GE Healthcare Life Sciences acquired Amersham/Pharmacia.

Name	GE Healthcare Life Sciences
Alternate	GE Healthcare
Place	Buckinghamshire, United Kingdom
Organization Type	Healthcare technology and diagnostics company
Connections	http://www.gelifesciences.com/webapp/wcs/stores/servlet/catalog/en/GELifeSciences-us/about-us/corporate-information/ http://www.theguardian.com/business/2010/jan/14/general-electric-amersham-healthcare http://www.ge.com/files/usa/company/investor/downloads/ge_amersham_032104.pdf http://www.lifescienceleader.com/doc/ge-healthcare-life-sciences-kubio-modular-biopharmaceutical-0001 Amersham/Pharmacia

9.1.72 Gemini Research Ltd.

Gemini Research Ltd., a subsidiary of Gemini Holdings, was a clinical genetics company focused on phenotype-based gene discovery. In 1999, it completed GeneFind™, one of the largest whole-genome human genetic studies undertaken at that time, on thousands of non-identical twins. It was acquired by the genotyping firm Sequenom in 2001 to expand the San Diego-based genotyping biotech's potential for discovering disease associated genes.

Name	Gemini Research Ltd.
Alternate Names	Gemini Holdings plc
Time Period	1997 - 2001
Other Top Management	Paul Kelly (president and CEO)
Public or Private	Private
Type of Firm	Tools and Technology
Location	162 Science Park Milton Road, Cambridge, CB4 OGH, UK
Acquisition History	Sequenom (2001)
Collaborations & Partnerships	Chiroscience (1998); Large Scale Biology (1999), Celera Genomics (1999); Affymetrix (1999)
Technologies and Products	Phenobase™ (genetic linkage technology)

Glossary	Population genetics, bioinformatics, pharmacogenetics
Connections	http://www.biocentury.com/Archives/

9.1.73 Genaera

Genaera was originally called Magainin Pharmaceuticals, founded to develop drugs from exotic animals that showed host immune activity. Its name is taken from magainin, a substance found on the skin of the African clawed frog, which the company developed into a topical cream for diabetic foot ulcers. Another substance it discovered, an anti-cancer compound called squalamine, was derived from the dogfish shark. Neither drug ever made it to market, however. The company changed its name to Genaera Corp. in 2001, and after thirty years and no marketable drugs, it was liquidated in 2009. Its asthma drug assets, partnered with MedImmune, was sold to Ligand Pharmaceuticals.

Name	Genaera Corporation
Alternate Names	Magainin Pharmaceuticals (1987 – 2001)
Time Period	1987 - 2009
Founders	Michael Zasloff
Public or Private	Public
Type of Firm	Therapeutics
Location	Plymouth Meeting, PA
Acquisition History	Ligand Pharmaceuticals buys asthma drug assets in 2010.
Collaborations & Partnerships	SmithKline Beecham (1997); Genentech (1999); MedImmune (2001)
Glossary	In vitro assays, anti-infectives
Connections	http://www.bizjournals.com/philadelphia/stories/2009/04/27/daily31.html http://www.biocentury.com/companies/genaera_corp

9.1.74 Genaissance Pharmaceuticals Inc.

Genaissance Pharmaceuticals uses population genomics and bioinformatics to profile the isogenes of a protein existing in a patient population in order to improve the specificity of drugs for protein targets. In 2000, the company raised $78 million in an IPO. Genaissance was one of four groups working on haplotype maps for use as markers for disease susceptibility or drug response. In 2003, it partnered with Bayer to develop a pharmacogenomics test for directing prescriptions for statins. Diagnostics company Clinical Data acquired Genaissance in 2005.

Name	Genaissance Pharmaceuticals Inc.
Time Period	1997- 2005
Founders	Gualberto Ruano and Kevin Rakin
Other Top Management	Anita Kaul, Krishnan Nadabalan, Olive Foellmer
Public or Private	Public (2000)
Type of Firm	Tools and Technology
Location	New Haven, CT
Acquisition History	Clinical Data (2005)
Mergers & Acquisitions	DNA Sciences (2003)

Mergers & Acquisitions	Amersham, Visible Genetics (1997); GeneLogic, J&J, Sequenom (2000); Pfizer (2001); Biogen (2002); Millennium, Bayer, AstraZeneca (2003)
Technologies and Products	HAP Markers, CodeSig expression profiling, medication prognostics
Glossary	Pharmacogenetics, haplotypes
Connections	http://www.biocentury.com/companies/genaissance_pharmaceuticals_inc

9.1.75 GeneLink

GeneLink Biosciences specializes in consumer genomics, analyzes single nucleotide polymorphisms (SNPs), and links assessments to personalized health and wellness products. In 2014, the FDA cited the company, telling it to stop making unsubstantiated health claims. The company settled, saying it would not claim its products as treatments for diseases. It now makes nutritional supplements and skincare products based on personal DNA.

Name	GeneLink Biosciences
Alternate	GeneLink, Inc.
Time Period	1995- present
Founders	Robert Ricciardi (CSO)
Other Top Management	Bernard Kasten (president and CEO)
Public or Private	Public
Type of Firm	Nutraceuticals
Location	8240 Exchange Dr, Orlando, FL 32809
Acquisition History	GeneWize sold to Capsalus Corp (2012)
Subsidiaries & Spin-offs	GeneWize Life Sciences (marketing unit)
Collaborations & Partnerships	Orchid BioSciences (2001)
Technologies and Products	Genetic tests, supplements
Keywords	Consumer genomics
Connections	http://genelinkbio.com/ http://www.biocentury.com/Archives/

9.1.76 Gene Logic Inc.

Gene Logic was founded in 1994 in Gaithersburg, Maryland, as a functional genomics company. It began research and development in 1996 and went public in 1997. The company's Restriction Enzyme Analysis of Differentially Expressed Sequences (READS) technology provides a "snapshot" of genes expressed in normal cells to compare them to genes expressed in diseased cells. Gene Logic sold its Gene Logic Labs to Bridge Pharmaceuticals in 2006, and the new unit was named Bridge Global Development Services. In 2007, Gene Logic was acquired by Ocimum Biosolutions.

Name	Gene Logic Inc.
Time Period	1994-2007
Founders	Alan Walton (Oxfors Bioscience Partners)

Other Top Management	Michael Brennan, Mark Gessler, Daniel Passeri, Greg Lennon, Douglas Dolinow, Eric Eastman, Victor Markowitz, Bethany Pimenter
Public or Private	Public/Private
Type of Firm	Tools and Technology
Location	708 Quince Orchard Road, Gaithersburg, MD 20878 50 West Watkins Mill Road, Gaithersburg, MD 20878
Acquisition History	Ocimum Biosolutions (2007)
Mergers & Acquisitions	Oncormed Inc. (1998)
Subsidiaries & Spin-offs	Gene Logic Labs sold to Bridge Pharmaceuticals (2006)
Collaborations & Partnerships	UCB Research (custom gene expression database); through Oncormed (Merck, Rhone-Poulenc Rorer, and Schering-Plough); Proctor & Gamble; SmithKline Beecham; American Home Products (Wyeth Ayerst Research Division); NV Organon; Japan Tobacco; Hoechst-Schering AgrEvo
Technologies and Products	Restriction Enzyme Analysis of Differentially Expressed Sequences (READS) technology; GeneExpress database; Flow-thru Chip; gene expression databases (BioExpress; ToxExpress)
Keywords	Functional genomics, database, gene chip

9.1.77 Genencor

Genencor was founded in 1982 as a joint venture between Genentech and Corning Glass to produce industrial enzymes and specialty chemicals. In 1990 it was the first to express mammalian genes in fungi. In 2005, Genencor was acquired by Danisco A/S, which in turn was acquired by DuPont in 2011. As part of its research, it sequenced a number of microbial genomes.

Name	Genencor
Time Period	Early 2000s; 1982-2005
Founders	Joint Venture established by Genentech and Corning Inc.
Other Top Management	Herb Heynecker
Public or Private	Private
Type of Firm	Industrial biotechnology
Location	925 Page Mill Road, Palo Alto, CA 94304
Acquisition History	Acquired by Danisco A/S (2005); Danisco A/S acquired by DuPont (2011)
Mergers & Acquisitions	Gist Brocades Enzymes N.V., enzymes unit of Solvay (1995)
Collaborations & Partnerships	DuPont joint venture DDCE to develop cellulosic ethanol (2008)
Technologies and Products	Industrial enzymes; bulk protein; BoIsoprene™ monomer
Glossary	Microbial genomes
Connections	http://biosciences.dupont.com/duponttm-genencorr-science/ DuPont

9.1.78 Genentech

David Botstein, a vocal supporter of the Human Genome Project during the 1980s, served as Vice President for Science at Genentech before moving to the Stanford University School of Medicine.

Genentech was acquired by the Swiss-based Roche Holding AG Holding Ltd. in 1990.

Name	Genentech
History of the Company	Genentech was founded in 1976 as one of the first biotechnology companies to grow out of the revolutionary discovery of recombinant DNA. As such, it produced the first drug based on recombinant DNA technology: synthetic human insulin, which was license to Eli Lilly and Company and marketed in 1982.
Historic Period	1976-present
Founders	Herbert Boyer and Robert Swanson
Place	San Francisco, CA
Organization Type	Biotechnology company
Glossary/Keywords	synthetic human insulin
Connections	http://www.gene.com/about-us http://library.cshl.edu/oralhistory/speaker/david-botstein/

9.1.79 General Electric

Amersham/Pharmacia was purchased by General Electric, and is now part of GE Healthcare.

Name	General Electric
Alternate	General Electric Co.; G.E.
History of the Company	In 1892, General Electric was incorporated and owned the assets of the former Edison General Electric company, which Thomas Edison had established to sell his lamp technology.
Historic Period	1892-present
Founders	Thomas Edison, Charles A. Coffin
Other Top Management	Jeffrey Immelt (Chairman & CEO)
Place	Fairfield, CT
Organization Type	Conglomerate
Connections	http://www.ge.com/ Amersham/Pharmacia GE Healthcare

9.1.80 GeneScan Europe AG

GeneScan Europe AG was founded in 1996 as a laboratory and research center to analyze genetically modified organisms (GMOs). It provides molecular biological tests for GMOs in food, feed and agricultural raw materials, and consulting services. They were acquired by Eurofins Group, the international bioanalytical service provider, in 2003.

Name	GeneScan Europe AG
Time Period	1996-2003
Public or Private	Private
Type of firm	Diagnostics, Agbiotech
Location	Engesserstr.4, 79108 Freiburg, Germany
Acquisition History	Eurofins Scientific (2003)
Mergers & Acquisitions	Oasis (pharmacogenomics)(2001)
Subsidiaries & Spin-offs	BioChip Technologies
Collaborations & Partnerships	Motorola (2001)
Technologies and Products	Biochips
Glossary	Molecular diagnostics, GMOs
Connections	http://www.bionity.com/en/companies/7134/genescan-europe-ag.html http://www.biocentury.com/companies/GeneScan_Europe_AG

9.1.81 Genethon

Located in Évry, France, Genethon is a nonprofit biotherapy research and development organization. At the time of its creation, it was involved in three major projects: a physical map of the human genome, a genetic map, and an inventory of gene transcripts for muscle and nerve cells. It collaborated with Cepheid in producing a physical map of chromosome 21 in 1992. In the mid-1990s, Genethon was responsible for identifying disease genes. Today Genethon is dedicated to the design, development and production of gene therapy treatments for rare diseases.

Name	Genethon
Time Period	1990-Present
Founders	AFM-TELETHON
Other Top Management	Daniel Cohen, Jean Weissenbach, Charles Auffray
Public or Private	Private
Type of Firm	Nonprofit R&D center
Location	1 Rue de l'internationale, 9 Évry, France
Subsidiaries & Spin-offs	Genethon BioProd (2013)
Collaborations & Partnerships	Cepheid (1992); Genset SA (1994)
Glossary	Physical maps; disease genes
Connections	http://www.genethon.fr/en/

9.1.82 Genetica Inc.

Genetica was founded by Cold Spring Harbor Laboratory (CSHL) and David Beach to use mammalian retrovirus expression vector technology (MARX) developed at CSHL for to identify and validate the function of novel genes for drug discovery. In 2002, it published research in the Proceedings of the National Academy of

Sciences (PNAS), demonstrating stable suppression of gene expression in mammalian cells using the RNA interference (RNAi) pathway.

Name	Genetica Inc.
Time Period	1996-
Founders	Greg Hannon (CSHL) and David Beach (founder of Mitotix)
Public or Private	Private
Type of firm	Tools and Technology
Location	Cold Spring Harbor, NY
Collaborations & Partnerships	Mitotix (1998); Osiris (1998)
Technologies and Products	Mammalian retrovirus expression vector technology (MARX)
Glossary	Functional genomics, drug discovery, RNAi
Connections	http://www.biocentury.com/companies/Genetica_Inc

9.1.83 Genetic Technologies Ltd.

Genetic Technologies is a molecular diagnostics company that offers predictive testing and assessment tools to help physicians manage women's health. In 2002, it licensed its non-coding sequence technologies to Sequenom for genome mapping and intron sequence analysis.

Name	Genetic Technologies Ltd.
Time Period	1987-Present
Other Top Management	Eutillo Buccilli (CEO)
Public or Private	Public
Type of Firm	Diagnostics
Location	60 Hanover Street, Fitzroy Vic 3065, Australia
Acquisition History	Primary Health Care (buys its Australian Genetics unit in 2014)
Mergers & Acquisitions	Perlegen (2010)
Subsidiaries & Spin-offs	Phenogen Sciences (USA)
Collaborations & Partnerships	Sequenom, Nanogen (2002); Orchid Biosciences (2003)
Technologies and Products	Non-coding sequence technology; BrevaGenplus (breast cancer predictive test)
Keywords	Pharmacogenetics, molecular diagnostics, sequencing, introns
Connections	http://gtgcorporate.com/ http://www.biocentury.com/companies/Genetic_Technologies_Ltd

9.1.84 Genetic Therapy Inc.

Genetic Therapy Inc (GTI) was the first biotech company developed to focus on gene therapies. It was founded in the late 1980s by entrepreneur M. James Barrett and NIH researcher French Anderson. The company was acquired by Sandoz in 1995, and became a subsidiary of Novartis when Sandoz merged with

Ciba-Geigy in 1996 to form Novartis. In 2003, GTI was acquired by Cell Genesys. Cell Genesys merged with BioSante Pharmaceuticals in 2009. In 2013, BioSante Pharmaceuticals merged with ANI Pharmaceuticals.

Name	Genetic Therapy Inc.
Time Period	Late 1980s - 1995
Founders	M. James Barrett and French Anderson
Public or Private	Public
Type of Firm	Therapeutics
Location	Gaithersburg, MD
Acquisition History	Acquired by Sandoz (1995); subsidiary of Novartis (1996); acquired by Cell Genesys (2003); Cell Genesys merges with BioSante Pharmaceuticals (2009); BioSante Pharmaceuticals merges with ANI Pharmaceuticals (2013)
Glossary	Gene Therapy
Connections	http://www.anipharmaceuticals.com/ Ani Pharmaceuticals BioSante Pharmaceuticals Cell Genesys Inc.

9.1.85 Genetix

Genetix Limited was focused on tools, software, and services to develop antibodies in cancer-focused cell biology. Its founder, Mark Reid developed the 384 Wellplate, a six-by-four inch plastic tray that scientists used to map human DNA in the early 1990s. In 2007, Genetix acquired US-based Applied Imaging Corp. Genetix was acquired by Danaher in 2009.

Name	Genetix Limited
Time Period	1991-2009
Founders	Mark Reid
Other Top Management	James Hill
Public or Private	Public (2000)
Type of Firm	Tools and Technology
Location	Queensway, BH25 5NN New Milton, UK
Acquisition History	Danaher (2009)
Mergers & Acquisitions	Applied Imaging Corp (2007)
Glossary	Imaging, diagnostics
Connections	http://www.dailyecho.co.uk/news/4825023.__63m_Genetix_sale/

9.1.86 GeneTrace Systems Inc.

In 1999, responding to the increased number of single-nucleotide polymorphisms (SNPs) produced by the Human Genome Project, GeneTrace Systems put out automated high-throughput SNP technology for more efficient analysis of these genetic variations.

Name	GeneTrace Systems Inc
Time Period	1995-2001

Other Top Management	Joseph A. Monforte (CSO), George LaMotte (CEO)
Type of Firm	Tools and Technology
Location	Menlo Park, CA
Mergers & Acquisitions	Strata Biosciences (2000)
Collaborations & Partnerships	Incyte Pharmaceuticals (1996); Monsanto (1998)
Technologies and Products	Genotyping, high-throughput gene expression screening
Glossary	Genomics, proteomics, bioinformatics
Connections	http://www.biocentury.com/companies/GeneTrace_Systems_Inc http://www.prnewswire.com/news-releases/genetrace-systems-inc-announces-high-throughput-snp-line-75533127.html

9.1.87 Genfit S.A.

Genfit was founded by a consortium of academic, pharmaceutical, and venture capital partners that included University of Lille, Institut Pasteur, Rhone-Poulenc Rorer, Synthelabo, Lipha Merck (Merck KGaA), and UCB Pharma. Genfit uses genomics, proteomics, and medicinal chemistry on known but not well understood genes to identify and validate druggable targets and potential therapeutic compounds. The company was formed with the intention of partnering while at the same time advancing its own therapeutic pipeline. By 2003, it had seven corporate partnerships, and was profitable. The company completed an IPO in 2007.

Name	Genfit S. A.
Time Period	1999-Present
Founders	Jean-Charles Fruchart
Other Top Management	Jean-Francois Mouney (CEO)
Public or Private	Public
Type of Firm	Therapeutics, Technology
Location	885, Avenue Eugène Avinée, 59120 Loos, France
Collaborations & Partnerships	Merck-Lipha, Aventis, UCB Pharma (2000); Kowa (2002); Servier (2004); Pierre Fabre (2005)
Technologies and Products	Therapeutic candidates targeting metabolic diseases, liver diseases, inflammation, autoimmune diseases
Glossary	Genomics, proteomics, medicinal chemistry
Connections	http://www.genfit.com/contact-us/ http://www.biocentury.com/companies/genfit_sa

9.1.88 GenMark

GenMark develops instruments and molecular tests for diseases using its eSensor detection technology. In 1995, its gene-finding programs were used to provide automatic gene annotation for a number of microbial genomes. In 2010, London-based diagnostics firm Osmetech, founded GenMark as part of its plan to relocate in the US and transfer its listing. GenMark completed an IPO in May 2010. GenMark technology is based on the principles of competitive DNA hybridization and electrochemical detection.

Name	GenMark
Alternate Names	Osmetech (UK) (1993-2010)
Time Period	1993-Present
Founders	Jon Faiz Kayyem (SVP of R&D)
Public or Private	Public
Type of Firm	Diagnostic
Location	5964 La Place Court, Carlsbad, CA 92008 London, UK
Technologies and Products	eSensor® technology
Glossary	Diagnostics, eSensor detection technology, XT-8 system
Connections	http://ir.genmarkdx.com/

9.1.89 Genome Corporation

Genome International was the successor of an earlier company, Genome Corp., which dissolved.

Genome Corporation was founded by Walter Gilbert in 1987 to develop a physical map of the genome, begin sequencing, and sell information from the company's database. However, he failed to raise sufficient capital and the company collapsed later that year.

Name	Genome Corporation
Time Period	1987
Founders	Walter Gilbert
Glossary	Physical mapping; sequencing
Connections	http://www.genome.com/about-us/about-us Genome International

9.1.90 GenoMed Inc.

GenoMed is working to translate knowledge of medical genomics--the study of which genes cause disease--into clinical practice, combining biotechnology with disease management. GenoMed was inspired by David Moskowitz's research on the angiotensin I-converting enzyme (ACE) gene during the mid 1990s. His lab discovered that ACE was a "master" disease gene, found to be associated with many different diseases.

Name	GenoMed Inc.
Time Period	2001-present
Founders	David Moskowitz, Jerry White, Richard Kranitz, Peter Brooks
Public or Private	Public
Type of firm	Tools and Technology
Location	Leesburg, FL 34748
Glossary	Pharmacogenetics
Connections	www.genomed.com

9.1.91 Genome International

Genome International Corporation was founded in 1992. It develops bioinformatics products for translational, biomedical, and plant sciences. Genome International was the successor of an earlier company, Genome Corp., which dissolved.

Name	Genome International
Time Period	1992-Present
Public or Private	Private
Location	8000 Excelsior Dr. Ste #202 Madison, WI 53717
Glossary	Bioinformatics
Connections	http://www.genome.com/about-us/about-us Genome Corp.

9.1.92 Genome Therapeutics Corporation

GTC Sequencing Center, Genome Therapeutics Corporation, Waltham, Mass., U.S. was part of the International Human Genome Sequencing Consortium.

Genome Therapeutics Corporation was originally known as Collaboratorive Research, which was founded in 1961 and changed its name in 1994. In 1994, the company sequenced the genome of the bacteria *H. pylori*.

Thermo Fisher Scientific acquired Life Technologies, and, in effect, Invitrogen, Applera, Applied Biosystems, Genome Therapeutics, Collaborative Research.

Name	Genome Therapeutics Corporation
Alternate	Collaborative Research
History of the Company	Collaborative Research was established in 1961 as one of the first biotech companies, before the term "biotechnology" was in use. Collaborative Research went public in 1982. The company became known as Genome Therapeutics Corporation in 1994 and switched its name again in 2004, when it became Oscient Pharmaceuticals.
Historic Period	1961-1994 (as Collaborative Research); 1994-2004 (as Genome Therapeutics); 2004-2010 (as Oscient Pharmaceuticals)
Founders	Orrie M. Friedman
Place	Waltham, MA
Organization Type	Biotechnology company
Glossary/Keywords	bacterial genomics, human genomics
Connections	http://ir.thermofisher.com/investors/Investor-Overview/default.aspx http://www.businesswire.com/news/home/20040413005856/en/Genome-Therapeutics-Oscient-Pharmaceuticals-Corporation-Reflect-Focus http://www.boston.com/yourtown/waltham/articles/2009/07/01/dr_orrie_m_friedman_94_biotech_pioneer/ http://www.nature.com/ng/wilma/v13n1.867861436.html http://www.nytimes.com/1984/05/09/business/business-people-technology-company-president.html Applera Applied Biosystems Collaborative Research Invitrogen Life Technologies Thermo Fisher Scientific

9.1.93 Genomic Health Inc.

Genomic Health develops genomic-based molecular diagnostic tests, which provide individualized information on response to certain types of cancer therapy and the likelihood of disease recurrence. The company's Oncotype DX is a clinically validated breast cancer assay that consists of 16 cancer genes identified by Genomic Health as possibly associated with breast cancer tumor behavior. The company completed an IPO in 2005.

Name	Genomic Health Inc.
Time Period	2000-Present
Founders	Randy Scott
Other Top Management	Kimberly Popovits
Public or Private	Public (2005)
Type of Firm	Diagnostics
Location	101 Galveston Drive Redwood City, CA 94063-4700
Collaborations & Partnerships	Incyte Genomics (2001); Imclone Systems, Bristol-Myers Squibb (2005); Sanofi-aventis (2006); Pfizer (2008)
Technologies and Products	Oncotype DX
Glossary	Diagnostics, pharmacogenetics
Connections	http://www.biocentury.com/companies/Genomic_Health_Inc www.genomichealth.com

9.1.94 Genomics One Corporation

Genomics One is a biotechnology company focused on developing and providing genomics and proteomics technologies and services to life sciences companies. Its TrueBlue technology, a high-throughput color selection system for identification of cloned DNA, was patented in the US in 2000 and was used in the Human Genome Project. In June 2006, Genomics One changed its name to ALERT B&C Corporation, a provider of solutions to the biodefense industry.

Name	Genomics One Corporation
Alternate Names	Alert B&C Corporation
Time Period	1995-2003
Founders	Steve N. Slilaty
Other Top Management	Kurt G. J. Soost (CEO and president)
Public or Private	Public (1999)
Type of Firm	Tools and Technology
Location	3090 Le Carrefour Blvd, Ste 306, Laval, QC H7T 2J7, Canada
Acquisition History	BioCan Scientific subsidiary sold to Medicorp in 2005
Mergers & Acquisitions	Bio/Can Group (2000); Abionix Sarl (2005)
Technologies and Products	TrueBlue® (used to clone and sequence DNA)
Glossary	Genomics, sequencing, proteomics

Connections	http://www.biocentury.com/companies/Genomics_One_Corp http://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapId=3155571

9.1.95 Genomyx

DNA sequencing company Genomyx was founded at Genentech with Human Genome Project funding. It was acquired by Beckman Instruments in 1996 (which then went on to form part of Beckman Coulter Inc).

Name	Genomyx
Time Period	1980s
Founders	Genentech
Other Top Management	Frank Ruderman
Public or Private	Private
Type of Firm	Tools and Technology
Location	Foster City, CA
Glossary	Instruments, sequencing
Connections	http://www.beckmancoulter.com http://ipmall.info/risk/vol5/spring/cookdeeg.htm Beckman Corporation Beckman Coulter Inc.

9.1.96 Gen-Probe

Gen-Probe made nucleic acid probe assays for use in clinical diagnostics, blood screening, and research. It was a wholly-owned subsidiary of Chugai Pharmaceutical in the 1990s, and was spun off as an independent public company in 2002, ahead of its merger with Roche Holding AG. In August 2012, Gen-Probe merged with Hologic in a deal valued at $3.7 billion.

Name	Gen-Probe Inc.
Time Period	1983-2012
Founders	David Kohne, Howard Birndorf
Other Top Management	Henry Nordhoff (president and CEO)
Public or Private	Public
Type of Firm	Diagnostics, Tools and Technology
Location	San Diego, CA
Acquisition History	Chugai Pharmaceutical (1989); Hologic (2012)
Collaborations & Partnerships	Becton Dickinson (1995); bioMerieux (1997); Chiron (1998); Tosoh Bioscience (2003); Corixa, Millipore (2005)
Technologies and Products	Infectious disease tests; nucleic acid probe assay systems
Glossary	Molecular diagnostics, blood screening
Connections	https://en.wikipedia.org/wiki/Gen-Probe http://www.biocentury.com/companies/gen-probe_inc

9.1.97 GenSet

Founded in 1989 in Paris, France, Genset was the first biotech company to go public simultaneously in the US and France. Genset's US headquarters were located in San Diego. It employed a high-throughput genomics technology platform based on industrial-scale mapping, sequencing and polymorphism analysis. Genset was acquired by Serono in 2002, which itself was acquired by Merck KGaA in 2007, becoming Merck Serono.

Name	GenSet
Time Period	1989-2002
Founders	Marc Vasseur
Other Top Management	Pascal Brandys, Chatherine Faure-Cachard, Audrey Keane, Agnes Le Saux-Narjoz, Bruno Poddevin
Public or Private	Public
Location	Genset SA 24, rue Royale 75008 Paris, France U.S. Headquarters in San Diego, CA
Type of Firm	Tools and Technology
Subsidiaries & Spin-offs	Surgen (1998; joint venture with the Royal College of Surgeons in Ireland)
Collaborations & Partnerships	Synthelabo; Algene Biotechnologies Corp. (SignalGene); Abbot Laboratories; Janssen Research; Pharmacia & Upjohn; Johns Hopkins University; Wyeth-Lederle; Commissariat a l'Energie Atomique; Wyeth-Ayerst
Glossary	Mapping, sequencing, polymorphism analysis, disease gene discovery, gene libraries, pharmacogenomics, obesity
Connections	http://www.merck.com/investors/home.html Merck Merck Serono Rosetta Inpharmatics Serono

9.1.98 Genzyme Molecular Oncology

Genzyme Molecular Oncology was established in 1997 when Genzyme Corp. acquired Pharmagenics Inc. The company focuses on the development of novel cancer therapeutics. It's Serial Analysis Gene Expression (SAGE) technology detects and measures nearly all genes expressed in a cell at a given time. The company went public in 1998.

Name	Genzyme Molecular Oncology
Time Period	1997-present
Other Top Management	Gail Maderis, Mark Enyedy, Mark Goldberg, Clifford Hendrick, Katherine Klinger
Location	Cambridge, MA
Collaborations & Partnerships	Schering-Plough; Merck; Isis Pharmaceuticals; Zeneca Pharmaceuticals; Hybridon Inc.; Johns Hopkins University; Park-Davis (Warner-Lambert); Reprogen Inc.; Hexagen plc; Ontogeny; Bayer Corp; University of Reading; University of Montana
Technologies and Products	Serial Analysis Gene Expression (SAGE) technology; cancer therapeutics and vaccines

Connections	http://www.prnewswire.com/news-releases/genzyme-molecular-oncology-stock-to-trade-on-nasdaq-76656677.html

9.1.99 GlaxoSmithKline (GSK)

GlaxoSmithKline acquired Human Genome Sciences, a biopharmaceutical company, in 2012.

GSK was formed when Glaxo Wellcome merged with SmithKline Beecham in 2000.

Name	GlaxoSmithKline
Alternate	GSK
Historic Period	2000-present
Place	Brentford, London, UK
Organization Type	Pharmaceutical company
Glossary/Keywords	vaccines
Connections	http://www.gsk.com/en-gb/investors/ http://dealbook.nytimes.com/2012/07/15/glaxosmithkline-in-talks-to-buy-human-genome/ GSK Human Genome Sciences SmithKline Beecham Wellcome plc

9.1.100 Glaxo Wellcome

Glaxo Wellcome was formed from the merger of Glaxo and Wellcome plc in 1995.

Glaxo Wellcome merged with SmithKline Beecham in 2000 to become GlaxoSmithKline (GSK).

Name	Glaxo Wellcome
Historic Period	1995-2000
Place	London, England
Organization Type	Pharmaceutical company
Connections	http://www.gsk.com/en-gb/investors/ GlaxoSmithKline Human Genome Sciences SmithKline Beecham Wellcome plc

9.1.101 HealthCare Ventures

Founded in 1985, HealthCare Ventures is a private equity and venture capital firm focused on companies developing pharmaceuticals, including Human Genome Sciences, LuekoSite, and MedImmune.

The company was originally known as Healthcare Investment Corporation but changed its name in 1997.

Name	HealthCare Ventures
Historic Period	1985-present
Founders	Wally Steinberg

Place	47 Thorndike St. Suite B1-1 Cambridge, MA 02141
Organization Type	Investment company
Connections	http://www.hcven.com/ http://www.healthinvcorp.com/2201.html http://www.nytimes.com/1995/07/29/obituaries/wallace-steinberg-dies-at-61-backed-health-care-ventures.html http://corp.sec.state.ma.us/CorpWeb/CorpSearch/CorpSummary.aspx?FEIN=223412546&SEARCH_TYPE=1

9.1.102 Helicos Biosciences

Helicos Biosciences was founded in 2003 by Stanley Lapidus, Stephen Quake, and Noubar Afeyan. It developed the Helicos Genetic Analysis Platform, the first DNA-sequencing instrument that employed single molecule fluorescent sequencing. The company went into Chapter 11 bankruptcy in 2012. SeqLL has purchased the technology.

Name	Helicos Biosciences
Time Period	2003-2010
Private or Public	Public
Location	Cambridge, MA
Glossary	Sequencing
Connections	http://thebigone.stanford.edu/ http://seqll.com/ SeqLL

9.1.103 Hewlett Packard

Hewlett Packard spun out Agilent; acquired Compaq.

Hewlett Packard contributed to the laboratory technology of the Human Genome Project, and the use of its computing technology was central to completing the large-scale sequencing effort. One such piece of equipment was the Hewlett Packard ORCA, a robotic microassay system used in the 1990s by the Lawrence Berkeley Laboratory, among other places.

HP also worked with the Wellcome Trust Sanger Institute and Celera Genomics.

Name	Hewlett Packard
Alternate	HP
History of the Company	In 2015, Hewlett Packard split into two separate companies, HP Inc. and Hewlett Packard Enterprises.
Historic Period	1939-2015
Founders	William Hewlett and David Packard
Place	Palo Alto, CA
Organization Type	Computer company
Connections	http://h30261.www3.hp.com/ http://www2.lbl.gov/Science-Articles/Archive/human-genome-mapping-sequencing.html https://h10131.www1.hpe.com/public/contract-vehicles/cdc-cims/about-hp/partnerships/ Agilent Compaq

9.1.104 Hitachi

Hitachi sponsored a DNA sequencing project in Japan (also sponsored by Seiko, Toyo, Soda, Fuji Photo, and Matsui Knowledge Industries) in the early 1980s that was housed at the RIKEN in Tsukuba Science City (Gene Wars, pp. 71, 215). “Seiko developed a DNA purification system and another microchemical robot, Fuji began to mass-produce its gel, and Hitachi developed a prototype DNA sequencing machine” (Gene wars, p. 215). Hitachi only sells the sequencer in Japan and eventually leaves the project.

Name	Hitachi
Time Period	Early 1980s
Location	Japan
Connections	http://www.hitachi.us/about/index.html?WT.ac=us_mm_about Hoffmann-La Roche

9.1.105 Hoffmann-La Roche

Hitachi was formed from Hoffmann-La Roche.

Hoffmann-La Roche established the Roche Institute of Molecular Biology in 1967. The institute, located in Nutley, New Jersey, became a renowned center of biological research but closed unexpectedly in 1996.

Hoffmann-La Roche acquired the rights to the polymerase chain reaction (PCR) technology, a revolutionary laboratory technique, from Cetus in December 1991, paying a $300 million price.

Starting in 1994, Hoffmann-La Roche collaborated with Millennium Pharmaceuticals to work on using genomics for drug discovery in the areas of obesity and diabetes. In 1998, the two companies announced they had discovered a novel gene linked to obesity.

In 1998, Hoffmann-La Roche sought to develop drugs based on discoveries from deCODE Genetics, the Icelandic firm that used its studies of Iceland's largely homogenous population to find new disease genes. Their deal was worth $200 million. The following year, in March 1999, deCODE announced that it had discovered a gene linked to osteoarthritis and that Roche planned to use the discovery to develop new diagnostic tools and therapies for that disease.

Name	Hoffmann-La Roche
Alternate	F. Hoffmann-La Roche AG
History of the Company	Hoffmann-La Roche was formed in 1896, and its early work focused on the mass production of vitamins. In the mid-twentieth century, it expanded its drug portfolio into benzodiazepines, antidepressants, antimicrobials, and cancer therapies.
Historic Period	1896-present
Founders	Fritz Hoffmann-La Roche
Place	Basel, Switzerland
Organization Type	Healthcare and pharmaceutical company
Glossary/Keywords	obesity, polymerase chain reaction, human genomics
Connections	http://www.hitachi.us/about/index.html?WT.ac=us_mm_about http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1523369/ http://www.nytimes.com/1994/03/30/business/drug-makers-plan-genetics-research-deal.html http://www.prnewswire.com/news-releases/millennium-pharmaceuticals-inc-and-hoffmann-la-roche-achieve-research-milestone-in-obesity-77513062.html http://content.time.com/time/magazine/article/0,9171,1158968,00.html http://www.prnewswire.com/news-releases/hoffmann-la-roche-and-decode-genetics-sign-genomics-collaboration-to-identify-genes-involved-in-common-diseases-76523967.html

	http://www.the-scientist.com/?articles.view/articleNo/17625/title/Camelot-In-Nutley--N-J---Roche-Institute-Of-Molecular-Biology-Remembered/ http://www.decode.com/decode-genetics-and-roche-announce-progress-in-osteoarthritis-research-program/ Hitachi

9.1.106 Human Genome Sciences

Human Genome Sciences was founded in 1992 as the entity for commercializing discoveries arising out of The Institute for Genomic Research (TIGR). It went public in 1993 and established the largest genomics collaboration ever ($125 million) with SmithKline Beecham. HGS analyzed messenger RNA to identify genes coding proteins and their functions. HGS established Vascular Genetics as a joint venture with St. Elizabeth's Medical Center of Boston and Cato Holding Company. GlaxoSmithKline purchased HGS in 2012 for $3.6 billion.

Name	Human Genome Sciences
Time Period	1992-2012
Other Top Management	William Haseltine; Craig Rosen; Arthur Mandell; Steven Mayer; Jim Davis; Arthur Louie; Michael Fannon; Reiner Gentz; (Craig Venter); (Alan Walton); (Wally Steinberg)
Private or Public	Public
Location	Rockville, MD
Acquisition History	Acquired by GlaxoSmithKline (2012)
Subsidiaries & Spin-offs	Vascular Genetics
Collaborations & Partnerships	The Institute for Genomic Research (TIGR); SmithKline Beecham; St. Elizabeth's Medical Center; Cato Holding Company
Glossary	Functional genomics, gene isolation, secreted protein identification, gene sequencing, expression profiling and mapping, proteomics, antibodies, high-throughput screening, biological activity and specificity, animal models, myeloid progenitor inhibitory factor-1 (MPIF-1) and keratinocyte growth factor-2 (KGF-2)
Connections	http://www.gsk.com/en-gb/investors/ GlaxoSmithKline (GSK) GSK SmithKline Beecham Wellcome plc

9.1.107 HySeq

Founded in 1992 in Sunnyvale, CA. The company also went public in 1997, raising $56 million. In 1999, the company's subsidiary, GeneSolutions, launched a website providing researchers access to more than 12 million DNA samples. In 2000, it developed sequencing chip that could sequence 3,000 bases of any gene in a single reaction. Has produced a number of product candidates. The company later changed its name to Nuvelo. In 2008, Nuvelo merged with ARCA Biopharma.

Name	HySeq
Alternate Names	Nuvelo
Time Period	1992-
Other Top Management	Robert Weist; Lewis Gruber; Christopher Wolf; Radoje Drmanac; Radomir Crkvenjakov; James Fletcher

Public or Private	Public
Location	670 Almanor Avenue Sunnyvale, CA 94086
Mergers & Acquisitions	Merged with ARCA Biopharma (2008)
Collaborations & Partnerships	Chiron, Perkin-Elmer, UCSF, and Kirin Brewery, American Cyanamid, Imperial Cancer Research Technology, Conservation International, Molecular Informatics, SmithKline Beechham Clinical Laboratories.
Technologies and Products	HyGenomics Database; HyChip DNA sequencing chip; HyProfile Portfolio; HyGenomics; Hyseq (target discovery program) Database
Glossary	Instrumentation; array; gene chip; bioinformatics; database; sequencing; disease gene discovery; genetic variances (polymorphisms)
Connections	http://www.arcabiopharma.com/39/Corporate%20Profile/index.html ARCA Biopharma Nuvelo

9.1.108 IBM

IBM computer technology was used for sequencing during the Human Genome Project.

In December 1999, IBM proposed creating a supercomputer, even more powerful than the famous Deep Blue, that would simulate molecular biological processes such as protein folding. IBM unveiled the computer, Blue Gene, in 2004.

Since the end of the Human Genome Project, IBM has been heavily involved in developing new DNA sequencing technologies.

Name	IBM
Alternate	International Business Machines Corporation
Historic Period	1911-present
Founders	Charles Ranlett Flint
Place	Armonk, NY
Organization Type	Technology and computer company
Connections	http://www.ibm.com/investor/?lnk=fif-inve-usen http://crab.rutgers.edu/~goertzel/bluegene.htm

9.1.109 Illumina

Illumina was founded in 1998 in San Diego by David Walt, Larry Bock, John Stuelpnagel, Anthony Czarnik, and Mark Chee. Illumina acquired Lynx Pharmaeuticals in 2005 and Solexa in 2007.

Name	Illumina
Time Period	1998-present
Public or Private	Public
Place	San Diego, CA
Connections	http://www.illumina.com/company/investor-information.html Lynx Pharmaceuticals Solexa

9.1.110 Immucor

Immucor, a diagnostics company, acquired Lifecodes, another company specializing in transplantation diagnostics (including DNA testing), in 2013.

Name	Immucor
Historic Period	1982-present
Place	Norcross, GA
Organization Type	Diagnostics company
Glossary/Keywords	transfusion and transplantation diagnostics
Connections	http://www.immucor.com/en-us/Products/Pages/LIFECODES-Transplant-Products.aspx http://investor.immucor.com/releasedetail.cfm?ReleaseID=874152 https://globenewswire.com/news-release/2013/01/03/514579/10017017/en/Immucor-to-Acquire-the-LIFECODES-R-Business-From-Hologic-Inc.html Lifecodes

9.1.111 Incyte Genomics

Incyte Pharmaceuticals was founded in Palo Alto in 1991 and went public in 1993. It was the first genomics company set up to supply genetic information from random gene sequencing for subscribers. It is modeled after a contract research organization. In 1996 it acquired Genome Systems and in 1998 it acquired Hexagen plc and Synteni Inc. The company changed its name to Incyte Genomics in 2000.

Starting in 1992, following on trends started by the Human Genome Project, Incyte Pharmaceuticals began a significant research project in EST sequencing.

In 1998, Incyte announced it would mount its own effort to sequence the human genome but that it would do so for commercial purposes and would not focus on sequencing all regions.

Name	Incyte Genomics
Alternate Names	Incyte Genomics (2000)
Time Period	1991-
Other Top Management	Jeffrey Collinson; Roy Whitfield; Randal Scott; Mike Lack; Lee Bendekgey; Jim Neal; Jeffrey Seilhamer; Scott Clarke; David Bailey; Lisa Peterson; Kent Davidson
Public or Private	Public
Place	3174 Porter Drive Palo Alto, CA 94304
Mergers & Acquisitions	Genome Systems (1996); Hexagen plc (1998); Synteni Inc. (1998)
Subsidiaries & Spin-offs	DiaDexus (1997; joint venture with SmithKline Beecham)
Collaborations & Partnerships	Pfizer; Huntsman Cancer Institute; CV Therapetuics; NetGenics; Oxford GlycoSciences plc; Synomics
Technologies and Products	LifeSeq Database, LifeSeq FL (full-length) Database, LifeSeq Atlas Database, Life Gold Database, PathoSeq Database, ZooSeq Database, Satellite database, LifeTools, LifeArray
Glossary	Databases, bioinformatics, PPAR-gamma gene, database, microarrays
Connections	http://investor.incyte.com/phoenix.zhtml?c=69764&p=irol-irhome http://www.fundinguniverse.com/company-histories/incyte-genomics-inc-history/ http://www.nytimes.com/1998/08/18/science/new-company-joins-race-to-sequence-human-genome.html Incyte Pharmaceuticals

	LifeSeq

9.1.112 IntelliGenetics

in 1987, IntelliGenetics successfully bid to run the GenBank sequencing database, taking over from Bolt, Beranek and Newman (BBN).

Name	IntelliGenetics
Location	Hilton Head Island, SC
Glossary	Diagnostics, DNA testing, pharmacogenomics DNA Analysis
Connections	http://intelligenetics.com/about-us/ http://www.fundinguniverse.com/company-histories/intellicorp-inc-history/ http://www.ncbi.nlm.nih.gov/books/NBK225676/ Book: Digital Code of Life: How Bioinformatics is Revolutionizing Science ... By Glyn Moody InfoWorld Article May 7, 1984https://books.google.com/books?id=ti4EAAAAMBAJ&pg=PA44&lpg=PA44&dq=intelligenetics+founded&source=bl YDYUQ6AEIHDAA#v=onepage&q=intelligenetics%20founded&f=false

9.1.113 Invitrogen

In 2000, Invitrogen acquired Research Genetics.

In 2008, Invitrogen acquired Applied Biosystems and the merged entity became known as Life Technologies.

In 2014, Thermo Fisher Scientific acquired Life Technologies, and, in effect, Invitrogen, Applera, Applied Biosystems, Genome Therapeutics, Collaborative Research.

Name	Invitrogen
History of the Company	Invitrogen went public in February 1999. The company acquired Applied Biosystems in 2008.
Historic Period	1987-2008
Founders	Lyle Turner, Joe Fernandez, William McConnell
Place	Carlsbad, CA
Organization Type	Biotechnology and life sciences product company
Connections	http://ir.thermofisher.com/investors/Investor-Overview/default.aspx http://www.sandiegouniontribune.com/news/2013/apr/15/history-invitrogen-carlsbad-merger/ Applera Applied Biosystems Collaborative Research Genome Therapeutics Life Technologies Thermo Fisher Scientific

9.1.114 Lifecodes

Immucor acquired Lifecodes in 2013. Lifecodes, founded in 1982, was one of the first companies to conduct forensic DNA testing in the United States, in the 1980s. It is known today for its work in transplantation diagnostics.

Name	Lifecodes
Historic Period	1982-present
Place	Stamford, CT; Valhalla, NY
Organization Type	Diagnostics company
Glossary/Keywords	DNA testing, transplantation diagnostics
Connections	http://www.immucor.com/en-us/Products/Pages/LIFECODES-Transplant-Products.aspx Immunicor

9.1.115 Life Technologies

In 2014, Thermo Fisher Scientific acquired Life Technologies, and, in effect, Invitrogen, Applera, Applied Biosystems, Genome Therapeutics, Collaborative Research.

Name	Life Technologies
History of the Company	In 2008, a merger of Invitrogen and Applied Biosystems made Life Technologies. The company was acquired by Thermo Fisher Scientific in 2014.
Historic Period	2008-2015
Organization Type	Biotechnology company
Connections	http://ir.thermofisher.com/investors/Investor-Overview/default.aspx Applera Applied Biosystems Collaborative Research Genome Therapeutics Invitrogen Thermo Fisher Scientific

9.1.116 Lynx Pharmaceuticals

In 1992, Applied Biosystems formed Lynx Therapeutics as a subsidiary focused on antisense DNA research. The company's technology allows DNA molecules to be simultaneously analyzed in order to efficiently identify and characterize gene expression. Illumina acquired Lynx Pharmaceuticals in 2005.

Name	Lynx Pharmaceuticals
Alternate Names	Lynx Therapeutics
Time Period	1992-2005
Other Top Management	Norrie Russell; Sam Eletr; Edward Albini; Benjamin Bown; Stephen Macevitz; Kathy San Roman; Glenn Albrecht; Jen-I Mao; Sydney Brenner
Public or Private	Private
Location	25861 Industrial Blvd. Hayward, CA 94545
Subsidiaries & Spin-offs	Began as a subsidiary of Applied Biosystems; BASF-LYNX Bioscience AG (1996; joint venture of Lynx and BASF AG); Lynx GMbH (wholly owned subsidiary in Heidelberg)
Collaborations & Partnerships	DuPont; BASF AG; Hoechst Shering AgrEvo GmbH; Oxagen Ltd.
Technologies and Products	Megaclone Technology; Megasort Technology; Massively Parallel Signature Sequencing (MPSS); Megatyping technology
Glossary	DNA analysis, differential gene expression, gene identification
Connections	http://www.illumina.com/company/investor-information.html

	Illumina Solexa

9.1.117 MedImmune

MedImmune is a member of AstraZeneca Group.

Name	MedImmune
History of the Company	MedImmune was founded in 1988 as Molecular Vaccines, Inc. It changed its name to MedImmune in 1990. The company was acquired by AstraZeneca in 2007.
Historic Period	1988-present
Founders	Wayne T. Hockmeyer
Place	Gaithersburg, MD
Organization Type	Pharmaceutical company
Connections	https://www.medimmune.com/ AstraZeneca Group

9.1.118 Merck & Co.

In 1994, Merck launched the Merck Gene Index, a project to make available sequences for human genes and to identify cDNA clones for those genes.

In February 1995, the company announced that, after collaborating with Washington University, it was releasing the first 15,000 expressed sequences into the index.

In 1996, Merck opened a laboratory for research on human genetics, genomics, and gene therapies. In 1997, they formed the Merck Genome Research Institute. One of the institute's roles was to support the Merck Gene Index.

In 2001, Merck acquired Rosetta Inpharmatics.

Merck & Co. and Merck KGaA are two separate companies. Outside the U.S., Merck & Co. is known as MSD (Merck Sharp & Dohme).

Name	Merck & Co.
Alternate	Merck & Co. or Merck in the U.S. and Canada; Merck Sharp & Dohme or MSD outside North America
History of the Company	Merck (Merck & Co.) was originally set up in 1891 as the U.S.-based subsidiary of the German parent company E. Merck, now known as Merck KGaA. Merck & Co. is now considered a separate, independent company, however.
Historic Period	1891-present
Founders	George Merck
Place	Kenilworth, NJ
Organization Type	Pharmaceutical company
Connections	http://www.merck.com/investors/home.html http://www.ncbi.nlm.nih.gov/Web/Whats_New/Announce/merck_feb10_95.html http://www.ncbi.nlm.nih.gov/pubmed/10322263 http://www.pharmaphorum.com/articles/a-history-of-merck-co http://www.emdserono.com/en/about_us/history/History.html Rosetta Inpharmatics

9.1.119 Merck KGaA

Merck KGaA is German-based multinational pharmaceutical and life sciences company.

Merck KGaA should not be confused with Merck & Co., the U.S.-based company that was once the American division of Merck KGaA but which is now a separate entity. In the United States, the German-based Merck does business under the name EMD Serono.

Name	Merck KGaA
Alternate	EMD; EMD Serono (U.S. trading names)
History of the Company	Merck's origins lay in the acquisition of the Angel Pharmacy in Darmstadt, Germany, in 1668 by Friedrich Jacob Merck.
Historic Period	1668-present
Founders	Friedrich Jacob Merck
Place	Darmstadt, Germany
Organization Type	Pharmaceutical company
Connections	http://www.merck.com/investors/home.html

9.1.120 Merck Serono

Merck KGaA acquired Rosetta Inpharmatics, Merck Serono, Serono, Genset.

Name	Merck Serono
Place	Darmstadt, Germany
Organization Type	Biopharmaceutical company
Connections	http://www.merck.com/investors/home.html Genset Merck Rosetta Inpharmatics Serono

9.1.121 Microsoft Corporation

In 1991, Bill Gates, co-founder and then-CEO of Microsoft, gave $12 million to the University of Washington to develop a department of molecular biotechnology. Part of the funding was meant to recruit Leroy Hood, who had developed the first automated DNA sequencing machine.

Name	Microsoft Corporation
Alternate	Microsoft
History of the Company	Microsoft went public in 1986.
Historic Period	1975-present
Founders	Bill Gates and Paul G. Allen
Place	Redmond, WA
Organization Type	Technology and computer software company
Connections	http://www.microsoft.com/investor/default.aspx http://www.britannica.com/topic/Microsoft-Corporation http://www.bloomberg.com/bw/stories/1992-11-15/lighting-a-fire-at-camp-dna

9.1.122 Millennium Pharmaceuticals

Founded in 1993 to discover human disease genes. In 1998, Bayer AG paid Millennium $465 million to supply 225 genetic drug targets to the company. Millennium acquired ChemGenex in 1997 in a stock swap valued at $90 million, and acquired LeokoSite in 1999 for $635 million in stock. In 2000, Millennium merged with Cambridge Discovery Chemistry in 2000 and with COR Therapeutics in 2002. Takeda acquired Millennium in 2008 as a wholly owned subsidiary. Since then, the company has done business under the name Millennium Pharmaceuticals.

Name	Millennium Pharmaceuticals
Time Period	1993-present
Other Top Management	Mark Levin
Public or Private	Public
Location	640 Memorial Drive Cambridge, MA 02139
Acquisition History	Acquired by Takeda (2008)
Mergers & Acquisitions	ChemGenics (1997); LeokoSite (1999); Cambridge Discovery Chemistry (2000); COR Therapeutics (2002)
Collaborations & Partnerships	Bayer AG
Glossary	Human disease genes, obesity, inflammation, campath
Connections	http://www.takeda.com/investor-information/ Takeda

9.1.123 Mitsui Knowledge Industry

Mitsui Knowledge Industry sponsored a DNA sequencing project in Japan (also sponsored by Seiko, Toyo, Soda, Fuji Photo, and Hitachi) in the early 1980s that was housed at the RIKEN in Tsukuba Science City (Gene Wars, 71, 215).

Name	Mitsui Knowledge Industries
Connections	http://www.mki.co.jp/english/

9.1.124 Myriad Genetics

Myriad Genetics was founded Salt Lake City, Utah in 1991 to discover human disease genes. Its researchers discovered the breast cancer genes BRCA1 (in 1994) and BRCA2 (in 1995), and developed the BRACAnalysis test. The company's patenting of isolated DNA sequences eventually resulted in a case being decided before the Supreme Court in 2013, Association for Molecular Pathology v. Myriad Genetics. In 2009, it spun off Myriad Pharmaceuticals to discover and develop therapeutic products.

Name	Myriad Genetics
Time Period	1991-
Founders	John Horan, Walter Gilbert, Peter Meldrum, Mark Skolnick
Public or Private	Public
Location	Salt Lake City, UT

Technologies and Products	ProNet system
Glossary	Human disease gene discovery, diagnostics, breast cancer, BRCA1, BRCA2, diabetes
Connections	https://www.myriad.com/

9.1.125 Neurome

Neurome specialized in quantitative database technology to study gene expression patterns in the brain.

Neurome Newco, a Bermuda-based subsidiary of Neurome, was a joint venture with the Eli Lilly pharmaceutical company.

in 2005, Neurome acquired Digital Gene Technologies, a genomics and bioinformatics company.

Name	Neurome
Historic Period	2000s
Place	La Jolla, CA
Organization Type	Biotechnology company
Connections	http://www.lilly.com/about/Pages/default.aspx http://www.evaluategroup.com/Universal/View.aspx?type=Story&id=19671 http://www.biospace.com/News/neurome-acquires-digital-gene/17101220 http://diablomanagement.com/case-studies/neurome-inc.html https://opencorporates.com/companies/bm/29338 Digital Gene Technologies Eli Lilly

9.1.126 New England Biolabs

Founded in 1974, New England Biolabs began as a group of scientists devoted to producing restriction enzymes for use in laboratories. The company eventually progressed to producing various other products for biological scientists. The company conducts significant basic research as well.

NEB's chief scientific officer is Nobel Laureate Richard Roberts, who has had a long association with the company since its founding. Roberts was chairman of the scientific advisory board of Celera while the company sought to complete the human genome sequence.

Alternate	NEB
Historic Period	1974-present
Place	Ipswich, MA
Organization Type	biotechnology
Keywords	restriction enzymes

9.1.127 Novartis International

In April 1998, Novartis announced it would build a research institute to focus on genomics and disease-gene research. The center was originally known as the Novartis Institute for Functional Genomics; today it goes by the name of The Genomics Institute of the Novartis Research Foundation.

Novartis International acquired Chiron in 2006.

Name	Novartis International
Alternate	Novartis
History of the Company	Novartis was formed in 1996 when Ciba-Geigy merged with Sandoz.
Historic Period	1996-present
Place	Basel, Switzerland
Organization Type	Pharmaceutical company
Connections	http://www.novartis.com/investors/index.shtml http://www.nytimes.com/1998/04/08/business/international-business-novartis-plans-to-research-disease-genes.html http://www.berkeley.edu/news/media/releases/98legacy/11-23-1998.html Chiron

9.1.128 Nuvelo

ARCA Biopharma acquired Nuvelo in 2009.

Name	Nuvelo
History of the Company	Nuvelo was formed in 2003 from the merger of HySeq Pharmaceuticals and Variagenics, Inc.
Historic Period	2003-2009
Organization Type	Biopharmaceutical company
Connections	http://www.arcabiopharma.com/39/Corporate%20Profile/index.html ARCA Biopharma HySeq

9.1.129 OpGen

Opgen develops diagnostic tests for hospitals to test for drug-resistant bacterial infections in hospitals.

Name	OpGen
Public or Private	Public
Location	708 Quince Orchard Road Gaithersburg, MD 20878
Technologies and Products	Acuitas MDRO Gene Test, Acuitas Lighthouse MDRO Management System, Acuitas Resistome Test
Glossary	Diagnostics
Connections	http://opgen.com/about-us/investor-relations

9.1.130 Oxford Nanopore Technologies

Oxford Nanopore Technologies was spun out of Oxford by Hagan Bayley, Gordon Sanghera, and Spike Willcocks in 2005. Initially known as Oxford NanoLabs Ltd., the company took on its current name in 2008.

Name	Oxford Nanopore Technologies
Alternate Names	Oxford NanoLabs

Time Period	2005-
Founders	Hagan Bayley, Gordon Sanhera; Spike Willcocks
Public or Private	Private
Location	Oxford Science Park, UK
Subsidiaries & Spin-offs	Spun out of Oxford
Technologies & Products	MinION, PromethION, GridION
Glossary	Nanopore sequencing, array sensor chip
Connections	https://nanoporetech.com/about-us/summary

9.1.131 Pacific Biosciences

Pacific Biosciences was established in Menlo Park, California, in 2004 by Stephen Turner. It has developed a technology platform described as single molecule real time sequencing (SMRT), released in 2011. The company went public in 2010.

Name	Pacific Biosciences
Alternate Names	Pacific Biosciences of California
Time Period	2004-present
Other Top Management	Mike Hunkapiller, Stephen Turner
Public or Private	Public
Location	Menlo Park, CA
Collaborations & Products	Partnered with Roche Diagnostics in 2013 to the development of *in vitro* diagnostics.
Technologies and Products	Single molecule real time sequencing (SMRT)
Glossary	Sequencing, instruments, reagents, diagnostics
Connections	http://investor.pacificbiosciences.com/

9.1.132 PE Applied Biosystems

PE Applied Biosystems (what Applied Biosystems was known as when owned by Perkin Elmer) was a major supplier of sequencing machines during the Human Genome Project.

Name	PE Applied Biosystems

9.1.133 Perkin Elmer

In 1986, Perkin Elmer partnered with Cetus Corp. to develop technology related to the polymerase chain reaction laboratory technique.

In 1993, Perkin Elmer bought Applied Biosystems.

In 1998, they announced they were cooperating with The Institute for Genomic Research to create a new genomics company, which turned out to be Celera Genomics.

Name	PerkinElmer
Alternate	PE
History of the Company	Since its founding, PerkinElmer has made its mark in several fields, such as optical tools and instruments for space and military purposes. After years of working in those areas, in the 1980s the company sought new opportunities in the biotechnology industry.
Historic Period	1931-present
Founders	Richard Perkin and Charles Elmer
Place	Waltham, MA
Organization Type	Health products company
Glossary/Keywords	diagnostics, medical instruments and technology
Connections	http://www.perkinelmer.com/corporate/investors/ https://www.genome.gov/10000606 http://jcvi.org/cms/press/press-releases/full-text/article/perkin-elmer-dr-craig-venter-and-tigr-announce-formation-of-new-genomics-company/ http://articles.baltimoresun.com/1998-08-06/business/1998218002_1_elmer-craig-venter-celera http://www.fundinguniverse.com/company-histories/the-perkin-elmer-corporation-history/

9.1.134 Perlegen

Perlegen started as a subsidiary of Affymetrix in 2000 and was spun off in 2001. The company conducted research on genetic variations to compile information for physicians, and participated in the International HapMap Project. Perlegen went out of business in 2009.

Name	Perlegen
Time Period	2000-2009
Founders	Stephen Fodor
Public or Private	Private
Location	2021 Stierlin Court Mountain View, CA 94043
Subsidiaries & Spin-offs	Spin-off Affymetrix
Glossary	Diagnostics, breast cancer, whole genome association studies
Connections	http://investor.affymetrix.com/phoenix.zhtml?c=116408&p=irol-IRHome

9.1.135 Pfizer

In December 1999, shortly before the draft sequence of the human genome was completed, Pfizer finalized a deal with Celera Genomics and Incyte Pharmaceuticals in which the two companies would help Pfizer develop new drugs based on genomics discoveries. Under the agreement, Pfizer would have access to Celera's databases for five years; the companies would also work together on drug development.

Pfizer acquired Pharmacia in 2003.

Before his unexpected death in 2013, the renowned geneticist and researcher David Cox was Pfizer's senior vice president, a position he had held since 2008. Previously Cox worked on the Human Genome Project, being part of one of the first groups to begin sequencing.

Name	Pfizer
History of the Company	Pfizer was founded in 1849 as Charles Pfizer & Company, a chemicals business based in a brick building in Brooklyn, New York. The company was the first domestic producer of tartaric acid and cream of tartar, both very important to the food industry. In the 1880s, Pfizer would begin manufacturing citric acid; this made the company incredibly successful, as demand for the product dramatically increased when drinks like Coca-Cola and Dr. Pepper became popular. In the 1930s Pfizer began producing vitamin C, eventually becoming the world's leader in production of ascorbic acid. They began producing other vitamins as well. In 1941, they began mass-producing penicillin for the U.S. government as part of the war effort, eventually becoming the largest producer of the antibiotic in the world. Pfizer would continue to expand both within the United States and internationally. A privately held company for nearly a century, Pfizer went public in June 1942.
Historic Period	1849-present
Founders	Charles Pfizer and Charles Erhart
Place	New York, NY; Groton, CT
Organization Type	Pharmaceutical company
Connections	http://www.pfizer.com/investors http://www.pfizer.com/about/history/timeline https://www.genome.gov/19518582 The Day Newspaper https://www.genomeweb.com/informatics/pfizer-seals-genomic-research-and-data-deals-celera-and-incyte http://www.nytimes.com/1999/11/23/business/pfizer-and-celera-in-deal.html LKB-Pharmacia

9.1.136 Pharmacia

Pfizer bought Pharmacia in 2003.

Name	Pharmacia
Alternate	LKB-Pharmacia
Historic Period	1911-2003
Place	Uppsala, Sweden; later headquarters in England and New Jersey
Organization Type	Pharmaceutical company
Connections	http://www.pfizer.com/investors http://www.pfizer.com/about/history/pfizer_pharmacia http://money.cnn.com/2003/04/16/news/companies/pfizer_pharma/ http://www.referenceforbusiness.com/history2/70/Amersham-PLC.html

9.1.137 Promega

Founded in 1978 in Madison, Wisconsin, by Bill Linton, Promega Corporation manufactures enzymes for researchers in the life sciences and pharmaceutical industry. The company provides a number of reagent products for genomics researchers used for cloning and PCR.

Name	Promega
Time Period	1978-present
Public or Private	Private

Location	2800 Woods Hollow Road Madison, WI 53711
Glossary	Reagents
Connections	http://www.promega.com/

9.1.138 Qiagen

Qiagen was established in 1984 by scientists at the Heinrich Heine University Dusseldorf. Acquired Rapigene in 2000 for approximately $12 million. It acquired Digene in 2007, and entered into personalized healthcare with its 2009 acquisition of DxS Ltd.

Name	Qiagen
Time Period	1984-present
Public or Private	Public
Location	Venlo, Netherlands
Mergers & Acquisitions	Rapigene (2000); Digene (2007); DxS (2009)
Glossary	Diagnostics
Connections	https://www.qiagen.com/us/about-us/

9.1.139 Quest Diagnostics

Quest Diagnostis acquired Celera Genomics in 2011.

Name	Quest Diagnostics
History of the Company	Quest Diagnostics was founded in 1967 by Paul Brown as MetPath. It was acquired by Corning in 1982.
Historic Period	1967-present
Founders	Paul Brown
Place	Madison, NJ
Organization Type	Healthcare services
Connections	http://www.questdiagnostics.com/home/about Celera Genomics

9.1.140 Raytheon BBN Technologies

Raytheon BBN Technologies was originally Bolt, Beranek & Newman (BBN).

Name	Raytheon BBN Technologies
History of the Company	Raytheon acquired BBN Technologies in 2009.
Historic Period	2009-present
Place	Cambridge, MA
Organization Type	Engineering and defense contracting
Connections	http://www.raytheon.com/ourcompany/bbn/

	Bolt, Beranek & Newman (BBN)

9.1.141 Research Genetics

Founded by Jim Hudson in 1987, Research Genetics was a respected name in the genomics field, becoming a significant player in the Human Genome Project. A leader in genetic linkage products, the company produced DNA microarrays, PCR primers, and synthetic DNA.

In late 1999/early 2000, Invitrogen acquired Research Genetics for $139.2 million.

Historic Period	1987-2000
Place	Huntsville, Alabama
Organization Type	Genomics company
Keywords	genetic linkage
Links	http://www.nytimes.com/1999/12/09/business/company-news-invitrogen-to-acquire-research-genetics.html http://ir.thermofisher.com/investors/news-and-events/news-releases/life-technologies-archive/life-technologies-archive-details/1999/INVITROGEN-CORPORATION-AND-RESEARCH-GENETICS-SIGN-LETTER-OF-INTENT-TO-MERGE/default.aspx http://hudsonalpha.org/our-founding-passion/biotech-visionaries

9.1.142 Roche Holding AG

Roche Holding AG is the parent company of Hoffmann-La Roche.

Roche acquired the rights to PCR from Cetus in 1991. In 2006, Roche acquired 454 Life Sciences for 154.9 million, and NimbleGen Systems for $272.5 million. In 2013 it acquired Genia Technologies and Bina Technologies. In 2014, it acquired Signature Diagnostics, a German oncology and genomics firm.

Name	Roche Holding
Alternate Name	Roche Holding AG; Hoffman-La Roche; Roche Diagnostics
Time Period	1896-present
Public or Private	Public
Mergers & Acquisitions	454 Life Sciences (2006); NimbleGen Systems (206); Genia Technologies (2013); Bina Technologies (2013); Signature Diagnostics (2013)
Glossary	Sequencing
Connections	http://www.rocheusa.com/ Roche Diagnostics Roche Molecular Systems

9.1.143 Roche Molecular Diagnostics

In the early 1990s, Roche Molecular Systems was founded to capitalize on Roche's recently acquired rights to the polymerase chain reaction (PCR) technology.

The company is a business area of Roche Holding.

Name	Roche Molecular Diagnostics
Alternate	Roche Molecular Systems

Historic Period	1991-present
Place	Pleasonton, CA
Organization Type	Biotechnology company
Glossary/Keywords	polymerase chain reaction
Connections	http://www.rocheusa.com/ http://molecular.roche.com/About/Pages/default.aspx http://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapId=4471495 Roche Roche Diagnostics

9.1.144 Rosetta Inpharmatics

Founded in 1996 by Leroy Hood, Lee Hartwell, and Stephen Friend, Rosetta combined informatics biological platforms and expression profiling data sets to speed up the drug discovery process. In 1999, it launched its Rosetta Resolver Expression Data Analysis System to identify new genes or targets, or compare compound profiles. Also in 1999, it acquired Acacia Biosciences and its Genome Reporter Matrix System. Merck & Co. acquired Rosetta Inpharmatics in 2001. Merck shut down the research site of Rosetta Inpharmatics in 2008.

Name	Rosetta Inpharmatics
Time Period	1996-2001
Founders	Leroy Hood, Lee Hartwell, Stephen Friend
Public or Private	Private
Location	12040-115th Ave, NE Kirkland, WA 98034
Acquisition History	Acquired by Merck (2001) and shut down in 2008
Mergers & Acquisitions	Acacia Biosciences (1999)
Technologies and Products	Rosetta Resolver Expression Data Analysis System software, Genome Reporter Matrix system, FlexJet (microarray)
Glossary	Bioinformatics, drug discovery, software
Connections	http://www.merck.com/investors/home.html http://articles.latimes.com/2001/may/12/business/fi-62536 Genset Merck Merck Serono Serono

9.1.145 Seiko

Seiko sponsored a DNA sequencing project in Japan (also sponsored by Hitachi, Toyo, Soda, Fuji Photo, and Matsui Knowledge Industries) in the early 1980s that was housed at the RIKEN in Tsukuba Science City (Gene Wars, pp. 71, 215). “Seiko developed a DNA purification system and another microchemical robot, Fuji began to mass-produce its gel, and Hitachi developed a prototype DNA sequencing machine” (Gene wars, p. 215).

Name	Seiko
Time Period	Early 1980s
Location	Japan

Glossary	DNA purification
Connections	http://seikousa.com/index.php

9.1.146 Sequana

Sequana was founded in 1993 by Jay B. Lichter and Kevin Kinsella in San Diego to discover disease genes. It was acquired by Arris Pharmaceuticals in 1998 to for the company AxyS Pharmaceuticals, which was acquired by Celera Genomics in 2001.

Name	Sequana
Alternate	Sequana Therapeutics
Founders	Jay B. Lichter, Kevin Kinsella
Location	11099 North Torrey Pines Road Suite 160 La Jolla, CA 92037
Acquisition History	Acquired by Arris Pharmaceuticals (1998) to form AxyS Pharmaceuticals; AxyS Pharmaceuticals acquired by Celera (2001)
Glossary	Disease gene discovery
Connections	https://www.celera.com/celera/about Axys Pharmaceuticals Celera Celera Genomics

9.1.147 Sequenom

Sequenom was founded in San Diego in 1994. It combined molecular biology, solid-phase nucleic acid biochemistry, and physics to produce a rapid DNA analysis technology (DNA MassARRAY). Its 1999 IPO raised $70 million.

Name	Sequenom Inc.
Time Period	1994-present
Public or Private	Public
Location	11555 Sorrento Valley Road San Diego, CA 92121
Technologies and Products	DNA Mass ARRAY, Spectro CHIP, MALDI-TOF (matrix-assisted laser desorption ionization-time of flight) mass spectrometry
Glossary	Single nucleotide polymorphism analysis, mass spectrometry, micro array, gene chip
Connections	https://www.sequenom.com/

9.1.148 Serono

In 2006, Merck KGaA acquired Serono. Thereafter the company was known as Merck Serono.

Before being acquired, Serono focused on developing therapies for neurological and metabolic disorders.

Name	Serono

History of the Company	Founded in Rome as the Istituto Farmacologico Serono; moved to Geneva in 1977.
Historic Period	1906-2007
Founders	Cesare Serono
Place	Geneva, Switzerland
Organization Type	Biotechnology company
Connections	http://www.merck.com/investors/home.html Genset Merck Merck Serono Rosetta Inpharmatics

9.1.149 SmithKline Beecham

In May 1993, SmithKline Beecham entered a partnership with Human Genome Sciences to fund drug discovery. They were part of a consortium of companies that provided HGS with critical funding and other support. According to SmithKline's deal with HGS, SmithKline retained first right to market drugs based on HGS's genomic discoveries.

In 2000, SmithKline Beecham merged with GlaxoWellcome to form GlaxoSmithKline.

Name	SmithKline Beecham
History of the Company	SmithKline Beckman merged with Beecham in 1989 to form SmithKline Beecham.
Historic Period	1989-2000
Organization Type	Pharmaceutical company
Connections	http://www.gsk.com/en-gb/investors/ http://commercialbiotechnology.com/index.php/jcb/article/viewFile/619/580 http://www.etcgroup.org/fr/node/485 GlaxoSmithKline GSK Human Genome Sciences SmithKline Beecham GlaxoWellcome Wellcome plc

9.1.150 Solexa

Solexa was founded in 1998 by Shankar Balasubramanian and David Klenerman, based on a sequencing technology they developed that employs very dense arrays of single molecules for massively parallel sequencing chemistry. Starting in 2005, it was publicly traded on NASDAQ and merged with Lynx Pharmaceuticals. In 2007 Illumina acquired Solexa.

Name	Solexa Inc.
Time Period	1998-2007
Founders	Shakar Balasubramanian, David Klenerman
Public or Private	Public
Location	Cambridge, UK

Acquisition History	Illumina (2007)
Mergers & Acquisitions	Lynx Pharmaceuticals (2005)
Glossary	Sequencing, massively parallel sequencing chemistry
Connections	http://www.illumina.com/company/investor-information.html Illumina Lynx Pharmaceuticals

9.1.151 Summa Corporation

Baker Hughes was formed from merger of Summa Corporation and Baker International.

Name	Summa Corporation
Historic Period	1972-1987
Founders	Howard Hughes
Organization Type	Holding company
Connections	http://www.bakerhughes.com/ Baker Hughes Baker International

9.1.152 Synthetic Genomics

Synthetic Genomics was founded in 2005 by J. Craig Venter and Hamilton Smith, who contributed significantly to landmark sequencing projects during the 1990s, including the sequencing of *Haemophilus influenzae* and Celera's private effort to sequence the human genome.

Name	Synthetic Genomics
Historic Period	2005-present
Founders	J. Craig Venter
Place	La Jolla, CA
Organization Type	Biotechnology company
Connections	http://www.syntheticgenomics.com/

9.1.153 Takeda

Takeda acquired Millennium, the biopharmaceutical company, in 2008. Millennium Pharmaceuticals, as it was thereafter known, is a wholly owned subsidiary of Takeda.

Name	Takeda
Alternate	Takeda Pharmaceuticals
Historic Period	1781-present
Founders	Chobei Takeda I
Place	Osaka, Japan and Tokyo, Japan
Organization Type	Pharmaceutical company

Connections	http://www.takeda.com/investor-information/ http://www.takeda.com/news/2008/20080410_3611.html Millennium Pharmaceuticals

9.1.154 Thermo Fisher Scientific

Thermo Fisher Scientific acquired Life Technologies, and, in effect, Invitrogen, Applera, Applied Biosystems, Genome Therapeutics, Collaborative Research.

Name	Thermo Fisher Scientific
History of the Company	Formed by a merger of Thermo Electron (a UK company) and Fisher Scientific.
Historic Period	2006-present
Place	Waltham, MA
Organization Type	Biotechnology company
Connections	http://ir.thermofisher.com/investors/Investor-Overview/default.aspx Applera Applied Biosystems Collaborative Research Genome Therapeutics Invitrogen Life Technologies

9.1.155 Time Logic

Time Logic is a division of Active Motif, which is based in California. Time Logic focuses on high-throughput technology for bioinformatics researchers. Its products and tools have been used in many sequencing projects, including that of the E. coli. K-12 genome in 1997.

Name	Time Logic
History of the Company	TimeLogic was founded in 1981 by Jim Lindelien as a computer-engineering firm. According to Lindelien, in 1989 the company began working on genetic database and analysis technology.
Historic Period	1981-present
Founders	Jim Lindelien
Place	Carlsbad, CA
Organization Type	Bioinformatics company
Glossary/Keywords	bioinformatics
Connections	http://www.timelogic.com/

9.1.156 URS Corporation

URS Corporation, an engineering firm, acquired EG&G in 2002.

URS Corporation was acquired by Aecom Technology Corp. in 2014.

Name	URS Corporation
Alternate	URS; United Research Services

Historic Period	1951-2014
Place	San Francisco, CA
Organization Type	Engineering company
Connections	http://www.urs.com/ http://www.nytimes.com/2002/07/18/business/company-news-urs-will-buy-eg-g-technical-for-335-million.html http://www.bloomberg.com/news/articles/2014-07-13/aecom-technology-agrees-to-buy-urs-for-about-4-billion EG&G Biomolecular

9.1.157 Verenium Corporation

Verenium was formed in 2007 from the merger of Diversa and Celunol. BASF, a large German chemical firm, acquired Verenium in 2013.

Name	Verenium Corporation
Alternate	Verenium; Verenium Corp.
Historic Period	2007-2013
Place	San Diego, CA
Organization Type	Biotechnology company
Connections	http://www.verenium.com/ http://www.bloomberg.com/news/articles/2013-09-20/basf-agrees-to-buy-verenium-as-it-attacks-dupont-novozymes http://www.prnewswire.com/news-releases/diversa-and-celunol-complete-merger-to-create-verenium-corporation-a-leader-in-the-emerging-biofuels-industry-58236112.html Diversa

9.1.158 Vertex Pharmaceuticals

Vertex Pharmaceuticals acquired Aurora Biosciences in 2001.

Name	Vertex Pharmaceuticals
Alternate	Vertex
History of the Company	Vertex was founded in 1989 by Dr. Joshua Boger, who had previously worked at Merck for over ten years.
Historic Period	1989-present
Founders	Joshua Boger
Place	Boston, MA
Organization Type	Pharmaceutical company
Glossary/Keywords	oncology, cystic fibrosis
Connections	http://www.vrtx.com/ http://investors.vrtx.com/releasedetail.cfm?releaseid=62799 Aurora Biosciences

9.1.159 Wellcome plc

Wellcome plc was created in 1986 as the Wellcome Trust began selling off shares of its wholly owned, privately held pharmaceutical company, Burroughs Wellcome. The Wellcome Trust sold its remaining position in Wellcome plc to Glaxo in 1995. The resulting company, Glaxo Wellcome, merged with SmithKline Beecham in 2000 to become GlaxoSmithKline.

Name	Wellcome plc
History of the Company	The Wellcome Trust was established in 1936 as the legacy of Sir Henry Wellcome. Its goal was to administer Henry Wellcome's fortune and to fund basic biomedical research. The Trust was the sole shareholder of a pharmaceutical company, Burroughs Wellcome, which Henry Wellcome had co-founded in 1880. Burroughs Wellcome was a significant source of income for the charitable trust, which used the company's profits to fund research.
Historic Period	1986-1995
Founders	Sir Henry Wellcome, Silas Burroughs
Place	London, England
Organization Type	Pharmaceutical company
Connections	http://www.gsk.com/en-gb/investors/ http://www.wellcome.ac.uk/About-us/History/WTX052938.htm http://blog.wellcome.ac.uk/2011/05/05/75th-stories-sir-john-sulston-and-the-human-genome-project/ Book: Digital Code of Life: How Bioinformatics is Revolutionizing Science ... By Glyn Moody http://www.gracesguide.co.uk/Burroughs,_Wellcome_and_Co http://www.wellcome.ac.uk/About-us/History/WTX051562.htm http://www.nytimes.com/1995/01/24/business/company-news-glaxo-offers-14-billion-for-wellcome.html GlaxoSmithKline GSK Human Genome Sciences SmithKline Beecham

9.2 Foundations/Charities

9.2.1 Association Francaise contre les Myopathies (AFM)

A patient group that supports research in genetics and muscle physiology/pathophysiology. A very influential group in the field of human genetics.

In 1987, l'Association Française contre les Myopathies (AFM) held a successful telethon, and some of this funding went toward the initial human genome mapping and sequencing efforts in France. Daniel Cohen, director of CEPH, received funding from AFM to construct a YAC clone library for physical mapping. Généthon, an industrial-sized mapping and sequencing operation launched in 1991, was also funded by AFM.

Alternate	The French Muscular Dystrophy Association
Founders	Yolaine de Kepper
Place	Paris
Organization Type	1901 Law Association

Connections	http://www.afm-telethon.com/ http://www.afm-telethon.fr/ http://dij.sagepub.com/content/34/1/75.short https://fr.wikipedia.org/wiki/Association_fran%C3%A7aise_contre_les_myopathies

9.2.2 Atomic Bomb Casualty Commission (ABCC)

Established in 1947 and 1948 in Hiroshima and Nagasaki in accordance with a presidential directive to the US National Academy of Sciences (NAS)-National Research Council (NRC). Purpose was to initiate a long-term, comprehensive, epidemiological and genetic study of atomic bomb survivors. The ABCC was financed by the Atomic Energy Commission (which later became the DOE).

The ABCC was replaced in 1975 by the Radiation Effects Research Foundation (RERF), a Japanese non-profit foundation jointly managed and equally supported by the U.S. and Japanese governments.

Alternate	Joint Commission; ABCC; Radiation Effects Research Foundation (RERF)
Historic Period	1946-1975
Organization Type	Joint Commission
Connections	http://www.ncbi.nlm.nih.gov/pubmed/9576897 http://www.rerf.or.jp/index_e.html

9.2.3 Centre d'Etude du Polymorphisme Humaine (CEPH)

International research center created in 1984 by Jean Dausset and his collaborators, Daniel Cohen, Howard Cann, and Mark Lathrop. Aimed at better understanding the role of genetic polymorphism in complex human diseases, with a goal of developing the practice of personalized medicine.

CEPH's collection of DNA donated by intergenerational families for the study of hereditary disease was used to construct a complete genetic map of the human genome. Jean Weissenbach led this international effort.

Alternate	Human Polymorphism Study Center; Fondation Jean-Dausset
Founders	Jean Dausset, Daniel Cohen, Howard Cann, and Mark Lathrop
Place	Paris
Connections	http://www.cephb.fr/

9.2.4 CIBA Foundation

Established in 1947, the CIBA Foundation was an international scientific and educational charity that promoted international cooperation in biological, medical and chemical research. The CIBA Foundation organized several international symposia per year on multidisciplinary topics, including the scientific, legal, and ethical aspects of human genetic information.

Alternate	Novartis Foundation (successor June 1, 1979)
Historic Period	1949-
Founders	Robert Käppeli

Place	Basel, Switzerland
Connections	https://books.google.com/books/about/Portrait_of_a_Foundation.html?id=7sh7AAAACAAJ https://en.wikipedia.org/wiki/Novartis_Foundation

9.2.5 Hoffman Foundation

The Hoffman Foundation was created in memory of Max Hoffman, the U.S. importer of Volkswagen and BMW automobiles. In 1984, the Hoffman Foundation offered $36 million to the University of California, Santa Cruz to build a new telescope for its astronomy department. When the Keck Foundation offered to fund the entire project, there were some speculations about what else the $36 million from the Hoffman Foundation could be used for. Robert Sinsheimer, head of the molecular biology department, proposed that the funding could be used to sequence the entire human genome. This led to further discussions and meetings about genome sequencing organized by Sinsheimer and colleagues Robert Edgar, Harry Noller, and Robert Ludwig. The $36 million was ultimately returned to the Hoffman Foundation.

Alternate	The Maximilian E. & Marion O. Hoffman Foundation
Place	West Hartford, CT
Connections	http://www.ncbi.nlm.nih.gov/books/NBK234203/

9.2.6 Howard Hughes Medical Institute (HHMI)

The Howard Hughes Medical Institute (HHMI) was launched by business magnate Howard Hughes in 1953. HHMI is one of the largest private organizations devoted to biological and medical research. HHMI played an important role in supporting research and databases related to the HGP, and was actively involved in all DOE- and NIH-sponsored functions during the project. HHMI also provided start-up funding for the Human Genome Organization (HUGO).

Alternate	HHMI
Historic Period	1953-present
Founders	Howard Hughes
Place	Chevy Chase (CDP), Maryland
Connections	http://www.hhmi.org/

9.2.7 Imperial Cancer Research Fund (ICRF)

The Imperial Cancer Research Fund was founded in 1902 with an objective of investigating the cause, nature, and treatment of cancer. In the UK, the ICRF was an early major supporter of the Human Genome Project, along with the MRC. In the early 1990s, the Wellcome Trust made even larger investments in genome research and informatics centers.

Name	Imperial Cancer Research Fund (ICRF)
Alternate	Cancer Research UK
Place	London, UK
Connections	http://www.cancerresearchuk.org/ http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2311831/

9.2.8 James S. McDonnell Foundation

Established in 1950, the James S. McDonnell Foundation supports scientific, educational, and charitable causes throughout the world. In 1987, the James S. McDonnell Foundation was considering funding a private genome institute. They did not ultimately do this, but did fund the National Research Council/National Academy of Sciences study of mapping and sequencing the human genome

Historic Period	1950-
Founders	James S. McDonnell
Place	St. Louis, MO
Organization Type	Private Foundation
Connections	https://www.jsmf.org/

9.2.9 Louis Jeantet Foundation

Fondation Louis-Jeantet awards annual prizes to support the best European research projects in clinical medicine and biomedical science. The foundation also supports professorial positions at the Faculty of Medicine of the University of Geneva.

In 1986, Sydney Brenner got the UK genome program started with funds from an award he had received from the Louis Jeantet Foundation.

Alternate	Fondation Louis-Jeantet
Historic Period	1983-
Founders	Louis Jeantet
Place	Genève, Switzerland
Connections	http://www.jeantet.ch/en/home-2.php

9.2.10 March of Dimes

Franklin D. Roosevelt founded the National Foundation for Infantile Paralysis (NFIP), which now is known as the March of Dimes. In the beginning, the foundation provided aid to polio patients and funded research for the polio vaccines (Salk and Sabin) that put an end to the polio epidemic in the U.S. Currently, the foundation focuses on programs and research to prevent birth defects and infant mortality.

The Bar Harbor Short Course in Medical and Mammalian Experimental Genetics, started by Victor McKusick and held annually at the Jackson Laboratory, in Bar Harbor, Maine, received much funding from the March of Dimes. The March of Dimes also provided funding for conferences and resources on various medical genetics topics.

Alternate	National Foundation for Infantile Paralysis (NFIP)
Founders	Franklin D. Roosevelt
Connections	http://www.marchofdimes.org/

9.2.11 Markey Charitable Trust

The Lucille P. Markey Charitable Trust was established in 1975 and operated for fifteen years. Mrs. Markey's estate derived largely from oil and gas leases inherited from her first husband Warren Wright. The Markey

Trust supported biomedical research institutions through scholarships, fellowships, institutional grants, research program grants, and training grants.

Along with NHGRI, NIH, DOE, and the Institute of Medicine (IOM) of the National Academy of Sciences, the Markey Charitable Trust provided funding for a 1991-1993 study of the Committee on Assessing Genetic Risks.

Name	Markey Charitable Trust
Alternate	Markey Trust; Lucille P. Markey Charitable Trust
Historic Period	1983-1996
Founders	Lucille P. Markey
Connections	http://www.rockarch.org/collections/nonrockorgs/markey.php

9.2.12 Marshfield Medical Research Foundation

The Marshfield Clinic was founded in 1916. The Marshfield Medical Research and Education Foundation was founded in 1959. Now called the Marshfield Clinic Research Foundation, the organization focuses on: Biomedical Informatics; Clinical Epidemiology and Population Health; Human Genetics; Clinical Research; and Farm Medicine.

At a 1996 meeting in Bermuda, Jim Weber, then director of the Marshfield Medical Research Foundation, proposed a BAC-by-BAC method for sequencing the human genome, which he developed in collaboration with Gene Myers from the University of Arizona.

Name	Marshfield Medical Research Foundation
Alternate	Marshfield Clinic Research Foundation
Historic Period	1959
Founders	K. W. Doege, MD William Hipke, MD Victor Mason, MD Walter G. Sexton, MD H. H. Milbee, MD Roy P. Potter, MD
Place	Marshfield, WI, USA
Connections	http://www.marshfieldresearch.org/

9.2.13 Radiation Effects Research Foundation (RERF)

The Atomic Bomb Casualty Commission (ABCC) was established in 1947 and 1948 in Hiroshima and Nagasaki in accordance with a presidential directive to the US National Academy of Sciences (NAS)-National Research Council (NRC). The ABCC was replaced in 1975 by the Radiation Effects Research Foundation (RERF), a Japanese non-profit foundation jointly managed and equally supported by the U.S. and Japanese governments.

Alternate	RERF
Place	Hiroshima City, Japan & Nagasaki City, Japan
Organization Type	Bi-national Japan-US scientific organization
Connections	http://www.rerf.jp/index_e.html

9.2.14 The Wellcome Trust

The Wellcome Trust was established in 1936 from the estate of Sir Henry Wellcome, a businessman, collector, and philanthropist. Wellcome was the co-founder of a large, prosperous pharmaceutical company, Burroughs Wellcome. He used his wealth to create a massive collection of historical objects, which was even larger than the collections of Europe's world-famous museums. Wellcome also funded cutting-edge medical research. The Wellcome Trust today is a major supporter of biomedical research and public understanding of science.

The Wellcome Trust Sanger Institute, founded by Sir John Sulston in 1992, spearheaded the UK side of the Human Genome Project. The Sanger Institute made the largest single contribution to the sequencing effort, and also played a vital role in ensuring open access to sequence data. The Sanger Institute has also been involved in numerous projects to sequence human pathogens, understand the genetic basis of disease, and identify drug targets.

Founders	Sir Henry Wellcome
Place	London, United Kingdom
Connections	http://www.wellcome.ac.uk/

9.3 Government Agencies/Departments

9.3.1 Atomic Energy Commission (AEC)

The Atomic Energy Commission, a precursor to the U.S. Department of Energy, was heavily involved in genetics research after the Second World War. Its considerable budget meant that even its relatively modest portion of funds for genetics research was significant.

Name	Atomic Energy Commission (AEC)
Alternate	AEC; Energy Research and Development Administration (ERDA); Nuclear Regulatory Commission (NRC); Energy Resources Council
Historic Period	1946-1974
Organization Type	US Government Agency
Connections	http://energy.gov/sites/prod/files/ERDA%20History.pdf http://www.nrc.gov/about-nrc/history.html http://www.fordlibrarymuseum.gov/library/guides/findingaid/U.S.%20Energy%20Resources%20Council%20-%20Records.htm

9.3.2 Beijing Genomics Institute (BGI)

Beijing Genomics Institute/Human Genome Center, Institute of Genetics, Chinese Academy of Sciences, Beijing, China, was part of the International Human Genome Sequencing Consortium. It was created in 1999 as the epicenter of China's efforts in genomics research.

Name	Beijing Genomics Institute (BGI)
Historic Period	1999-present
Place	Beijing, China
Connections	http://www.genomics.cn/index

9.3.3 Biomedical Ethics Advisory Committee (BEAC)

The Biomedical Ethics Advisory Committee (BEAC) was created in 1985 along with the Biomedical Ethics Board as a means of studying the ethical and social implications of human genome research. The Biomedical Ethics Board was a congressional body, and the BEAC was linked to it but considered separate and independent.

Federal legislation authored by Senator Al Gore led to the creation of both the BEAC and the Biomedical Ethics Board.

Name	Biomedical Ethics Advisory Committee (BEAC)
Alternate	BEAC
Historic Period	1988-1990
Organization Type	US Presidential Commission
Connections	http://bioethics.gov/former-commissions https://bioethics.georgetown.edu/library-materials/digital-collections/us-bioethics-commissions/ http://www.ncbi.nlm.nih.gov/books/NBK231976/

9.3.4 Biomedical Ethics Board

The Biomedical Ethics Board was a congressional board created by the U.S. federal government in 1985 (as a consequence of legislation authored by Senator Al Gore) to study the ethical and social issues raised by human genome research. The board worked with a separate committee known as the Biomedical Ethics Advisory Committee. The two bodies did work mostly from September 1988 to September 1989, even though they existed longer than that.

Name	Biomedical Ethics Board
Historic Period	1988-1989
Connections	https://bioethicsarchive.georgetown.edu/pcbe/reports/past_commissions/ http://www.ncbi.nlm.nih.gov/books/NBK231976/

9.3.5 BIONET

BIONET was a national computer resource for molecular biology funded by the NIH from 1984-1989. The goals of this resource were to provide computational assistance in data analysis and problem solving; to serve as a focus for development and sharing of software tools; and to promote collaboration and rapid sharing of information among the community of scientists.

Along with GenBank, BIONET was critical for the dissemination and analysis of sequence data.

Name	BIONET
Alternate	BIONET National Computer Resource

Connections	http://www.ncbi.nlm.nih.gov/pubmed/3945548 http://www.ncbi.nlm.nih.gov/pubmed/2698820

9.3.6 Biotechnology Science Coordinating Committee (BSCC)

The Biotechnology Science Coordinating Committee (BCSS) was an interagency body created in October 1985 to coordinate federal regulation for biotechnology. The BSCC formed a Subcommittee on the Human Genome in 1987.

Name	Biotechnology Science Coordinating Committee (BSCC)
Alternate	BSCC
Connections	https://www.acus.gov/recommendation/federal-regulation-biotechnology https://repository.library.georgetown.edu/handle/10822/539769 https://books.google.com/books?id=rBHyBwAAQBAJ&pg=PA220&lpg=PA220&dq=biotechnology+science+coordinating H1clfndKl23G_JWH1bRNZQ&hl=en&sa=X&ved=0CB0Q6AEwAGoVChMIj66GoZiLyQIVyHE- Ch3RUQim#v=onepage&q=biotechnology%20science%20coordinating%20committee%20%22human%20genome%20 http://www.the-scientist.com/?articles.view/articleNo/9077/title/Graham-Shakes-Up-U-S--Biotech-Panel/ http://jolt.law.harvard.edu/articles/pdf/v05/05HarvJLTech019.pdf http://www.ncbi.nlm.nih.gov/books/NBK235172/

9.3.7 Brookhaven National Laboratory

Name	Brookhaven National Laboratory
Alternate	BNL
Address	Brookhaven National Lab PO Box 5000 Upton, NY 11973-5000 (631) 344-8000
Historic Period	1948-Present
Place	Long Island, NY
Organization Type	US National Laboratory
Connections	https://www.bnl.gov/world/

9.3.8 Centers for Disease Control

The Centers for Disease Control (CDC) has been involved in genomics research by running the Office of Public Health Genomes (OPHG) and describes its role as the following: “CDC's Office of Public Health Genomics (OPHG) works to integrate advances in human genetics into public health research, policy and programs. CDC provides support to other agencies, conducts research, communicates and distributes information, and develops training programs for medical and public health professionals.”

Name	Centers for Disease Control
Place	Atlanta, GA
Organization Type	Federal agency
Connections	http://www.cdc.gov/ http://www.cdc.gov/genomics/public/faq.htm

9.3.9 Chinese Academy of Sciences (CAS)

The Chinese Academy of Sciences is China's national institute for basic and applied research. The CAS oversees the Beijing Genomics Institute, founded in November 2003.

Name	Chinese Academy of Sciences (CAS)
Connections	http://english.cas.cn/ http://english.big.cas.cn/au/bi/

9.3.10 CNRS

CNRS (Le *Centre national de la recherche scientifique*, or the National Center for Scientific Research) is a major French governmental scientific research organization. During the Human Genome Project, it was one of the constituent institutions of the International Human Genome Sequencing Consortium; as such, it helped other organizations and laboratories around the world sequence the genome. It is one of the overseers of the French National Sequencing Center, also known as Genoscope, which was a major part of the HGP.

Name	CNRS
Historic Period	1939-present
Connections	http://www.cnrs.fr/

9.3.11 ELSI Research, Planning and Evaluation Group (ERPEG)

In July 1997, the ERPEG was created by the National Advisory Council for Human Genome Research. ERPEG was created in response to recommendations from a committee on restructuring the existing ELSI oversight infrastructure in the federal government.

9.3.12 Equal Employment Opportunity Commission (EEOC)

With the passage of the Genetic Information Nondiscrimination Act of 2008, which prohibits private-sector discrimination against individuals based on their genetic information, the EEOC became involved in ensuring that the advances of the Human Genome Project not be used to discriminate against people in the areas of insurance and employment.

Name	Equal Employment Opportunity Commission (EEOC)
Historic Period	1965-present
Connections	http://www.eeoc.gov/

9.3.13 European Bioinformatics Institute

The European Bioinformatics Institute was established in 1992 as part of the European Molecular Biology Laboratory (EMBL). It became the European center for maintaining important sequencing databases, such as the EMBL Nucleotide Sequence database. Like GenBank and Japan's DNA database (with both of which EBI collaborated), the EMBL database stored all DNA sequences found by researchers as part of the Human Genome Project.

Name	European Bioinformatics Institute
Alternate	EMBL-EBI
Historic Period	1992-present
Place	Cambridge, UK
Connections	http://www.ebi.ac.uk/ http://nar.oxfordjournals.org/content/24/1/6.full

9.3.14 European Community (EC)

The European Community (EC) was the name used from 1993 to 2009 to refer to the common market within what is now the European Union. Before the establishment of the European Union in 1993, the EC was known as the European Economic Community.

From the earliest years of discussions on the Human Genome Project, many European scientists were keen to get involved in large-scale DNA sequencing to keep Europe competitive in science and medicine. For a while, the EC grappled with whether to embrace a project to sequence the human genome, with many worrying there were too many overwhelming social and ethical implications. The HGP was accepted by the European Community Council of Ministers in 1990.

Name	European Community (EC)
Historic Period	1993-2009
Connections	http://europa.eu/index_en.htm http://www.britannica.com/topic/European-Community-European-economic-association Book: Responsible Genetics: The Moral Responsibility of Geneticists for the ... By A. Nordgren

9.3.15 European Molecular Biology Laboratory (EMBL)

EMBL is an intergovernmental European biology laboratory that is considered the lead organization or standard bearer for the biological sciences in Europe. EMBL's involvement in genomics and the Human Genome Project goes back to the earliest years of the project, in the 1980s.

EMBL was established by multilateral agreement among a number of European nations in 1974; it was funded by contributions from the constituent member governments.

As Robert Cook-Deegan, a historian of the HGP, has written of EMBL's centrality to sequencing the human genome: "In addition to ongoing work in genetics, it also maintained the European node of the DNA sequence database, shared initially with GenBank in the United States. (In 1987, the DNA Database of Japan was also brought in.) EMBL was also the center of an effort to develop a fluorescence-based automated DNA sequencing instrument."

Name	European Molecular Biology Laboratory (EMBL)
Historic Period	1974-present
Connections	http://www.embl.org/

9.3.16 European Molecular Biology Organization (EMBO)

EMBO is a consortium of biological scientists in Europe, supported by member nations.

During the 1980s, molecular biologists in Europe sought to secure more funding for genomics research. They also sought a more cohesive program for European genomics. EMBO was one of the bodies willing to

support this idea, both financially and organizationally. EMBO is not itself a laboratory or research organizations, but helps research through sponsoring fellowships and meetings, among other things.

The structure of EMBO was also the basis of HUGO, the Human Genome Organisation, an international body established to foster cooperation among international genomics researchers and other molecular biology and genomics organizations.

Name	European Molecular Biology Organization (EMBO)
Historic Period	1964-present
Connections	http://www.embo.org/ Book: The Human Genome Project: Cracking the Genetic Code of Life By Thomas F. Lee Book: A Guide to the Human Genome Project: Technologies, People, and Institutions By Susan L. Speaker, M. Susan Lindee, Elizabeth Hanson

9.3.17 European Patent Office

In the early 1990s, the European Patent Office was involved in an ongoing controversy over whether it should be permissible to patent human genes, or partial nucleotide sequences of those genes. In June 1991, the U.S. National Institutes of Health filed for patents on hundreds of DNA sequences found by J. Craig Venter, then a researcher at the National Institute of Neurological Disorders and Stroke (NINDS).

Many people in the United States and abroad vigorously opposed the patent application. One of them was Hubert Curien, the French minister for research and technology. In response to the controversy, the European Patent Office announced that they would not allow patents on the DNA sequences in question.

Name	European Patent Office
Connections	https://www.epo.org/index.html http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2935940/

9.3.18 European Science Foundation (ESF)

In the early 1990s, in an effort to help bring Europe up to speed in genome research, the ESF commissioned the U.K. Medical Research Council to conduct a study on the state of genomics work around the world. Writing its own report in response to the survey, the ESF concluded that "European efforts appear fragmented, and command individually, fairly insignificant levels of support.... There is a danger that the European contribution to genome research may thus be dismissed as insignificant...." The ESF proposed a stronger, more unified European genomics program.

Name	European Science Foundation (ESF)
Connections	http://www.esf.org/home.html

9.3.19 Federal Bureau of Investigation (FBI)

As a law enforcement agency, the FBI has been involved with the sometimes controversial use of genetic information to investigate criminal cases. Through its Combined DNA Index System (CODIS), the FBI can search the National DNA Index System (NDIS) in order to check DNA collected from a crime scene against samples submitted by forensic laboratories nationwide. This has sparked debate over privacy and constitutional issues. In 2013, in the case of Maryland v. King, the U.S. Supreme Court ruled that law

enforcement may collect DNA samples from anyone arrested for a crime, just as officers would collect fingerprints or photographs of suspects.

Name	Federal Bureau of Investigation (FBI)
Historic Period	1908-present
Place	Washington, DC
Organization Type	Law enforcement agency
Connections	https://www.fbi.gov/

9.3.20 GenBank

In 1979, the Los Alamos National Laboratory created the Los Alamos Sequence Database, which in 1982 became known as GenBank. Then as now, GenBank collected all known DNA nucleotide sequences and made them available to researchers. The database was eventually transferred to the control of the National Center for Biotechnology Information, which is based in Bethesda, Maryland. GenBank is one of the most important open-access biological databases in the world, used by scientists worldwide.

Name	GenBank
Historic Period	1982-present
Place	Bethesda, MD
Connections	http://www.ncbi.nlm.nih.gov/genbank/

9.3.21 Genoscope

Genoscope and CNRS UMR-8030, Evry, France was part of the International Human Genome Sequencing Consortium.

The French National Sequencing Center, also known as Genoscope, was created in early 1997 by the French Ministry of Research as a major center of sequencing and sequencing data collection in France. It is a joint project, overseen in part by the French National Center for Scientific Research (CNRS). Genoscope was created as France's part of the Human Genome Project, which comprised an international consortium to conduct the sequencing work.

Name	Genoscope
Historic Period	1997-present
Place	Evry, France
Connections	http://www.genoscope.cns.fr/spip/

9.3.22 German Research Centre for Biotechnology (GBF)

The German Research Centre for Biotechnology (GBF) in Braunschweig, Germany, was one of the constituent centers of sequencing research as part of the International Human Genome Sequencing Consortium.

Name	German Research Centre for Biotechnology (GBF)
Connections	http://www.helmholtz-hzi.de/en/

9.3.23 Health and Environmental Research Advisory Committee (HERAC)

As an advisory body of the U.S. Department of Energy, the Health and Environmental Research Advisory Committee (HERAC) was responsible for giving advice to the director of the Office of Energy Research. A HERAC subcommittee was formed in 1986 to advise the DOE on its role in human genome research.

Name	Health and Environmental Research Advisory Committee (HERAC)
Connections	https://www.osti.gov/accomplishments/genomehistory.html Mapping our genes : the genome projects : how big, how fast? Serving Science and Society Into the New Millenium By Commission on Life Sciences, Division on Earth and Life Studies, U.S. Department of Energy, National Research Council

9.3.24 Human Fetal Tissue Transplantation Research Panel

The Human Fetal Tissue Transplantation Research Panel was a consultant advisory group convened by the National Institutes of Health in 1988 to study the ethical dimensions of the use of human fetal tissue in transplantation. Their specific objective was to study whether it was ethical for the U.S. federal government to subsidize research into the transplantation of fetal tissue. According to one article: "The majority opinion of the panel stated that abortion and fetal tissue use are entirely separate issues, and that tissue use is ethically acceptable because it can be morally insulated from the issue of abortion."

The panel convened at a time of significant controversy within the biological sciences, having mainly to do with increased debate over the ethics and social implications of genetics and genomics research.

Name	Human Fetal Tissue Transplantation Research Panel
Alternate	Fetal Tissue Transplantation Research Panel; HFTTR Panel
Historic Period	1988
Organization Type	NIH-Appointed Panel
Connections	http://www.ncbi.nlm.nih.gov/books/NBK234204/ http://grants.nih.gov/grants/guide/notice-files/not93-091.html http://www.ncbi.nlm.nih.gov/books/NBK234204/ http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1376000/ http://link.springer.com/article/10.1007%2FBF02624404

9.3.25 Human Genome Organization (HUGO)

The Human Genome Organization (HUGO) is an international group originally established to act as a coordinator of human genome research around the world. Since then, it has grown considerably in size and scope. HUGO grew out of a meeting at Cold Spring Harbor Laboratory in April 1988, at the first annual conference on Genome Mapping and Sequencing. It was formally established in 1989.

Name	Human Genome Organization (HUGO)
Historic Period	1989-present
Place	Singapore
Connections	http://www.hugo-international.org/

9.3.26 International Human Genome Sequencing Consortium

The International Human Genome Sequencing Consortium was the cooperative group of sequencing laboratories around the world that worked together to complete the Human Genome Project. The consortium consisted of 20 sequencing centers, based in the United States, United Kingdom, Japan, China, Germany, and France.

Name	International Human Genome Sequencing Consortium
Historic Period	1990-2003
Connections	https://www.genome.gov/11006939 https://www.genome.gov/11006929

9.3.27 Joint Genome Institute

The U.S. Department of Energy Joint Genome Institute in Walnut Creek, California, was part of the International Human Genome Sequencing Consortium.

In 1997, the U.S. Department of Energy established the Joint Genome Institute "to unite the expertise and resources in DNA sequencing, informatics, and technology development pioneered at the U.S. Department of Energy (DOE) genome centers at Lawrence Berkeley National Laboratory (LBNL), Lawrence Livermore National Laboratory (LLNL), and Los Alamos National Laboratory (LANL)."

Name	Joint Genome Institute
Historic Period	1997-present
Place	Walnut Creek, CA
Connections	http://jgi.doe.gov/ http://jgi.doe.gov/about-us/history/

9.3.28 Joint Working Group on Ethical, Legal and Social Implications (ELSI) of Human Genome Research

Established in 1989 by the National Institutes of Health and the Department of Energy, the working group handled proposals and options for the ethical, legal, and social implications of the Human Genome Project.

9.3.29 Laboratory of Molecular Biology, Cambridge (LMB)

The MRC Laboratory of Molecular Biology at the University of Cambridge, England, was the long-time professional home of Frederick Sanger, the father of DNA sequencing. Over the years it has produced many Nobel Laureates and key figures in the biological sciences. An important figure in the early debates over the Human Genome Project was Sydney Brenner, who was director of the Laboratory of Molecular Biology until 1986, after which point he became director of the MRC Molecular Genetics Unit at Cambridge.

Brenner and other figures from the LMB, such as John Sulston, were involved with many important genome meetings in the United States in the 1980s, during the lead-up to the HGP.

Name	Laboratory of Molecular Biology, Cambridge (LMB)
Historic Period	1962-present
Place	Cambridge, UK

Connections	http://www2.mrc-lmb.cam.ac.uk/ https://www.scripps.edu/research/faculty/brenner

9.3.30 Lawrence Berkeley National Laboratory

The Lawrence Berkeley National Laboratory is a federally run laboratory controlled by the Department of Energy. The Berkeley Lab is one of the organizations that operate the Joint Genome Institute, which was established in 1997 as a collaborative effort to aid in the Human Genome Project. (The other controlling organizations are the Lawrence Livermore and Los Alamos national laboratories.)

Name	Lawrence Berkeley National Laboratory
Historic Period	1931-present
Place	Berkeley, CA
Organization Type	National laboratory
Connections	http://www.lbl.gov/ https://str.llnl.gov/str/Branscomb.html

9.3.31 Lawrence Livermore National Laboratory

Lawrence Livermore National Laboratory is a federally funded laboratory based in Livermore, California. During the Human Genome Project, Lawrence Livermore was one of three laboratories run by the Department of Energy that acted as centers for the wide-scale sequencing effort. According to Linda Ashworth, a scientist at the Laboratory, “In 1992, about 80% of our effort was devoted to generating road maps for specific chromosomes or regions on a chromosome.” The Laboratory had already cemented a reputation as an excellent center for genetics research. In 1987, the Laboratory was focusing on chromosome 19, and many scientists around the world consulted with Lawrence Livermore for their own work on the chromosome.

Name	Lawrence Livermore National Laboratory
Historic Period	1952-present
Place	Livermore, CA
Organization Type	National laboratory
Connections	https://www.llnl.gov/ https://str.llnl.gov/str/Ashworth.html

9.3.32 Los Alamos National Laboratory

In 1979, the Los Alamos National Laboratory played an essential role in the history of genomics (and, later, the Human Genome Project) by creating the Los Alamos Sequence Database, which in 1982 became known as GenBank. This database stores all known nucleotide sequences and has became an important and widely accessed tool for researchers worldwide. In the late 1980s and early 1990s, GenBank was moved under the purview of the National Center for Biotechnology Information (NCBI), headquartered in Bethesda, Maryland.

Name	Los Alamos National Laboratory
Historic Period	1943-present
Place	Los Alamos, NM

Organization Type	National laboratory
Connections	https://www.lanl.gov/

9.3.33 Medical Research Council (MRC)

The Medical Research Council (MRC) is a national body in the United Kingdom dedicated to funding research in the biomedical sciences.

The idea of the Human Genome Project in the United States spurred scientists in other countries to begin pushing for funds from their own governments to complete genome research. As the most notable and prestigious center for molecular biology in Britain, the Laboratory of Molecular Biology in Cambridge, run by the Medical Research Council, was heavily involved in genomics from the get-go.

Sydney Brenner, an important figure at the MRC Laboratory, was involved in early meetings about the genome project and used his influence as a prominent scientist to push the United Kingdom to the forefront of the field.

"The British genome debate began in 1986," writes Robert Cook-Deegan in his book *The Gene Wars*, "when Brenner suggested to the MRC that he start a Molecular Genetics Unit that would include genome research. Brenner jump-started the UK genome program with funds from a private £300,000 ($525,000) award he received from the Louis Jeantet Foundation. He proposed to apply the physical mapping methods developed for *Caenorhabditis elegans*, pioneered by John Sulston and Alan Coulson of the MRC Laboratory in Cambridge, to the human genome."

"Brenner thus drew MRC directly into genome planning," Cook-Deegan explains. "At Brenner's request, MRC established a scientific advisory board, chaired jointly [by] Sir James Cowan, as secretary of the MRC, and Bodmer, as director of the ICRF [Imperial Cancer Research Fund]."

The British government announced in February 1989 that the MRC would receive £11 million over the next three years.

Name	Medical Research Council (MRC)
Place	UK
Organization Type	Government body
Connections	http://www.mrc.ac.uk/

9.3.34 Ministry of Health and Welfare (Japan)

As of 1999, Japan's role in the Human Genome Project represented only 8 percent of the whole international endeavor. The Japanese government then declared a plan for increasing its participation in global genomics research. The Ministry of Health and Welfare was one of Japan's governmental agencies that become more involved in the HGP, along with its Ministry of Education, Science, Sports and Culture and the Ministry of Agriculture, Forestry and Fisheries. Eventually the ministry merged genome research into its Research Project for Aging and Health.

Name	Ministry of Health and Welfare
Place	Japan
Organization Type	Government ministry
Connections	http://www.mhlw.go.jp/english/ http://www.nature.com/nature/journal/v400/n6743/full/400389a0.html

9.3.35 NASA

Name	NASA
Alternate	National Aeronautics and Space Administration
Address	NASA Headquarters 300 E. Street SW, Suite 5R30 Washington, DC 20546
Historic Period	1958-Present
Connections	https://www.nasa.gov/

9.3.36 National Academy of Sciences (NAS)

The National Academy of Sciences (NAS) is a private non-profit organization established by the U.S. Congress in 1863. It serves as an independent advisory group on scientific matters in the United States. According to the National Human Genome Research Institute:

"The main goals of the Human Genome Project were first articulated in 1988 by a special committee of the U.S. National Academy of Sciences, and later adopted through a detailed series of five-year plans jointly written by the National Institutes of Health and the Department of Energy. At this time, the principal goals laid out by the National Academy of Sciences have been achieved, including the essential completion of a high-quality version of the human sequence. Other goals included the creation of physical and genetic maps of the human genome, which were accomplished in the mid-1990s, as well as the mapping and sequencing of a set of five model organisms, including the mouse. All of these goals have been achieved within the time frame and budget first estimated by the NAS committee."

Such scientific luminaries as James Watson, Sydney Brenner, Leroy Hood, David Botstein, and Maynard Olson sat on this special committee.

Name	National Academy of Sciences (NAS)
Historic Period	1863-present
Organization Type	Non-profit
Connections	http://www.nasonline.org/ https://www.genome.gov/11006943 http://www.ncbi.nlm.nih.gov/books/NBK218258/

9.3.37 National Cancer Institute (Canada)

Canada's National Cancer Institute was involved in the funding and start-up of a genome program in Canada in the late 1980s and early 1990s. In 1991, a special Canadian government advisory committee pushed for the creation of a national genome research program to keep Canada competitive in medicine and the biological sciences. The program began in 1992 with funds from several Canadian governmental bodies, including $5 million from the Canadian NCI.

Canada's genome program was a joint project, with the country's NCI playing a leading role in its management and direction.

Name	National Cancer Institute (Canada)
Connections	http://www.cihr-irsc.gc.ca/e/12506.html Robert Cook-Deegan, *The Gene Wars* (New York: W.W. Norton, 1994), 204-205

9.3.38 National Cancer Institute (U.S.)

In December 2005, the National Cancer Institute, which is part of the National Institutes of Health, worked with the National Human Genome Research Institute to begin a large-scale effort to harness genomic technology to study the molecular basis of cancer. The name of the project, which began as a $100-million pilot program, was The Cancer Genome Atlas (TCGA). As part of the project, scientists genetically profiled thousands of tumors in order to study comprehensively the mutations related to the corresponding cancers. As of January 2015, there was debate over whether TCGA should cease. “TCGA should be completed and declared a victory,” Bruce Stillman, president of Cold Spring Harbor Laboratory, told *Nature*. The project, however, remains ongoing.

Name	National Cancer Institute (U.S.)
Historic Period	1937-present
Place	Rockville, MD
Connections	http://www.cancer.gov/ http://www.genome.gov/17515933 http://www.nature.com/news/end-of-cancer-genome-project-prompts-rethink-1.16662

9.3.39 National Center for Biotechnology Information (NCBI)

The National Center for Biotechnology Information (NCBI) is located in Bethesda, Maryland, and is part of the National Institutes of Health. NCBI was established in 1988 and runs several important databases for the biological sciences. These include GenBank and PubMed.

Name	National Center for Biotechnology Information (NCBI)
Historic Period	1988
Place	Bethesda, MD
Connections	http://www.ncbi.nlm.nih.gov/

9.3.40 National Center for Human Genome Research (NCHGR)

The National Center for Human Genome Research (NCHGR) was created in 1989 as the part of the National Institutes of Health responsible for leading the Human Genome Project. The precursor to the NCHGR was the Office of Human Genome Research.

The NCHGR coordinated with the Department of Energy to lead genome research in the United States.

The first director of the NCHGR was James Watson, co-discoverer of the chemical structure of DNA. Watson took up the position in 1989 and was succeeded by Francis Collins in 1993.

In 1997, the NCHGR become known as the National Human Genome Research Institute (NHGRI).

Name	National Center for Human Genome Research (NCHGR)
Historic Period	1989-1997
Connections	https://www.genome.gov/ https://www.nih.gov/about-nih/what-we-do/nih-almanac/national-human-genome-research-institute-nhgri

9.3.41 National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research

The National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research existed from 1974 to 1978 and is considered to be the first bioethics commission created by the U.S. federal government. It was created as a result of the National Research Act of 1974. The commission was concerned with forming basic principles and guidelines for research practices involving human volunteers; according to the federal government, the commission's resulting Belmont Report (submitted in 1978 and published in 1979) was influential to all later regulations on those issues.

Name	National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research
Historic Period	1974-1978
Organization Type	National Commission, Part of US Department of Health, Education, and Welfare (DHEW)
Connections	http://www.hhs.gov/ohrp/archive/nationalcommission.html http://www.hhs.gov/ohrp/humansubjects/guidance/belmont.html http://bioethics.gov/history

9.3.42 National Human Genome Research Institute (NHGRI)

The National Human Genome Research Institute (NHGRI) is the division of the National Institutes of Health (NIH) that oversees federal genome research. It was formed in 1997 when the National Center for Human Genome Research (established in 1989) was renamed. The NCHGR had been established to lead the NIH's role in the Human Genome Project.

Type	Federal research institute
Historic Period	1997-present
Links	https://www.genome.gov/

9.3.43 National Institute of Allergy and Infectious Diseases

The National Institute of Allergy and Infectious Diseases, which is part of the National Institutes of Health, has been involved in sequencing by supporting several institutions (namely the Broad Institute and the J. Craig Venter Institute) in producing microbial genome sequences.

Name	National Institute of Allergy and Infectious Diseases
Historic Period	1955-present
Place	Bethesda, MD
Connections	http://www.niaid.nih.gov/Pages/default.aspx National Institute of Allergy and Infectious Diseases, NIH: Volume 2: Impact ... By Vassil St. Georgiev

9.3.44 National Institute of General Medical Sciences (NIGMS)

The National Institute of General Medical Sciences (NIGMS) is a part of the National Institutes of Health and supports basic research in the biomedical sciences.

NIGMS played a role in the start-up of the Human Genome Project. In the late 1980s, NIGMS was a significant funding source for research in basic genetics—the largest in the world, in fact. The research that would eventually be undertaken by the Human Genome Project had its origins in that supported by NIGMS.

In 1988, the Office of Human Genome Research was created and at the time fell under the control of NIGMS. In 1989, however, the Office of Human Genome Research became the Center for Human Genome Research and was no longer operating under NIGMS.

Name	National Institute of General Medical Sciences (NIGMS)
Connections	http://www.nigms.nih.gov/Pages/default.aspx https://nihrecord.nih.gov/newsletters/2014/09_12_2014/milestones.htm From Biotechnology to Genomes: The Meaning of the Double Helix By Philippe Goujon

9.3.45 National Institute of Neurological and Communicative Disorders and Stroke (NINCDS)

Name	National Institute of Neurological and Communicative Disorders and Stroke
Alternate	NINCDS
Address	NIH Neurological Institute P.O. Box 5801 Bethesda, MD 20824
Connections	http://www.ninds.nih.gov/

9.3.46 National Institute of Neurological Disorders and Stroke (NINDS)

The National Institute of Neurological Disorders and Stroke (NINDS) is the part of the National Institutes of Health concerned with basic research on the brain, nervous system, and neurological diseases.

One well known HGP figure associated with NINDS was J. Craig Venter, who was a researcher there from 1984 to 1992. (NINDS was known as the National Institute of Neurological and Communicative Disorders and Stroke from 1975 to 1988.) While at NINDS, Venter's research focused mainly on membrane receptors. In 1990, however, he wrote a summary of a genome-sequencing conference, and his interests shifted to genomics.

Before the Human Genome Project got underway in 1990, NINDS was conducting its own sequencing work on several chromosomes (particular 4 and 17, in relation to Huntington's disease), making use of the new automated sequencing technology that had still only recently become available.

Name	National Institute of Neurological Disorders and Stroke (NINDS)
Historic Period	1950-present
Place	Bethesda, MD
Connections	http://www.ninds.nih.gov/ NINDS at 50: Celebrating 50 Years of Brain Research By Dr. Lewis P. Rowland, MD http://www.nih.gov/about-nih/what-we-do/nih-almanac/national-institute-neurological-disorders-stroke-ninds#events

9.3.47 National Institutes of Health (NIH)

The National Institutes of Health (NIH) was one of the federal overseers of the Human Genome Project, along with the U.S. Department of Energy. In 1990, the two organizations joined institutions around the world to sequence the genome.

Name	National Institutes of Health (NIH)
Historic Period	1887-present
Place	Bethesda, MD
Connections	http://www.nih.gov/ http://report.nih.gov/nihfactsheets/ViewFactSheet.aspx?csid=45

9.3.48 National Library of Medicine (NLM)

The National Library of Medicine runs the National Center for Biotechnology Information, which in turn runs the GenBank database that stores sequencing information derived from the Human Genome Project.

Name	National Library of Medicine (NLM)
Historic Period	1836-present
Place	Bethesda, MD
Connections	https://www.nlm.nih.gov/

9.3.49 National Research Council (NRC)

The National Research Council, part of the United States National Academies, influences science in the United States by putting out studies and reports that help to guide policy and research. According to Maynard Olson in 1993, "the programmatic direction" of the Human Genome Project "was largely set by a National Research Council report issued in 1988." "In the United States," Olson writes, "the Human Genome Project first took clear form in February 1988, with the release of the National Research Council (NRC) report *Mapping and Sequencing the Human Genome*."

Name	National Research Council (NRC)
Connections	http://www.nationalacademies.org/nrc/ http://www.pnas.org/content/90/10/4338.full.pdf

9.3.50 National Science Advisory Board for Biosecurity (NSABB)

Name	National Science Advisory Board for Biosecurity (NSABB)
Alternate	NSABB
Historic Period	2005-
Organization Type	Expert Advisory Panel
Connections	http://osp.od.nih.gov/office-biotechnology-activities/biosecurity/nsabb http://news.sciencemag.org/biology/2014/07/updated-u-s-biosafety-panel-come-out-hibernation-new-members

9.3.51 National Science Foundation

The National Science Foundation was involved early on in studying the ethical, legal, and social implications of the Human Genome Project. The NSF was one part of a working group that drew up a plan of action for addressing these ethical issues. In 1989, the working group held its first meeting, at which they agreed to come up with policy proposals, educate the public, and encourage debate on the issues.

Name	National Science Foundation
Historic Period	1950-present
Place	Arlington, VA
Connections	http://www.nsf.gov/ http://www.ncbi.nlm.nih.gov/books/NBK231976/

9.3.52 Office of Health and Environmental Research (OHER)

The Office of Health and Environmental Research (OHER) was a division of the U.S. Department of Energy that focused on the department's biologically centered research, specifically the harmful genetic effects of nuclear radiation. In 1985, the OHER was led by Charles DeLisi, a founding figure in the Human Genome Project. The HGP grew out of DeLisi's idea, while head of OHER, to spearhead a human DNA sequencing program.

Name	Office of Health and Environmental Research (OHER)
Connections	http://www.nap.edu/openbook.php?record_id=6325&page=3

9.3.53 Office of Human Genome Research

The Office of Human Genome Research was the original headquarters for genome research within the National Institutes of Health. Created in October 1988, it worked together with the U.S. Department of Energy to coordinate research on the human genome. A year later, in October 1989, The Office of Human Genome Research was changed to the National Center for Human Genome Research.

Name	Office of Human Genome Research
Historic Period	1988-1989
Connections	http://www.genome.gov/10001763 http://www.genome.gov/12011239

9.3.54 Office of Management and Budget (OMB)

The Office of Management and Budget is an executive-level office that works to assist the President of the United States in drawing up a federal budget. During the early years of the Human Genome Project, the OMB was surprisingly supportive of the new push for genome research; as authors like Robert Cook-Deegan have written, the OMB is normally a formidable obstacle when it comes to securing funding for any new initiative.

Name	Office of Management and Budget (OMB)
Historic Period	1970-present
Place	Washington, DC

Organization Type	Executive Branch office
Connections	https://www.whitehouse.gov/omb Current Controversies in the Biological Sciences: Case Studies of Policy ... By Karen F. Greif, Jon F. Merz

9.3.55 Office of Scientific Research and Development (OSRD)

The Office of Scientific Research and Development was one of the federal agencies that preceded the U.S. Department of Energy.

Name	Office of Scientific Research and Development (OSRD)
Historic Period	1941-1947
Connections	http://www.loc.gov/rr/scitech/trs/trsosrd.html

9.3.56 Office of Technology Assessment (OTA)

The Office of Technology Assessment, which existed from 1972 to 1995, was a body that helped members of Congress consider complex issues of science and technology by providing them with objective analysis. One of the OTA's reports, released in 1988, was highly influential in starting the Human Genome Project.

According to Robert Cook-Deegan, who directed the OTA's study of genome research from 1986 to 1988: "...the OTA report focused more on policy (why Congress should or should not support it). OTA surveyed international activity and dwelt far more on issues of technology transfer, ethical and social implications of genome research, and research management. OTA's only substantive difference with the NRC report centered on the notion of a 'lead agency.' OTA warned that if a lead agency meant control of all funding, then picking one would invite internecine warfare between NIH and DOE, the most likely result of which would be death of the project. OTA did not offer specific recommendations, but in congressional testimony, it clearly favored a truly collaborative effort worked out between the two agencies, with a congressionally mandated task force as the backup option if the agencies failed to produce an acceptable agreement."

Name	Office of Technology Assessment (OTA)
Historic Period	1972-1995
Connections	https://www.princeton.edu/~ota/ https://www.ndsu.edu/pubweb/~mcclean/plsc431/students98/bennett.htm http://www.genome.gov/10001477

9.3.57 Office of Technology Transfer, NIH (OTT)

The Office of Technology Transfer manages all the discoveries, inventions, and intellectual property of the National Institutes of Health and the Food and Drug Administration. During the early 1990s, the NIH was involved in the controversy over the patenting of human gene sequences, a recurring issue throughout the Human Genome Project.

In June 1991, working with the OTT, the NIH applied for patents on several hundred DNA sequences worked out by J. Craig Venter. At the time, Venter was a researcher working at the National Institute of Neurological Disorders and Stroke. The patent application touched off more controversy, with many people, including James Watson, opposing the filing.

The OTT at the time defended the patent application as a way to protect Venter's work and, in the words of office's director, "give meaningful patent protection to companies that might seek a license from NIH."

Name	Office of Technology Transfer, NIH (OTT)
Place	Rockville, MD
Connections	https://www.ott.nih.gov/ http://ipmall.info/risk/vol5/spring/harnett.htm

9.3.58 Patent and Trademark Office (PTO)

The U.S. Patent and Trademark Office (PTO) was involved in one of the more controversial aspects of the Human Genome Project, namely the question of whether human genes (i.e. specific nucleotide sequences) could or should be patented. As one analyst has written, “in 1991, the US Patent and Trademark Office received 4000 patent requests for nucleic acid sequences. In 1996, that number had jumped to 500,000.”

The fear was that much genetic information would be closed off by patents and also hidden away in proprietary databases.

According to the National Human Genome Research Institute:

"The earliest genetic patents were issued in 1982, following the U.S. Supreme Court case of Diamond vs. Chakrabarty, which opened the door to patenting biotechnology discoveries. Since then, the core of the debate over gene patents has been whether or not the discovery of a gene or sequence of DNA rises to the level of invention required by Title 35 of the United States Code, which lays out the criteria that must be satisfied for a patent to be granted. According to the Code, a patent may only be granted on 'any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof.' Laws of nature, natural phenomena, and abstract ideas cannot be patented. Even if this first hurdle is passed, the invention must be novel; the existence of 'prior art' shows that someone else invented it first, of course. Also, the invention cannot be obvious to 'a person having ordinary skill in the art to which said subject matter pertains.'"

In 2009, a U.S. District Court judge ruled that the BRCA1 and BRCA2 genes, which are linked to breast cancer, are products of nature and therefore not patent-eligible. After a lengthy appeals and review process, the U.S. Supreme Court reached a similar ruling in 2013.

Name	Patent and Trademark Office (PTO)
Place	Alexandria, VA
Connections	http://www.uspto.gov/ http://www.genome.gov/19016590 https://www.ndsu.edu/pubweb/~mcclean/plsc431/students98/bennett.htm

9.3.59 President’s Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research

The President’s Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research existed from 1979 to 1983 and studied the broader implications of future research in genetics. It produced eleven reports while it existed. In its final report, released in 1983, the commission focused on genetic counseling, gene therapy, and genetic screening, among other issues. The report noted that continued genetics research, as well as the introduction of genetic testing, would undoubtedly put pressure on the medical field in various economical, ethical, and legal ways.

Another of the commission's reports, entitled *Splicing Life* and released in November 1982, would be influential to Senator Al Gore in proposing an independent bioethics commission.

Name	President's Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research
Historic Period	1979-1983
Organization Type	US Presidential Commission
Connections	http://bioethics.gov/former-commissions https://bioethics.georgetown.edu/library-materials/digital-collections/us-bioethics-commissions/ http://www.presidency.ucsb.edu/ws/?pid=32607 https://bioethics.georgetown.edu/documents/pcemr/splicinglife.pdf

9.3.60 Recombinant DNA Advisory Committee (RAC)

Established in the 1970s during the advent of genetic engineering, the Recombinant DNA Advisory Committee (RAC), run by the National Institutes of Health, continues to advise the NIH director on research involving the manipulation of nucleic acids.

The ethical, legal, and social issues raised by the Human Genome Project drew the RAC into some early debates over the propriety of genome research. In January 1989, the author and activist Jeremy Rifkin attended one of the committee's meetings to voice his opposition to the HGP and to push for the creation of an "Advisory Committee on Human Eugenics." The committee rejected Rifkin's suggestion.

Name	Recombinant DNA Advisory Committee (RAC)
Alternate	RAC
Historic Period	1974-present
Organization Type	NIH Advisory Committee
Connections	http://osp.od.nih.gov/office-biotechnology-activities/biomedical-technology-assessment/hgt/rac http://iom.nationalacademies.org/Reports/2013/Oversight-and-Review-of-Clinical-Gene-Transfer-Protocols.aspx

9.3.61 Science and Technology Agency (STA)

The Science and Technology Agency is a Japanese governmental body responsible for science policy in Japan. It plays an indirect but important role in the history of the Human Genome Project. In the early 1980s, before the HGP was conceived, the STA funded a project in Japan called "Extraction, Analysis, and Synthesis of DNA." The goal of the project was harness the power of technology from robotics and electronics companies to automate DNA sequencing.

The STA continued to fund the Japanese project into the mid-1980s. The head of the project was Akiyoshi Wada, who came to the United States in late 1986 trying to organize an internationally coordinated project to sequence DNA. The idea to sequence the human genome had just begun to take shape in the United States, so Wada and the STA-funded project are important precursors to what came to be known as the Human Genome Project.

Name	Science and Technology Agency (STA)
Place	Tokyo, Japan
Connections	http://www.jst.go.jp/EN/

9.3.62 Securities and Exchange Commission, U.S.

Name	Securities and Exchange Commission, U.S.

Connections	http://www.sec.gov/

9.3.63 Task Force on Genetic Information and Insurance

9.3.64 U.S. Department of Defense (DOD)

The U.S. Department of Defense has contributed significant funding to human genome research over the years. In the 1990s, for instance, J. Craig Venter's team at The Institute for Genomic Research (TIGR) was working on a genomic analysis of *Haemophilus influenza* to study how the virus dodged attacks by the human immune system. According to author Victor McElheny, "The money from this bombshell had not come from NIH: Its reviewers doubted that Venter could close the gaps in his sequence. So, as happened at a number of crucial junctures in the genome project, the Department of Defense supported the work."

Name	U.S. Department of Defense (DOD)
Historic Period	1947-present
Place	Arlington, VA
Organization Type	Federal agency
Connections	http://www.defense.gov/ Science and Social Science: An Introduction By Malcolm Williams Drawing the Map of Life: Inside the Human Genome Project By Victor K. McElheny

9.3.65 U.S. Department of Energy (DOE)

The U.S. Department of Energy (DOE) was the first federal agency to oversee human-genome research. In 1985, Charles DeLisi, who was then the director of the Office of Health and Environmental Research at the DOE, proposed a Human Genome Initiative. He was therefore responsible for, in the words of scientist and historian Robert Cook-Deegan, "set[ting] aside the first funding for human genome research" and "in effect putting the genome project on the public policy agenda for the first time."

DeLisi's motivation for proposing a DOE-sponsored genome-research program stemmed from the idea of studying the genetic mutations of atomic-bomb survivors. "The history of the genome project," writes Cook-Deegan, "is linked to an attempt to determine if there would be a final, genetic wave of effects from bomb exposure."

When the Human Genome Project officially began, in 1990, it was overseen jointly by the DOE and the National Institutes of Health.

Name	U.S. Department of Energy (DOE)
Historic Period	1977-present
Place	Washington, DC
Organization Type	Federal agency
Connections	http://www.energy.gov/ http://genomicscience.energy.gov/program/timeline.shtml

9.3.66 U.S. Department of Health, Education, and Welfare (HEW)

The U.S. Department of Health, Education, and Welfare (HEW) was a federal department that existed from 1953 to 1979.

HEW was renamed the Department of Health and Human Services (HHS) in May 1980, after federal legislation (namely the Department of Education Organization Act) created a separate Department of Education.

Name	U.S. Department of Health, Education, and Welfare (HEW)
Historic Period	1953-1979
Connections	http://www.hhs.gov/about/historical-highlights/index.html http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1521806/ http://www.archives.gov/research/guide-fed-records/groups/235.html

9.3.67 U.S. Department of Health and Human Services (HHS)

The U.S. Department of Health and Human Services is the cabinet-level department that runs and oversees the National Institutes of Health, which was one of the administrators of the Human Genome Project.

Name	U.S. Department of Health and Human Services (HHS)
Historic Period	1980-present
Place	Washington, DC
Organization Type	Federal agency
Connections	http://www.hhs.gov/

9.3.68 U.S. Geological Survey

The U.S. Geological Survey is a federally run agency responsible for providing research and information about the environment, ecosystems, natural resources, and natural hazards of the United States.

The USGS was not directly involved with the Human Genome Project, but the agency runs many facilities throughout the United States that conduct genetics and genomics research on plants, fish, endangered species, and wildlife diseases.

Name	U.S. Geological Survey
Historic Period	1879-present
Place	Washington, DC
Connections	http://www.usgs.gov/ http://www.usgs.gov/ecosystems/genetics_genomics/capabilities.html http://www.nwhc.usgs.gov/publications/wildlife_health_bulletins/WHB_2009-03_WNS.pdf

9.3.69 U.S. House of Representatives

Since all spending bills must originate in the U.S. House of Representatives, the House was an essential governmental body for the creation and funding of the Human Genome Project.

In April 1988, the Office of Technology Assessment (OTA) submitted a report to the House of Representatives about funding and the roles of the National Institutes of Health and Department of Energy in

the project. In fiscal year 1988, the House and the Senate funded the two agencies to continue exploring the creation of a genome initiative.

Name	U.S. House of Representatives
Alternate	Congress
Place	Washington, DC
Organization Type	Legislature
Connections	http://www.house.gov/ http://www.nature.com/ng/journal/v20/n4/full/ng1298_333.html http://www.genome.gov/12011239 http://www.genome.gov/10001477

9.3.70 U.S. Senate

As one house of Congress, the U.S. Senate was necessary for the start-up funding of the Human Genome Project. One of the most important figures in this area was Senator Pete Domenici, who represented New Mexico in the Senate from 1973 to 2009. Domenici was a vocal supporter of the idea to sequence the human genome, and from his position in the Senate he continually pushed for funding for the project. For this, Francis Collins has called Domenici "the father of the genome project." In fiscal year 1988, both the Senate and the House started funding the HGP by appropriating money to the National Institutes of Health and the Department of Energy.

The Senate remained vigilant throughout the HGP regarding issues relating to the ethical, social, and legal implications of the project. In October 2003, the Senate passed the Genetic Information Nondiscrimination Act, which prohibits companies from using genetic information to determine a person's eligibility for employment or insurance plans.

Name	U.S. Senate
Place	Washington, DC
Organization Type	Legislature
Connections	http://www.senate.gov/index.htm http://www.genome.gov/10001763 https://www.genome.gov/10001379 http://www.nature.com/nature/journal/v393/n6683/full/393296b0.html Whose View of Life? By Jane MAIENSCHEIN http://www.genome.gov/10001477

9.3.71 U.S. Supreme Court

The Supreme Court has made many important decisions concerning genetics and genomics over the past several decades. One of the most consequential occurred when the American Civil Liberties Union and other groups filed suit in 2009 against Myriad Genetics, the U.S. Patent and Trademark Office, and the University of Utah Research Foundation. The suit concerned the validity of the patents covering two genes, BRCA1 and BRCA2, linked to breast cancer. After many decisions and appeals in lower courts, the Supreme Court ultimately decided in June 2013 that unmodified DNA is not eligible for patenting.

Name	U.S. Supreme Court
Place	Washington, DC
Connections	http://www.supremecourt.gov/

	http://www.genome.gov/19016590

9.3.72 United Nations Educational, Scientific, and Cultural Organization (UNESCO)

During the early years of the Human Genome Project, UNESCO took the initiative in addressing the ethical and social issues the HGP posed by beginning work on what would become the Universal Declaration on the Human Genome and Human Rights. The declaration, which UNESCO adopted in November 1997, asserts that the human genome should not be used to undermine human rights or dignity, and it takes strong positions against the cloning of human beings.

Name	United Nations Educational, Scientific, and Cultural Organization (UNESCO)
Historic Period	1945-present
Place	Paris, France
Connections	http://en.unesco.org/

9.3.73 World Health Organization (WHO)

In the early 1980s, the World Health Organization (WHO) established the Hereditary Diseases Program (HDP) to focus on medical genetics as part of its mission to support international advances in health. The program expanded as the Human Genome Project came to the fore of the biological sciences. According to the WHO, "gradually, the Hereditary Disease Programme ... expanded its focus on the genetic approaches to prevention and control of major hereditary single-gene diseases (thalassemia, cystic fibrosis, haemophilia, hemochromatosis), congenital malformations and to common diseases with genetic predispositions." In 1995, the HDP was renamed the Human Genetics Programme.

The WHO also provides information about the ethical, social, and legal implications (ELSI) of research into human genetics and genomics.

Name	World Health Organization (WHO)
Historic Period	1948-present
Place	Geneva, Switzerland
Connections	http://www.who.int/en/ http://www.who.int/genomics/elsi/en/

9.4 Hospitals/Medical Centers

9.4.1 Hospital for Sick Children

Founded in 1875, the Hospital for Sick Children (SickKids) is a dedicated to improving the health of children. The hospital led the fight in Canada for compulsory pasteurization of milk and the development of various nutritional standards. In response to the polio epidemic of 1937, the hospital provided aid to polio patients. Surgeons at the hospital pioneered important surgical techniques.

Researchers at the Hospital for Sick Children have made important advances in genetics, such as identifying and cloning the genes responsible for causing Duchenne muscular dystrophy and cystic fibrosis.

In 1998, the Genome Database (GDB) launched was moved from Johns Hopkins University to the Hospital for Sick Children in Toronto after the U.S. DOE cut off support for the project. In 2001, when the GDB's director, Jamie Cuticchia, was fired from the Hospital for Sick Children, the future of the GDB was in question.

Alternate	SickKids
Historic Period	1975-
Place	Toronto, Ontario
Organization Type	Hospital
Connections	http://www.sickkids.ca/

9.4.2 Massachusetts General Hospital

In 1811 the Massachusetts legislature granted a charter for the incorporation of Massachusetts General Hospital. Fundraising was led by Rev. John Bartlett, Chaplain of the Almshouse in Boston, Dr. James Jackson, and Dr. John Collins Warren. The original building opened its doors in 1821 for admission of the first Mass General patient.

Mass General became the first teaching hospital of Harvard Medical School. It has been the site of many advances in medicine, such as the first public demonstration of surgical anesthesia, the identification of appendicitis and the first replantation of a severed arm by a surgical team.

In 1953, Paul Zamecnik at Mass General pioneered the in vitro synthesis of proteins. In 1956, with Mahlon Hoagland, he co-discovered transfer RNA (tRNA). In 1978, Zamecnik and Mary Stephenson first demonstrated the potential of antisense oligonucleotide (ASO)-based therapeutics.

In 1983, James Gusella and his team at Mass General identified the gene responsible for Huntington's disease.

Alternate	Mass General
Historic Period	1811
Place	Boston, MA
Organization Type	Hospital
Connections	http://www.massgeneral.org/

9.4.3 Northern Genetics Service

The Northern Genetics Service is part of the Institute of Genetic Medicine in the UK. It provides diagnostic and genetic counseling services to individuals and families facing genetic disorders.

In 1998, Professor John Burn, head of the Northern Genetics Service, warned of the dangers of genetic discrimination.

Alternate	Newcastle upon Tyne Hospitals NHS Foundation Trust
Place	Newcastle upon Tyne, UK
Connections	http://www.newcastle-hospitals.org.uk/directorates/northern-genetics-service

9.4.4 St. Mary's Hospital

Founded in 1851, St Mary's was the first institution designed as a teaching hospital with a medical school attached.

In 1985, Brandon Wainwright, working with Robert Williamson's group at St Mary's, localized the cystic fibrosis locus to human chromosome 7cen-q22.

Alternate	St Mary's NHS Trust Imperial College Healthcare NHS Trust
Place	London, UK
Connections	http://www.imperial.nhs.uk/stmarys/index.htm http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1079568/

9.5 Research Institutes/Consortia

9.5.1 Arabidopsis Genome Initiative

Except from press release of September 25, 1996:

Scientists will soon have access to the first complete genetic information of a flowering plant. The Department of Energy (DOE), the National Science Foundation (NSF) and the Department of Agriculture (USDA) have funded three groups of researchers to begin systematic, large-scale genome sequencing of a plant named Arabidopsis thaliana. The ultimate goal is to sequence the entire Arabidopsis genome at a rate of about 200 genes per month and to develop the first complete gene sequence of a higher plant. The three-year awards total approximately $12 million.

Arabidopsis thaliana is a small plant in the mustard family, and has the smallest genome and the highest gene density so far identified in a flowering plant. "Decoding the DNA of this model plant will provide a complete catalog of all the genes involved in the life cycle of the typical plant, from seed to flower and fruit," says Martha Krebs, director of DOE's office of energy research. The Department of Energy is supporting the plant sequencing effort because the applications of the genetic information learned could be used to meet a number of agency mission needs. Potential applications include improved quality and quantity of biomass products such as alternative fuels and chemical feedstocks (which can conserve petroleum resources) and using plants to clean up contaminated soil (phytoremediation) at DOE's former nuclear weapons production sites.

9.5.1.1 AGI Principal Investigators (1996)

Figure 1 Standing from left to right: Kiyotaka Okada (Kyoto Univ.), Satoshi Tabata (Kazusa DNA Res. Inst.), Sakis Theologis (USDA/UC Berkeley), Rick Wilson (Wash Univ.), Joe Ecker (Univ. Penn.), Steve Rounsley (TIGR), Dick McCombie (CSHL), Ian Bancroft (John Innes Centre), Mike Bevin (John Innes Centre), Mike Cherry (Stanford

Univ.) Seated from left to right: Francis Quetier (Genethon), David Meinke (Oklahoma State Univ.), Chris Somerville (Carnegie Inst.), Nancy Federspiel (Stanford Univ.), Rob Martienssen (CSHL) September 1996

Alternative	AGI
Connections	AGI: Links to Participating Labs & Preliminary Sequences AGI: Data Release Policies AGI: Memorandum of Understanding Sequencing Announcement

9.5.2 Broad Institute

Founded in 2004, a year after the completion of the Human Genome Project, the Broad Institute is a leading research center in genomics and allied fields including neuroscience, oncology and chemical biology. Its founding director is Eric Lander, a key figure at the Whitehead Institute during the genome project.

Name	Broad Institute
Historic Period	2004-present
Place	Cambridge, MA
Connections	https://www.broadinstitute.org/

9.5.3 Cold Spring Harbor Laboratory

Cold Spring Harbor Laboratory, Lita Annenberg Hazen Genome Center, in Cold Spring Harbor, New York, was part of the International Human Genome Sequencing Consortium.

Cold Spring Harbor Laboratory's 1986 symposium on the Molecular Biology of Homo Sapiens was where scientists held one of the first discussions about the possibility of sequencing the entire human genome.

From 1968 to 1994, Cold Spring Harbor Laboratory was led by James Watson, who co-discovered the chemical structure of DNA and who became the first leader of the NIH component of the Human Genome Project.

Name	Cold Spring Harbor Laboratory

Alternate	CSHL
Place	Cold Spring Harbor, NY
Connections	http://www.cshl.edu/

9.5.4 Groupement d'Interet Public (GIP) Genopole

Founded in 1998, Genopole is France's premier bioscience cluster, composed of many companies and entities researching genomics and biotechnology.

Name	Groupement d'Interet Public (GIP) Genopole
Alternate	Genopole; GIP Genopole
Historic Period	1998-present
Place	Evry, Essonne, France
Organization Type	Biotech and Biotherapy Cluster
Connections	http://www.genopole.fr/?lang=en#.Vd47kpfDEV4 http://en.savoirs.essonne.fr/features/genopoler-a-ten-year-race-to-competitiveness/

9.5.5 Human Genome Resource Center

The Human Genome Resource Center was established in 1990 by the British Medical Research Council in Northwick Park, London, and constituted the beginning of the United Kingdom's involvement in sequencing and mapping the human genome.

Name	Human Genome Resource Center
Connections	The Gene Wars: Science, Politics, and the Human Genome By Robert M. Cook-Deegan http://science.sciencemag.org/content/sci/243/4899/1657.full.pdf

9.5.6 Institute for Systems Biology (Seattle)

Multimegabase Sequencing Center, The Institute for Systems Biology, Seattle, Wash., U.S. was part of the International Human Genome Sequencing Consortium.

The Institute for Systems Biology was founded by Leroy Hood, who, while a professor at Caltech in the 1980s, developed the first automated DNA sequencing technology that would enable the Human Genome Project.

Name	Institute for Systems Biology (Seattle)
Historic Period	2000-present
Place	Seattle, WA, USA
Connections	https://www.systemsbiology.org/

9.5.7 Institute of Molecular Biotechnology (Jena)

The Department of Genome Analysis of the Institute of Molecular Biotechnology in Germany was part of the International Human Genome Sequencing Consortium.

Name	Institute of Molecular Biotechnology (Jena)
Place	Jena, Germany
Connections	http://www.imb-jena.de/

9.5.8 J. Craig Venter Institute

Established in 2006, the J. Craig Venter Institute is run by Craig Venter, who with his company Celera mounted a private effort to sequence the human genome to compete with the international public consortium.

The J. Craig Venter Institute was formed by merging The Institute for Genomic Research (TIGR), The Center for the Advancement of Genomics (TCAG), and the J. Craig Venter Science Foundation (JCVSF).

Name	J. Craig Venter Institute
Alternate	JCVI
Historic Period	2006-present
Place	La Jolla, CA; Rockville, MD
Connections	http://www.jcvi.org/cms/home/

9.5.9 J. Craig Venter Science Foundation (JCVSF)

The J. Craig Venter Science Foundation was one of the organizations that merged with The Institute for Genomic Research in 2006 to become the J. Craig Venter Institute.

Name	J. Craig Venter Science Foundation (JCVSF)
Alternate	JCVSF
Historic Period	2002-2006
Connections	http://www.jcvi.org/cms/home/

9.5.10 Jackson Laboratory

For its entire history, the Jackson Laboratory has been a significant center of research on mouse genetics. In 1984, Jackson researchers concluded that the mouse genome is a good model for the human genome. The Laboratory was a part of the Mouse Genome Sequencing Consortium , which published a draft mouse genome in 2002, a year before the completion of the Human Genome Project.

Name	Jackson Laboratory
Historic Period	1929-present
Place	Bar Harbor, Maine
Connections	https://www.jax.org/ A Guide to the Human Genome Project: Technologies, People, and Institutions By Susan L. Speaker, M. Susan Lindee, Elizabeth Hanson

	https://www.jax.org/about-us/history/highlights

9.5.11 Kazusa DNA Research Institute

The Kazusa DNA Research Institute was created in Japan in 1994 as a way to push that country's research in sequencing and genome studies forward in the wake of the Human Genome Project.

Name	Kazusa DNA Research Institute
Alternate	KDRI
Historic Period	1991-present
Place	Kisarazu, Japan
Organization Type	Research institute
Connections	http://www.kazusa.or.jp/e/ http://www.nature.com/nature/journal/v399/n6732/full/399096a0.html Technology and Innovation in Japan: Policy and Management for the Twenty ... edited by Martin Hemmert, Christian Oberländer

9.5.12 Marine Biological Laboratory at Woods Hole

The Marine Biological Laboratory in Woods Hole, Massachusetts, was the site of an important early meeting on the possibility of sequencing the human genome, held by the National Academies of Science in August 1986. The meeting was important in laying out the scientific strategy for the future Human Genome Project, particularly its cooperative, international nature.

Name	Marine Biological Laboratory at Woods Hole
Historic Period	1888-present
Place	Woods Hole, MA
Connections	http://www.whoi.edu/ The Gene Wars: Science, Politics, and the Human Genome By Robert M. Cook-Deegan

9.5.13 Max Planck Institute for Molecular Genetics

Max Planck Institute for Molecular Genetics, in Berlin, Germany, was part of the International Human Genome Sequencing Consortium.

The Max Planck Institute was also an important center of research on the Neanderthal genome.

Name	Max Planck Institute for Molecular Genetics
Historic Period	1964-present
Place	Berlin, Germany
Connections	http://www.molgen.mpg.de/2168/en

9.5.14 Pasteur Institute

In April 2001, the Pasteur Institute formed an international consortium to sequence the genome of *Anopheles*, the mosquito.

Name	Pasteur Institute
Connections	http://www.pasteur.fr/en http://www.genoscope.cns.fr/spip/Anopheles-gambiae-vector-for-a.html

9.5.15 RIKEN

RIKEN Genomic Sciences Center, located in Yokohama, Japan, was part of the International Human Genome Sequencing Consortium.

Among other things, RIKEN was responsible for sequencing 60% of chromosome 11, an important chromosome for the study of human disease.

Name	RIKEN
Historic Period	1917-present
Connections	http://www.riken.jp/en/ http://www.nature.com/nature/journal/v440/n7083/full/nature04632.html http://metasystems.riken.jp/wiki/Sequence_Data

9.5.16 Roswell Park Cancer Institute

Geneticists at the Roswell Park Cancer Institute in Buffalo, New York, were responsible for creating the gene library used in the Human Genome Project. Anonymous DNA donors were asked to contribute via newspaper ads placed in Buffalo newspaper in 1997.

Name	Roswell Park Cancer Institute
Historic Period	1898-present
Place	Buffalo, NY
Connections	https://www.roswellpark.org/ http://www.nytimes.com/2013/04/16/science/the-human-genome-project-then-and-now.html?_r=0 https://www.roswellpark.org/careers/company-information/marks-distinction

9.5.17 Salk Institute

In 1986, the renowned molecular biologist Renato Dulbecco, then at the Salk Institute, wrote an influential opinion piece for *Nature* advocating the idea of sequencing the entire human genome.

Name	Salk Institute
Historic Period	1960-present
Place	La Jolla, California

Connections	http://www.salk.edu/ The Human Genome Project: Cracking the Genetic Code of Life By Thomas F. Lee

9.5.18 SNP Consortium

The SNP Consortium, formed in April 1999, was a two-year project that sought to identify the many thousands of single-nucleotide polymorphisms that exist on the human genome.

Name	SNP Consortium
Historic Period	1999-2001
Connections	http://www.ncbi.nlm.nih.gov/projects/SNP/ http://www.nature.com/nbt/journal/v17/n6/full/nbt0699_526.html

9.5.19 Superconducting Super Collider Consortia

The Superconducting Super Collider was a U.S. government-funded project, which Congress approved in 1987, that aimed to create the world's largest particle accelerator. Construction began in 1991 but the whole project was abandoned in 1993.

Along with the Human Genome Project, the Super Collider was emblematic of the type of Big Science projects that in the 1980s and 1990s often faced heavy criticism for their huge budgets and potential to crowd out funding for small-scale research.

Name	Superconducting Super Collider Consortia
Historic Period	1987-1983

9.5.20 The Center for the Advancement of Genomics (TCAG)

The Center for the Advancement of Genomics (TCAG) was one of the constituent organizations that merged to become the J. Craig Venter Institute in 2006.

Name	The Center for the Advancement of Genomics
Alternate	TCAG
Place	Rockville, MD
Organization Type	Non-profit organization
Connections	http://www.jcvi.org/cms/press/press-releases/full-text/article/the-institute-for-genomic-research-tigr-j-craig-venter-institute-j-craig-venter-science-founda/ http://jcvi.org/cms/about/overview/

9.5.21 The Institute for Genomic Research (TIGR)

The Institute for Genomic Research (TIGR) was a non-profit private research center that J. Craig Venter founded in 1992. The institute conducted significant research on the genomes of many microorganisms, including that of *Haemophilus influenzae*, which was the first genome of a free-living organism to be fully sequenced. In 2006, TIGR was one of the organizations that merged to become the J. Craig Venter Institute.

Name	The Institute for Genomic Research (TIGR)
Historic Period	1992-2006
Connections	http://www.jcvi.org/cms/press/press-releases/full-text/article/the-institute-for-genomic-research-tigr-j-craig-venter-institute-j-craig-venter-science-founda/ http://www.encyclopedia.com/doc/1G2-3409800548.html

9.5.22 Wellcome Trust Sanger Institute

The Wellcome Trust Sanger Institute, The Wellcome Trust Genome Campus, Hinxton, Cambridgeshire, U.K. was part of the International Human Genome Sequencing Consortium.

It was originally known as the Sanger Centre, named after Frederick Sanger, the father of DNA sequencing.

Their involvement in the Human Genome Project began in 1993. The institute kicked off the British contribution to sequencing the genome.

Name	Wellcome Trust Sanger Institute
Alternate	Sanger Centre
Historic Period	1992-present
Connections	https://www.sanger.ac.uk/ http://www.sanger.ac.uk/about/who-we-are/sanger-institute/history-sanger-institute/human-genome-project-and-sanger-institute

9.5.23 Whitehead Institute

During the Human Genome Project, the Whitehead Institute/MIT Center for Genome Research in Cambridge, Mass., was a key part of the International Human Genome Sequencing Consortium.

Eric Lander, a key figure in the HGP, was associated with Whitehead for many years as director of the institute's genome research.

Name	Whitehead Institute
Historic Period	1982-present
Place	Cambridge, MA
Connections	http://wi.mit.edu/

9.6 Societies/Associations

9.6.1 American Association for the Advancement of Science (AAAS)

The American Association for the Advancement of Science (AAAS) was founded in 1848. Its mission is to "advance science and serve society." The AAAS sponsors programs in the areas of science policy, international cooperation, science education, and public understanding of science.

In 1988, AAAS sponsored a symposium entitled, "The Human Genome Project: Progress and Prospects."

In 1992, AAAS sponsored a conference on the ethical aspects of large pedigree genetic research.

In 1997, AAAS sponsored a symposium entitled, "The Human Genome Project: What's the Public Got to do With it?"

In 2001, Science published the human genome sequence created by Celera Genomics (and Nature published a series of reports by the International Human Genome Sequencing Consortium (IHGSC)).

Alternate	AAAS
Place	Washington, D.C.
Organization Type	Professional Organization
Connections	http://www.aaas.org/ http://archives.aaas.org/exhibit/origins2.php

9.6.2 American Council of Life Insurers (ACLI)

The American Council of Life Insurers (ACLI) is a trade association that advocates for public policy that supports the life insurance industry and the customers that rely on life insurers' products.

In 1992, an ACLI/HIAA CEO-level joint task force conducted a study to assess the public policy implications of genetic testing. The task force issued a report on genetic testing with recommendations. The ACLI's Subcommittee on Privacy Legislation issued a report at the same time.

In 1993, the American Academy of Insurance Medicine, ACLI, HIAA, and the American Society of Human Genetics co-sponsored a conference for insurance medical directors on genetic issues in insurance medicine.

Name	American Council of Life Insurers (ACLI)
Alternate	American Council of Life Insurance; ACLI
Place	Washington, DC, USA
Organization Type	Lobbying and Trade Group
Connections	https://www.acli.com/Pages/DefaultNotLoggedIn.aspx

9.6.3 American Society for Microbiology

The Society of American Bacteriologists was founded in 1899. In 1960, the name was changed to the American Society for Microbiology (ASM). With 43,000 members, ASM is the largest life science professional organization in the world. ASM's mission is to advance the microbiological sciences and disseminate this knowledge throughout society.

In 1995, the entire DNA sequence of Haemophilus influenzae was presented at an ASM meeting in Washington, DC.

Alternate	Society of American Bacteriologists
Place	Washington, D.C.
Connections	http://www.asm.org/

9.6.4 American Society of Human Genetics

Established in 1948, the American Society of Human Genetics (ASHG) publishes the American Journal of Human Genetics; sponsors an annual research meeting; and provides other services related to human genetics research and education.

In 1991, the ASHG Human Genome Committee issued a report entitled, "The Human Genome Project: Implications for Human Genetics."

The ASHG has issued numerous policy and position statements on genetic testing and genetic information from 1980 to the present.

Name	American Society of Human Genetics
Alternate	ASHG
Place	Bethesda, MD
Organization Type	Professional membership organization
Connections	http://www.ashg.org/

9.6.5 Council of the American Society for Biochemistry and Molecular Biology

Founded in 1906, the American Society for Biochemistry and Molecular Biology (ASBMB) is a nonprofit scientific and educational organization with a mission to advance the science of biochemistry and molecular biology. ASBMB publishes journals, organizes scientific meetings, advocates for funding for research and education, supports science education, and promotes diversity in science. The governing council of the ASBMB consists of the President, President-Elect or Past-President, Treasurer, Secretary, and nine Councilors.

At a 1989 symposium entitled, "The Merging of Chemistry and Biology: Looking Backward/Looking Forward," sponsored by the ASBMB and the Arnold & Mabel Beckman Center for the History of Chemistry, there was much debate on a project to map the human genome.

Alternate	American Society for Biochemistry and Molecular Biology (ASBMB) American Society of Biological Chemists (ASBC)
Historic Period	1906
Place	Rockville, MD
Connections	http://www.asbmb.org/about/governance/council/

9.6.6 D.C. Science Writers Association (DCSWA)

Founded in 1987, the D.C. Science Writers Association (DCSWA) is an independent science writer organization with around 500 members. DCSWA brings science writers together for socializing, networking, and professional development.

In March 2000, after the publication of the *Drosophila* genome, J. Craig Venter hosted an open house at Celera, organized by the DCSWA.

Historic Period	1987
Organization Type	501(c)6 organization
Connections	http://www.dcswa.org/

9.6.7 Health Insurance Association of America (HIAA)

In 2003, the Health Insurance Association of America (HIAA) merged with the American Association of Health Plans to become America's Health Insurance Plans (AHIP). Serving as both a trade association and a political advocacy group, AHIP's mission is to simplify the administrative process of the industry and protect its members. Currently, AHIP has about 1,300 member companies. AHIP is known for its lobbying efforts.

In 1992, an ACLI/HIAA CEO-level joint task force conducted a study to assess the public policy implications of genetic testing. The task force issued a report on genetic testing with recommendations. The ACLI's Subcommittee on Privacy Legislation issued a report at the same time.

In 1993, the American Academy of Insurance Medicine, ACLI, HIAA, and the American Society of Human Genetics co-sponsored a conference for insurance medical directors on genetic issues in insurance medicine.

Alternate	America's Health Insurance Plans (AHIP)
Organization Type	Trade association
Connections	http://www.healthinsuranceproviders.com/health-insurance-association-of-america-hiaa/

9.6.8 Industrial Biotechnology Association (IBA)

In 1993, the Industrial Biotechnology Association (IBA), which primarily represented larger, established companies, and the Association of Biotechnology Companies (ABC), which represented emerging companies and universities, merged to form the Biotechnology Industry Organization (BIO).

BIO is the world's largest trade association representing biotechnology companies, academic institutions, state biotechnology centers, and related organizations. BIO advocates for its members and provides networking, partnering and education opportunities. BIO also produces the BIO International Convention and other meetings; BIOtechNOW, a blog; and the BIO Newsletter, a bi-weekly email newsletter.

In 1987, the Industrial Biotechnology Association surveyed its members about the HGP, and found strong support for the project, as long as it was carried out by NIH. However, they did not support patenting of DNA sequences; they felt this knowledge should be placed in the public domain.

Alternate	Association of Biotechnology Companies (ABC) Biotechnology Industry Organization (BIO)
Place	Washington, D.C.
Organization Type	Trade association
Connections	https://www.bio.org/

9.7 Universities and Colleges

9.7.1 Baylor College of Medicine

The Baylor College of Medicine Human Genome Sequencing Center was a major contributor to the Human Genome Project and was part of the International Human Genome Sequencing Consortium.

Name	Baylor College of Medicine
Alternate	Baylor
Place	Houston, TX, USA
Organization Type	Health Sciences University
Connections	https://www.hgsc.bcm.edu/ https://www.hgsc.bcm.edu/human-genome-project

9.7.2 California Institute of Technology

In the 1980s, Caltech was the home of Leroy Hood and Lloyd Smith, who developed the first automated DNA sequencing machine; the technology for that machine would underlay all the sequencing completed during the Human Genome Project.

Name	California Institute of Technology
Alternate	Caltech
Place	Pasadena, CA

Organization Type	Private Research University
Connections	http://mmjggl.caltech.edu/sequencing/ http://www.caltech.edu/news/caltech-and-human-genome-project-406

9.7.3 Columbia University

Pulsed field electrophoresis, which was used for generating physical maps, was developed by Charles Cantor and David Schwartz at Columbia University.

Name	Columbia University
Alternate	Columbia
Place	New York
Organization Type	Private Ivy League Research University
Connections	https://systemsbiology.columbia.edu/genome-center/sequencing-and-analysis

9.7.4 Duke University

The Duke Center for Public Genomics was a DOE/NHGRI/NIH-funded Center of Excellence in Ethical, Legal, and Social Implications (ELSI) Research from 2004 to 2015.

Robert M. Cook-Deegan, author of *The Gene Wars: Science, Politics, and the Human Genome* (W.W. Norton & Company, 1994), is the Director of the Center for Genome Ethics, Law and Policy at Duke University.

Name	Duke University
Alternate	Duke
Place	Durham, NC, USA
Organization Type	Private Research University
Connections	http://www.genome.duke.edu/ https://dukecpg.wordpress.com/ http://dukespace.lib.duke.edu/dspace/handle/10161/1561

9.7.5 Harvard University

In 2004, NHGRI established Centers of Excellence in Genomic Science (CEGS) at Harvard Medical School.

The Personal Genome Project (PGP), founded by George M. Church in 2005, is based at Harvard Medical School.

Name	Harvard University
Alternate	Harvard
Place	Cambridge, MA, USA
Organization Type	Private Ivy League Research University
Connections	https://www.broadinstitute.org/ http://www.hms.harvard.edu/DMS/BBS/Genetics/index.html http://www.personalgenomes.org/

9.7.6 Johns Hopkins University

Mendelian Inheritance in Man (MIM) (book version) was started in the early 1960s by Victor A. McKusick at Johns Hopkins University. Online Mendelian Inheritance in Man (OMIM) was created in 1985 by a collaboration between the NLM and the William H. Welch Medical Library at Johns Hopkins. OMIM is currently written and edited at the McKusick-Nathans Institute of Genetic Medicine, Johns Hopkins University School of Medicine.

Beginning in 1991, the DOE/NIH-funded Genome Database (GDB) launched was hosted at Johns Hopkins University.

The first complete genome of a free-living organism, *Haemophilus influenza*, was sequenced in 1995 by J. Craig Venter's team from The Institute for Genomic Research (TIGR) and Hamilton Smith of Johns Hopkins University.

In 1996, the Center for Inherited Disease Research (CIDR), an NIH-funded project to study the genetic components of complex disorders, was established at the Johns Hopkins Bayview Medical Center campus.

Since 1996, Johns Hopkins University and NHGRI have offered the JHU/NHGRI Genetic Counseling Training Program (GCTP).

In 2004, NHGRI established Centers of Excellence in Genomic Science (CEGS) at Johns Hopkins University School of Medicine.

Name	Johns Hopkins University
Alternate	Johns Hopkins; JHU; Hopkins
Place	Baltimore, MD, USA
Organization Type	Private Research University
Connections	http://genomics.jhu.edu/

9.7.7 Keio University

The Department of Molecular Biology at Keio University School of Medicine in Tokyo, Japan, was part of the International Human Genome Sequencing Consortium.

Name	Keio University
Alternate	Keio; Keidai
Place	Minato, Tokyo, Japan
Organization Type	Private University
Connections	http://www.iab.keio.ac.jp/en/component/option,com_frontpage/Itemid,1/

9.7.8 Kent State University

In 2002, the National Institutes of Health held one of several public health forums, "From Bench to Bedside and Beyond - How Research is Changing the Public's Health," at Kent State University, Stark Campus in Ohio.

Name	Kent State University
Alternate	Kent; Kent State; KSU
Place	Kent, OH, USA

Organization Type	Public Research University
Connections	http://www.kent.edu/biology/genomics-core-facility https://www.genome.gov/10506111

9.7.9 Massachusetts Institute of Technology (MIT)

As early as 1995, the Whitehead Institute/MIT Center for Genome Research had launched collaborative pilot genomic medicine projects among scientists from across MIT and Harvard.

The Whitehead Institute/MIT Center for Genome Research, in Cambridge, Massachusetts, was part of the International Human Genome Sequencing Consortium.

Victor McElheny, science writer and founder of the Knight Science Journalism Fellowships at MIT, wrote *Drawing the Map of Life: Inside the Human Genome Project*.

Name	Massachusetts Institute of Technology (MIT)
Alternate	MIT
Place	Cambridge, MA, USA
Organization Type	Private Research University
Connections	https://www.broadinstitute.org/ http://wi.mit.edu/about/history/genome http://compbio.mit.edu/

9.7.10 Princeton University

David Botstein, now Director of the Lewis-Sigler Institute for Integrative Genomics at Princeton, played a crucial role in advocating for the Human Genome Project. While serving on the NRC Committee, he emphasized that funding needed to be allocated to the sequencing of other simpler organisms with which the human genome could be compared.

Shirley M. Tilghman, now president emerita of Princeton University, and founding director of Princeton's Lewis-Sigler Institute for Integrative Genomics, also was a member of the NRC Committee, and one of the founding members of the National Advisory Council of the Human Genome Project Initiative for the NIH.

Name	Princeton University
Alternate	Princeton
Place	Princeton, NJ, USA
Organization Type	Private Ivy League Research University
Connections	http://lsi.princeton.edu/ http://molbio.princeton.edu/faculty/research/genomics

9.7.11 Rockefeller University

In 1944 Oswald Avery, Colin MacLeod, and Maclyn McCarty, then at the Rockefeller University, showed that DNA was the material of which genes are made.

In 1978, at a meeting at Rockefeller University, the idea of a database to contain the sequence information emerged as a priority. A study of this issue was conducted by Rockefeller University and the European Molecular Biology Laboratory (EMBL) in Heidelberg, Germany.

In 1989, Norton Zinder of Rockefeller University chaired the first meeting of the Program Advisory Committee on the Human Genome.

Name	Rockefeller University
Alternate	Rockefeller; RU
Place	New York, NY
Organization Type	Private University
Connections	http://www.rockefeller.edu/genomics/

9.7.12 Stanford University

The Stanford Genome Technology Center in Stanford, California, was part of the International Human Genome Sequencing Consortium.

The pioneering recombinant DNA research of Stanley N. Cohen and Paul Berg was done at Stanford.

Name	Stanford University
Alternate	Stanford
Place	Stanford, CA, USA
Organization Type	Private Research University
Connections	http://med.stanford.edu/sgtc/

9.7.13 University of California, Berkeley

In 1995, Richard Mathies' group at University of California, Berkeley, working with Amersham, developed improved sequencing dyes.

Name	University of California, Berkeley
Alternate	Berkeley; UC Berkeley; California; Cal
Place	Berkeley, CA, USA
Organization Type	Public Research University
Connections	https://mcb.berkeley.edu/barker/dnaseq/home http://qb3.berkeley.edu/ccb/

9.7.14 University of California, San Diego

Melvin I. Simon, a leader in the invention of BACs, is at UCSD.

Theodore Friedmann, a pioneer of gene therapy, is at UCSD.

Name	University of California, San Diego
Alternate	UC San Diego; UCSD
Place	La Jolla, CA, USA
Organization Type	Public Research University
Connections	http://igm.ucsd.edu/

9.7.15 University of California, San Francisco

The pioneering recombinant DNA research of Herbert Boyer was done at UCSF.

The NRC Committee was chaired by Bruce Alberts of UCSF.

Name	University of California, San Francisco
Alternate	UCSF; UC San Francisco
Place	San Francisco, CA, USA
Organization Type	Public University; Center of Health Sciences Research, Patient Care, and Education
Connections	http://humangenetics.ucsf.edu/

9.7.16 University of California, Santa Cruz

Jim Kent was a graduate student at UCSC and David Haussler is a professor at UCSC.

The Genome Browser is hosted at UCSC.

In 1985, Robert Sinsheimer convened a meeting of eminent scientists in Santa Cruz to propose a human genome project.

In 1999, David Haussler and graduate student Jim Kent joined the HGP to locate the genes in the human genome sequence.

In 2000, researchers at UCSC assembled the human genome sequence using a computer program developed by Jim Kent. The following month, the UCSC genome bioinformatics group released the first working draft of the human genome sequence on the web.

Later in 2000, Jim Kent developed the UCSC Genome Browser.

UCSC is involved in the ENCODE Project.

Name	University of California, Santa Cruz
Alternate	UC Santa Cruz; UCSC
Place	Santa Cruz, CA, USA
Organization Type	Public Collegiate University
Connections	https://genomics.soe.ucsc.edu/ https://genome.ucsc.edu/ http://www.ucsc.edu/features/genomics/milestones.html

9.7.17 University of Cambridge

Fred Sanger was based at the MRC Laboratory of Molecular Biology (LMB) at the University of Cambridge.

The MRC Laboratory is also where the work in sequencing the nematode *C. elegans* was done.

Name	University of Cambridge
Alternate	Cambridge University; Cambridge
Place	Cambridge, UK
Organization Type	Collegiate Public Research University
Connections	http://www.bioc.cam.ac.uk/dnasequencing

9.7.18 University of Chicago

The University of Chicago is involved in the ENCODE Project.

Name	University of Chicago
Alternate	U of C; Chicago; or UChicago
Place	Chicago, IL, USA
Organization Type	Private Research University
Connections	http://www.uchicago.edu/research/center/institute_for_genomics_and_systems_biology/ https://fgf.uchicago.edu/

9.7.19 University of Michigan

Francis Collins was a member of the University of Michigan medical faculty.

Name	University of Michigan
Alternate	U-M; UM; UMich; or U of M; Michigan
Place	Ann Arbor, MI, USA
Organization Type	Public Research University
Connections	http://seqcore.brcf.med.umich.edu/ http://www.lsi.umich.edu/centers/center-for-chemical-genomics https://sph.umich.edu/genomics/

9.7.20 University of Oklahoma

The University of Oklahoma's Advanced Center for Genome Technology was part of the International Human Genome Sequencing Consortium.

Name	University of Oklahoma
Alternate	OU
Place	Norman, OK, USA
Organization Type	Public Research University
Connections	http://www.genome.ou.edu/ http://www.ou.edu/microarray/ http://ieg.ou.edu/

9.7.21 University of Texas Southwestern Medical Center

The University of Texas Southwestern Medical Center at Dallas, in Dallas, Texas, was part of the International Human Genome Sequencing Consortium.

Name	University of Texas Southwestern Medical Center
Alternate	UT Southwestern
Place	Dallas, TX, USA
Organization Type	Medical Education and Biomedical Research Institution

Connections	https://microarray.swmed.edu/

9.7.22 University of Utah

The Church of Jesus Christ of Latter-Day Saints' Family History Library is the largest collection of genealogical records in the world. In the 1970s, with the help of the Church, researchers at the University of Utah extracted data on individuals who met very specific criteria and combined it with public health, birth/death records, and other data to create the Utah Population Database (UPDB). The UPDB has grown to include data on more than 7.3 million individuals. It has become a vital tool in genetics research.

In the early 1990s, the University of Utah was chosen to complete significant mapping work for the Human Genome Project. The university was integral to finding the BRCA1 and BRCA2 genes, which are linked to breast cancer.

A controversy grew out of this discovery when the Utah scientists who found the genes established a company, Myriad Genetics, to patent them. This was a major part of the fight over whether gene sequences should be patented.

Name	University of Utah
Alternate	The U; U of U; Utah
Place	Salt Lake City, UT, USA
Organization Type	Public Space-Grant Research University
Connections	http://www.genome.utah.edu/ http://ccgs.utah.edu/ http://healthsciences.utah.edu/utah-genome-project/ http://learn.genetics.utah.edu/ http://healthcare.utah.edu/healthfeed/postings/2015/03/052313joliebrca.php http://healthsciences.utah.edu/utah-genome-project/family/2015/030415-History%20of%20Genetics%20in%20Utah.php

9.7.23 University of Washington

The University of Washington Genome Center, in Seattle, Washington, was part of the International Human Genome Sequencing Consortium.

Robert Waterston is Professor and Chair of Genome Sciences at the University of Washington.

Name	University of Washington
Alternate	Washington; U-Dub; UW
Place	Seattle, WA, USA
Organization Type	Public Flagship Research University
Connections	http://www.gs.washington.edu/ http://depts.washington.edu/genomics/index.shtml

9.7.24 University of Wisconsin

In 1997, University of Wisconsin researchers completed the sequence of *E. coli* (Blattner et al. 1997).

Name	University of Wisconsin

Alternate	University of Wisconsin–Madison; Wisconsin; UW; UW–Madison; Madison
Place	Madison, WI, USA
Organization Type	Public Research University
Connections	https://www.biotech.wisc.edu/gcow http://www.genetics.wisc.edu/

9.7.25 Washington University in St. Louis

The Washington University School of Medicine Genome Sequencing Center, in St. Louis, Missouri, was part of the International Human Genome Sequencing Consortium.

Name	Washington University
Alternate	Washington University; WashU; WUSTL
Place	St. Louis, MO, USA
Organization Type	Private Research University
Connections	http://genome.wustl.edu/ https://gtac.wustl.edu/ http://gps.wustl.edu/

9.7.26 Yale University

Yale was the site of the Human Gene Mapping Workshop, which began in 1973 and is considered a precursor to the large-scale Human Genome Project that would officially begin in 1990. Led by the late biologist Frank Ruddle, this program sought to assign genes to locations on human chromosomes. While a professor at Yale, Ruddle also created the Human Gene Map Library, a prime source of information for the genetic mapping researchers of the 1980s.

Name	Yale University
Alternate	Yale
Place	New Haven, CT, USA
Organization Type	Private Ivy League Research University
Connections	http://medicine.yale.edu/keck/ycga/ http://ags.med.yale.edu/ http://www.ncbi.nlm.nih.gov/pubmed/6690233 http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3117405/

9.8 Other Organizations

9.8.1 Arnold & Porter

The firm first known as Arnold, Fortas & Porter was founded shortly after World War II by Thurman Arnold, Abe Fortas, and Paul Porter. Known today as Arnold & Porter, many of the firm's attorneys have held senior positions in the Federal government; several teach at law schools; many write for legal and business publications; and many participate in bar associations and continuing education programs.

Arnold & Porter represented TIGR and J. Craig Venter.

Maxwell J. Mehlman, formerly with Arnold & Porter, now Professor of Law and Director of the Law-Medicine Center at Case Western, writes and lectures on many issues in law and medicine, including the Human Genome Project.

Name	Arnold & Porter
Connections	http://www.arnoldporter.com/

9.8.2 Board on Basic Biology

The Board on Basic Biology was a part of the National Academy of Sciences/National Research Council. In 1986, John Burris was the executive director of the Board. The Human Genome Project was discussed at an August 1986 meeting of the Board in in Woods Hole, MA.

Name	Board on Basic Biology
Organization Type	Board of the National Research Council Commission on Life Sciences
Connections	http://www.ncbi.nlm.nih.gov/books/NBK218259/ http://libgallery.cshl.edu/items/show/53919

9.8.3 Commission on Life Sciences

The Commission on Life Sciences was a part of the National Academy of Sciences/National Research Council. The Board on Basic Biology was a part of the Commission on Life Sciences.

Name	Commission on Life Sciences
Organization Type	Commission of the National Research Council
Connections	http://www.nationalacademies.org/nrc/ http://www.ncbi.nlm.nih.gov/books/NBK218259/ http://libgallery.cshl.edu/items/show/53919

9.8.4 Council for Responsible Genetics

The Council for Responsible Genetics (CRG) was founded in 1983 by a coalition of scientists, public and occupational health activists, and reproductive rights advocates. CRG publishes a magazine called GeneWatch, which explores the societal impacts of advances in genetics and genomics. In 1990, the CRG issued a position paper on the human genome initiative.

Name	Council for Responsible Genetics (CRG)
Alternate	CRG
Historic Period	1983-present
Place	Cambridge, MA, USA
Organization Type	Non-Profit, Non-Governmental Organization
Connections	http://www.councilforresponsiblegenetics.org/ http://www.ncbi.nlm.nih.gov/pubmed/11650968

9.8.5 Delegation for Basic Biomedical Research

The Delegation for Basic Biomedical Research was a group founded in the early 1970s by Mahlon Hoagland to lobby for more funding for research. The Delegation consisted of 11 scientists and 2 university presidents. In 1987, the Delegation held a series of meetings with the Senate and House appropriations committees.

Name	Delegation for Basic Biomedical Research
Historic Period	1981
Organization Type	Lobby Group
Connections	http://www.nytimes.com/1981/05/07/us/scientists-seeking-research-funds-are-lectured-on-political-science.htmlhttp://library.cshl.edu/oralhistory/interview/cshl/research/delegation-basic-biomedical-research-successes/ http://library.cshl.edu/oralhistory/interview/cshl/research/delegation-basic-biomedical-research-successes/ http://libgallery.cshl.edu/items/show/35516

9.8.6 Hogan & Hartson

In 2010, Washington-based law firm Hogan & Hartson and London-based Lovells merged to form Hogan Lovells. The firm focuses on government regulatory, litigation and arbitration, corporate, finance, and intellectual property.

Hogan & Hartson represented Wally Steinberg and HealthCare Ventures.

Name	Hogan & Hartson
Connections	http://www.hoganlovells.com/

9.8.7 The Church of Jesus Christ of Latter-Day Saints

The Church of Jesus Christ of Latter-Day Saints is a Christian restorationist church headquartered in Salt Lake City, Utah, with congregations and temples worldwide.

Containing about eight billion names, the Church's Family History Library is the largest collection of genealogical records in the world. In the 1970s, with the help of the Church, researchers at the University of Utah extracted data on individuals who met very specific criteria and combined it with public health, birth/death records, and other data to create the Utah Population Database (UPDB). The UPDB has grown to include data on more than 7.3 million individuals. It has become a vital tool in genetics research.

Name	The Church of Jesus Christ of Latter-Day Saints
Alternate	Church of Latter-Day Saints; LDS Church; The Mormon Church
Place	Salt Lake City, UT, USA
Organization Type	Christian Restorationist Church
Connections	https://www.lds.org/?lang=eng http://www.nytimes.com/2004/07/31/us/by-accident-utah-is-proving-an-ideal-genetic-laboratory.html?pagewanted=all

10 PEOPLE (BY DISCIPLINE)

10.1 Agency Administrators

10.1.1 Adler, Reid

Attorney, Law Office of Reid Adler. A founding director of the NIH Office of Technology Transfer (January 1989 – December 1993) during its early implementation of the Federal Technology Transfer Act. In 1991, he advised J. Craig Venter to patent the ESTs he found before publishing them so that NIH could collect on patent royalties. Shortly before Venter published his landmark 1991 article in *Science*, Adler submitted a patent application for 337 ESTs; the following year, he applied to modify the patent by adding another 2,421 ESTs. Venter and Watson had ideological disagreement on commercialization of scientific discoveries.

General Counsel and Corporate Secretary of the J. Craig Venter Institute for Genomic Research (2002–2005). Previously EVP & Chief Legal Officer, Correlogic.

Birth Date	1954
Gender	Male
Selected Publications	Genome research: fulfilling the public's expectations for knowledge and commercialization Reid G. Adler, *Technology Transfer and Genome-Related Research* 9 (Oct. 22, 1991) Reid G. Adler, *Biotechnology as an Intellectual Property*, 224 SCIENCE 357, 363 n.12 (1984).
Connections	J. Craig Venter Institute National Institutes of Health (NIH)
External Links	http://radlerlaw.com/

10.1.2 Astrue, Michael

Former Commissioner of the Social Security Administration; previously served in the Social Security Administration as Counselor to the Commissioner, served in the US Department of Health and Human Services as General Counsel and as Acting Deputy Assistant Secretary for Legislation, where he handled James Watson's resignation as genome chief in 1993. He also served as Associate Counsel to the President of the United States at the White House in the Ronald Reagan and George Bush Sr administrations. In the private sector, he practiced law and was as a senior executive at several biotechnology companies.

Birth Date	1956
Gender	Male
Connections	• Astrue, Michael • Ronald Reagan Library/Archives
External Links	http://www.joslin.org/about/Michael-Astrue-Board-of-Trustees.html http://www.ssa.gov/news/press/factsheets/astrue.htm

10.1.3 Barataud, Bernard

An important figure in French genetics, Bernard Barataud was founder and president of Genethon, a genomics research organization involved in mapping and sequencing the human genome. He was also president of the French Muscular Dystrophy Association (AFM-Telethon).

In 1987, Barataud started a charity show (Telethon) and had the idea of funding genetics research with the donations.

Links	https://histoire-cnrs.revues.org/1323?file=1 http://www.normalesup.org/~adanchin/PDF_files/articles_00/bioinfo_fr_00.pdf http://www.genopole.fr/IMG/pdf/plaquette_Genopole_UK_2009.pdf https://books.google.com/books?id=81fVCgAAQBAJ&pg=PA199&lpg=PA199&dq=bernard+barataud+scientist&source=bl&ots=

10.1.4 Barnhart, Benjamin J.

Deceased. Former DOE Human Genome Program Manager during the launch of the Human Genome Project. Worked in the office of Health & Biological Research. Owned and operated a flooring retail shop after his DOE retirement.

Birth Date	1935
Death Date	2013
Gender	Male
Selected Publications	http://link.springer.com/chapter/10.1007/978-1-4684-5547-2_15#page-1

10.1.5 Healy, Bernadine

Deceased. Physician, cardiologist; former director, National Institutes of Health (1991-93), during which time she replaced James Watson with Francis Collins as director of the National Center for Human Genome Research.

Birth Date	1944
Death Date	2011
Gender	Female
Selected Publications	http://www.usnews.com/topics/author/bernadine-healy-md
External Links	https://www.washingtonpost.com/local/obituaries/bernadine-healy-nih-and-red-cross-leader-dies-at-67/2011/08/08/gIQAywhA3I_story.html https://www.nlm.nih.gov/changingthefaceofmedicine/physicians/biography_145.html

10.1.6 Ismail, Sherille

Senior Counsel, Office of Strategic Planning and Policy Analysis, Federal Communications Commission. Former Senior Counsel to Judiciary Committee, U.S. House of Representatives (1990-96). Principal Staff person for U.S. Representative John Conyers' bill on H.R. 2045, designed to protect people from genetic discrimination based on hereditary genes. The bill's passing served as a key to getting public support for the Human Genome Project. It was derived from Rifkin's original 5-page bill, H.R. 5617 (first introduced 9/13/1990 by John Conyers). Ismail fielded and collected and organized feedback on the bill from both allies and enemies of the bill.

Birth Date	1953
Gender	Male
Connections	Federal Communications Commission
External Links	http://lirneasia.net/about/iab/sherille-ismail-jd/

10.1.7 Jordan, Elke

Retired. 30-year veteran administrator at the NIH, joining in 1972. Following a spell at the National Institute of General Medical Sciences, she set up the National Center for Human Genome Research in 1989 and served as deputy director of the National Human Genome Research Institute.

Gender	Female
Selected Publications	http://www.sciencedirect.com/science/article/pii/0888754389900402
Connections	• Jordan, Elke
External Links	https://nihrecord.nih.gov/newsletters/09_17_2002/retirees.htm https://www.linkedin.com/pub/elke-jordan/44/b61/2b5

10.1.8 Kirschstein, Ruth

Deceased. Pathologist and long-time science administrator at the National Institutes of Health (NIH). Kirschstein served as director of the National Institute of General Medical Sciences, deputy director of NIH in the 1990s, and acting director of the NIH in 1993 and 2000-2002.

Birth Date	1926
Death Date	2009
Gender	Female
External Links	https://nihrecord.nih.gov/newsletters/2012/03_16_2012/story5.htm http://clinton4.nara.gov/WH/EOP/OSTP/html/rand/summit/kirschsteinbio.html http://msa.maryland.gov/msa/educ/exhibits/womenshall/html/kirschstein.html

10.1.9 Levinson, Rachel

Director of National Research Initiatives for Arizona State University, based in Washington D.C. She was previously assistant director for life sciences, White House Office of Science and Technology Policy.

Gender	Female
External Links	https://webapp4.asu.edu/directory/person/837335

10.1.10 Lindberg, Donald A.B.

Retired. In 2015, stepped down as director of the National Library of Medicine, NIH, after 31 years. He transformed public access to scientific information.

Gender	Male
External Links	https://www.nlm.nih.gov/od/roster/lindberg.html https://www.amia.org/news-and-publications/press-release/donald-lindberg-retires-serves-nlm-30years https://www.amia.org/about-amia/leadership/acmi-fellow/donald-b-lindberg-md-facmi http://www.cumc.columbia.edu/psjournal/archive/archives/jour_v18no3/profile.html https://www.nitrd.gov/documents/DrDonaldLindberg.pdf

10.1.11 Raub, William

Retired. Science Advisor to the Secretary, HHS (1995-2009); Science Advisor to the Administrator of the Environmental Protection Agency (1992-1995); Special Assistant within the Office of Science and Technology Policy, Executive Office of the President of the United States (1991-1992); Acting Director, NIH (1989-1991); and Deputy Director, NIH (1986-1991).

Gender	Male
Selected Publications	http://www.hhs.gov/asl/testify/t20020321.html
External Links	http://utah.himsschapter.org/Events/content.aspx?ItemNumber=41630

10.1.12 Shalala, Donna

CEO, The Clinton Foundation. Former president, University of Miami (2001-2015); former U.S. Secretary of Health and Human Services (1993-2001). Awarded Medal of Freedom (2008). Strong supporter of the Human Genome Project.

Birth Date	February 14, 1941
Gender	Female

Selected Publications	https://www.clintonfoundation.org/blog/authors/donna-e-shalala
External Links	http://president.miami.edu/history/donna-e-shalala/index.html http://www.welfareacademy.org/conf/papers/shalala.shtml

10.1.13 Sullivan, Louis Wade

Chairman/CEO of the Sullivan Alliance to Transform the Health Professions; founding Dean/President Emeritus, Morehouse School of Medicine; former U.S. Secretary of Health and Human Services (1989-1993).

Birth Date	1933
Gender	Male
External Links	http://www.thesullivanalliance.org/cue/about/board-of-directors.html#Louis_Sullivan

10.1.14 Vickers, Tony

Director, MRC human genome mapping project (1990-93).

Gender	Male
Selected Publications	http://www.cell.com/trends/pharmacological-sciences/abstract/0165-6147%2882%2991056-2
External Links	http://socgen.ucla.edu/wp-content/uploads/2012/02/de-Chadarevian-Making-of-Entrepreneurial-Science.pdf

10.1.15 Wood, Robert

Robert Wood was acting director of DOE's Office of Health and Environmental Research, 1987-1990.

Gender	Male
External Links	http://www.esp.org/misc/genome/temp/manage.pdf

10.1.16 Wyngaarden, James

Retired. Director of NIH, 1982-89. Previously professor and chairman, department of medicine, Duke University (1967-1982). Strong advocate for the Human Genome Project, noting in a 1989 interview: “The scientific judgment of the best geneticists is that there is a lot of information in the rest of that genome, otherwise why would we have it? … There will be important insights to be gained from a systematic exploration of the structure of the human genome. Insights that should teach us a great deal about the

biological systems, about development and differentiation, normal development and differentiation of the differences among human beings."

Birth Date	October 19, 1924
Gender	Male
External Links	http://library.cshl.edu/oralhistory/speaker/james-wyngaarden/ http://www.nytimes.com/1982/01/21/us/duke-professor-to-lead-natioinal-health-institutes.html http://ir.iderapharma.com/phoenix.zhtml?c=208904&p=irol-newsArticle&ID=1662429 https://archives.mc.duke.edu/xml?faids=collection-298.xml https://history.nih.gov/archives/downloads/James%20Wyngaarden%20interview.pdf https://repository.library.georgetown.edu/handle/10822/559568

10.2 Book Authors/Journalists

10.2.1 Bishop, Jerry

Deceased. Former *Wall Street Journal* science correspondent and deputy news editor for science, technology, and medicine. Co-author (with Michael Waldholz) of *Genome* in 1991, one of the first and best books to describe the medical implications of human genetics and the Human Genome Project.

Birth Date	March 29, 1931 - October 26, 2007
Gender	Male
Selected Publications	**Content by label** There is no content with the specified labels
Connections	• The story of the most astonishing scientific adventure of our time-the attempt to map all the genes in the human body

10.2.2 Cobb, Matthew

Matthew Cobb is senior lecturer in animal behavior at the University of Manchester. He is the author of Generation: The Seventeenth-Century Scientists Who Unraveled the Secrets of Sex, Life, and Growth (Bloomsbury, 2006) (published in the United Kingdom by Free Press as The Egg and Sperm Race) and Life's Greatest Secret: The Race to Crack the Genetic Code.

. Publication link: f159804f-d22b-4799-88c9-1297af59db88

Gender	Male
External Links	http://www.ls.manchester.ac.uk/people/profile/?alias=cobbm http://www.ls.manchester.ac.uk/people/profile/?alias=cobbm&view=publications

10.2.3 Cook-Deegan, Robert

Professor, School for the Future of Innovation in Society, Arizona State University. Research Professor, Sanford School of Public Policy, Duke University; Founding director, Genome Ethics, Law & Policy, Duke Institute for Genome Sciences & Policy (2002-12). Previously worked for more than a decade in various capacities at the National Academy of Sciences. Author of the essential book on the launch politics of the Human Genome Project, *The Gene Wars.*

Birth Date	
Gender	Male
Selected Publications	• Burris J, Cook-Deegan R, Alberts B. (1998) The human genome project after a decade: Policy issues. Nature Genetics • Burris J, et al. (1998) The Human Genome Project after a decade: policy issues • Cavalli-Sforza LL, et al. (1991) Call for a worldwide survey of human genetic diversity: A vanishing opportunity for the human genome project • Goad W (1979) Proposal to establish a national center for collection, and computer storage and analysis of nucleic acid sequences • Pohlhaus JR, Cook-Deegan RM. (2008) Genomics research: World survey of public funding. BMC genomics • Watson JD, Cook-Deegan RM (1991) Origins of the Human Genome Project • Watson JD, Cook-Deegan RM. (1990) The human genome project and international health. JAMA • Watson JD, Cook-Deegan RM. (1991) Origins of the human genome project. FASEB journal • Wiechers IR, Perin NC, Cook-Deegan R. (2013) The emergence of commercial genomics: Analysis of the rise of a biotechnology subsector during the human genome project, 1990 to 2004. Genome medicine
Connections	• Alta Summit (1984) • Cook-Deegan, Robert • Duke University • European Molecular Biology Laboratory (EMBL) • Gene Wars: Science, Politics, and the Human Genome • Medical Research Council (MRC) • National Cancer Institute (Canada) • Office of Management and Budget (OMB) • Office of Technology Assessment (OTA) • Questions and controversies • The Early Years 1990-1997 • The Origins of ELSI • U.S. Department of Energy (DOE) • University of California San Francisco (UCSF) School of Medicine/Archives
External Links	https://sanford.duke.edu/people/faculty/cook-deegan-robert-m https://globalhealth.duke.edu/people/faculty/cook-deegan-robert http://www.milkeninstitute.org/about/our-team/view/159

10.2.4 Courteau, Jacqueline

Lecturer & Faculty Advisor, Program on the Environment, University of Michigan. Former Research Assistant, Office of Technology Assessment (1986-88) and contributor to the 1988 report: *Mapping Our Genes.*

The task at OTA was to report to Congress on what the genome project was, whether or not it was worth funding, and how its underlying bureaucracy should be constructed.

Jacqueline gathered information about genome databases and researched information concerning foreign genome plans.

Birth Date	1963
Gender	Female
Selected Publications	Courteau, J. (1991). Genome Databases. *Science* 254 (11 October):201-207. Source: PubMed
Connections	• Courteau, Jacqueline • University of Michigan/Archives
External Links	http://graham.umich.edu/users/courteau https://repository.library.georgetown.edu/bitstream/handle/10822/708923/Robert%20Cook-Deegan%20Human%20Genome%20Archive%20Box%20Listing%20-%20Set%202.pdf?sequence=3

10.2.5 Davies, Kevin

British author and editor. Founding editor of *Nature Genetics* (1992), which published numerous key papers on positional cloning of disease genes, genetic mapping, and DNA sequencing throughout the Human Genome Project.

Author of three books on genetics and genomics, including *Cracking the Genome* and *The $1,000 Genome* (Simon & Schuster). Served as technical consultant for the film, *Decoding Annie Parker.* Currently working on 2nd edition of *DNA: The Secret of Life* (Knopf) with Jim Watson and Andrew Berry (scheduled to be published in 2017).

Birth Date	1960
Gender	Male
Selected Publications	Davies, K. Nature, Genetics and the Niven Factor. Nat. Genet. 39, 805-806 (2007)
Connections	• Cracking the Genome: Inside the Race to Unlock Human DNA - first popular science book on the Human Genome Project • Davies, Kevin • The $1,000 Genome: The Revolution in DNA Sequencing and the New Era of Personalized Medicine
External Links	http://authors.simonandschuster.com/Kevin-Davies/1879979 https://about.me/kdavies http://www.smith.edu/libraries/sites/default/files/Kevin-Davies-bio-2014.pdf Presentation “The $1,000 Genome” at HGP10 symposium, NHGRI April 2013

10.2.6 Ferry, Georgina

Science writer, editor; biographer and broadcaster. Co-author with Sir John Sulston of *The Common Thread*.

Birth Date	
Gender	Female
Selected Publications	**Content by label** There is no content with the specified labels
Connections	**Content by label** There is no content with the specified labels

10.2.7 Holtzman, Neil Anton "Tony"

Retired. Professor Emeritus Johns Hopkins School of Medicine. Holtzman chaired the NIH Department of Energy Task Force on Genetic Testing, co-editing its final report in 1998, "Promoting Safe and Effective Genetic Testing in the United States."

Former Director of genetics and public policy studies at Johns Hopkins. His research included studies on women's and providers' attitudes toward testing for genetic susceptibility to breast cancer; the relation between physicians' knowledge of genetics and their adoption of new genetic tests; the role of insurance coverage in the advent of new genetic technologies; and the development of such tests in academe and industry.

Author of *Proceed with caution: Predicting genetic risks in the recombinant DNA era*. Baltimore, MD: Johns Hopkins University Press (1989).

Birth Date	
Gender	Male
Selected Publications	Holtzman, N. A., Watson, M. S., & USA. *Promoting safe and effective genetic testing in the United States: Final report of the Task Force on Genetic Testing*. Baltimore, MD: Johns Hopkins University Press. 1998. Holtzman, N. A. *Proceed with caution: Predicting genetic risks in the recombinant DNA era*. Baltimore, Md: Johns Hopkins University Press. 1989. Maria Elizabeth Hewitt, Neil Anton Holtzman. *The Commercial Development of Tests for Human Genetic Disorders*. U.S. Office of Technology Assessment. 1988. Available from: http://www.altfutures.org/pubs/ForesightSeminars/1988EthicalIssuesGeneticTesting.pdf Holtzman, N. A., & United States. *Newborn screening for genetic-metabolic diseases: Progress, principles, and recommendations*. Rockville, Md: U.S. Dept. of Health, Education, and Welfare, Public Health Service, Health Services Administration, Bureau of Community Health Services. 1977. Myers, R. M., Holtzman, N. A., Beachy, R. N., University of California, San Francisco., San Francisco Exploratorium., Cold Spring Harbor Laboratory., & DNA Symposium. *Winding your way through DNA.* Plainview, N.Y: Cold Spring Harbor Laboratory Press. 1992.
External Links	Public Health and the Risk Factor: A History of an Uneven Medical Revolution (review) Neil A. Holtzman Journal: Bulletin of the History of Medicine Volume 78, Number 4, Winter 2004 pp. 927-928 | 10.1353/bhm.2004.0172

10.2.8 Jordan, Bertrand

Scientist who took sabbatical to write a book about the researchers and laboratories involved in the launch of the Human Genome Project. The book, *Traveling Around the Human Genome*, was published in 1994.

Birth Date	1939
Gender	Male

Selected Publications	Jordan, B. Traveling Around the Human Genome. An In Situ Investigation. (John Libbey Eurotext, 1994).

10.2.9 Judson, Horace Freeland

Deceased. Interviewed 100 scientists involved with the Human Genome Project and wrote "The Eighth Day of Creation" (1979). Following publication, Judson deposited the tapes and transcripts of the interviews at the American Philosophical Society in Philadelphia.

Former professor and Henry R. Luce chair in science writing at Johns Hopkins University. Author of Our Thumbprints in Our Clay: The Technology of the Gene (2009).

Judson never earned a doctorate—nor had any specific scientific training—but he held academic posts. He moved to Baltimore in 1981 and taught writing at Hopkins' Homewood campus. He was also a senior research scholar at Stanford University and a research professor at George Washington University.

Birth Date	1931
Death Date	2011
Gender	Male
Selected Publications	Judson, Horace Freeland. *The eighth day of creation: makers of the revolution in biology*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press; 1979
External Links	http://www.theguardian.com/science/2011/may/25/horace-freeland-judson-obituary http://www.amphilsoc.org/mole/view?docId=ead/Mss.B.J92-ead.xml

10.2.10 Lewin, Roger

Founding partner of Harvest Associates; Member, Complexity Research Group at the London School of Economics.

As the News Editor of *Science* (1979-89), Roger documented the early progress of establishing the Human Genome Project, including the 1986 dispute between molecular biologists and the DOE over the proposed Project. Lewin opened his report of the July 1986 meeting in *Science* with the observation, "The drive to initiate a Big Science project to sequence the entire human genome is running out of steam." Former staff writer for *New Scientist* (1970-79).

Lewin's book, *Complexity: Life at the Edge of Chaos*, was voted one of the top 100 science books for the 20th century. In 1989, he won a Royal Society Prize for Science Books for *Bones of Contention*.

Birth Date	1944
Gender	Male
Selected Publications	Lewin, Roger. "Proposal to Sequence Human Genome Stirs Debate," Science 232 (1986): 1598-1600 Lewin, Roger. "Shifting Sentiments Over Sequencing the Human Genome," Science 232 (1986) Lewin, Roger. "Politics of the Genome," Science 235 (1987): 1453 Lewin, Roger. "Genome Projects Ready to Go," Science 240 (1988): 602-604 Lewin, Roger. "Genome Planners Fear Avalanche of Red Tape," Science 244 (1989): 1543
Connections	'Genes and Mutations' Symposium, 1951 'Genetic Mechanisms: Structure and Function' Symposium, 1956
External Links	http://www.plexusinstitute.org/?pblewin http://befi.allianzgi.com/en/save-more-tomorrow/Pages/biographies.aspx

10.2.11 Maddox, John

Deceased. Sir John Maddox documented the entire chronicle of the Human Genome Project through his role as editor of *Nature*, and wrote numerous editorials and commentaries on the politics and science of sequencing the human genome. Authored the book *What Remains to be Discovered* (Simon & Schuster, 1998).

“Despite his original establishment of the peer-review process at Nature, Maddox always had strong reservations about its conservatism. These were perhaps best reflected in his view that the Watson and Crick paper on the structure of DNA wouldn't pass muster under the current system. That paper was published as a result of recommendations by Lawrence Bragg, the head of Watson and Crick's laboratory, and John Randall. (The idea of Nature publishing a paper on the recommendations of the head of the authors' lab is nowadays, of course, sadly but appropriately laughable.)”

In 1990, Maddox was elected an honorary Fellow of the Royal Society. He had two stints as editor of *Nature* -- 1966-1973 and 1980-1995. He established the journal’s system of peer review and instituting a strong tradition of journalism. He previously worked as a science correspondent at the Manchester Guardian (1955-64), and 1949–55: Lecturer on Theoretical Physics at the University of Manchester (1949-55). His wife Brenda authored a critically acclaimed biography, *Rosalind Franklin: The Dark Lady of DNA.*

His literary agent, John Brockman, was quoted as saying, "John Maddox was a dominant figure in a golden age of science. A fierce proponent of reason, rationalism, and science-based thinking, he ran the best publication of its kind in the world and gave those in his orbit permission to be great." - Philip Campbell (http://www.nature.com/news/2009/090417/full/458985a.html)

Birth Date	1925
Death Date	2009
Gender	Male
Selected Publications	Maddox, John. “Brenner Homes in on the Human Genome,” *Nature* 326 (1987): 119-119. doi:10.1038/326119c0 Maddox, John. “The Case for the Human Genome,” *Nature* 352 (1991): 11-14. doi: 10.1038/352011a0 Maddox, John. “Directory to the Human Genome,” Nature 376 (1995): 459-460. doi:10.1038/376459a0
External Links	http://www.theguardian.com/media/2009/apr/15/sir-john-maddox-obituary http://www.nytimes.com/2009/04/14/science/14maddox.html http://www.bio-itworld.com/archive/031003/firstbase.html

10.2.12 McElheny, Victor K.

Author and journalist. Visiting scholar, MIT. Founding Director of Knight Science Journalism Fellowships at MIT(1982-88); former technology reporter for the *New York Times* (1973-78); and science editor, *The Boston Globe* (1966-72). Author of *Drawing the Map of Life: Inside the Human Genome Project* (2010), and *Watson and DNA: Making a Scientific Revolution* (2003).

Birth Date	
Gender	Male
Selected Publications	**Content by label** There is no content with the specified labels
Connections	• Biological Research/Methods Development • Drawing the Map of Life: Inside the Human Genome Project • Massachusetts Institute of Technology (MIT)

	• McElheny, Victor K. • U.S. Department of Defense (DOD)
External Links	http://niemanreports.org/articles/victor-k-mcelheny-nf-63/ http://www.americanscientist.org/bookshelf/pub/victor-mcelheny

10.2.13 Nelkin, Dorothy

Deceased. Sociologist of science and author: Studied the promotional metaphors used in relation to the Human Genome Project, arguing that the gene had become a pop-icon of the age in *The DNA Mystique*. She has also explored the aesthetic of DNA, and its increasing depiction in art and popular culture.

Former Professor of Sociology and Affiliate Professor of Law at New York University. She was the author or co-author of 26 books.

Birth Date	1933
Death Date	2003
Gender	Female
Authority	Nelkin, Dorothy; Lindee, Susan. *The DNA Mystique: the gene as a cultural icon*, New York: WH Freeman; 1995. Call number: QH430 .N46 1995 Nelkin, Dorothy. *Dangerous Diagnostics: the social power of biological information*, Basic Books; 1989. Call number: RA427.5 .N45 1989
Connections	• Dangerous diagnostics: The social power of biological information • Nelkin, Dorothy • NYU/Archives • Tancredi, Laurence • The DNA mystique: The gene as a cultural icon
External Links	http://www.nytimes.com/2003/06/02/nyregion/dorothy-nelkin-69-expert-on-science-and-society-dies.html http://www.thelancet.com/pdfs/journals/lancet/PIIS0140673603140895.pdf

10.2.14 Pines, Maya

Science writer and editor. Senior science editor, Howard Hughes Medical Institute, 1986-2002. In 1986, commissioned to describe gene mapping and sequencing to the Howard Hughes Medical Institute (HHMI) trustees. Briefing papers include:

“Shall We Grasp the opportunity to Map and Sequence All human Genes and Create a ‘Human Gene dictionary’?” 1986

Laid out the scientific strategy to answer the question “What Gene is at Fault?”

Birth Date	
Gender	Female
Selected Publications	Pines, Maya. Exploring the biomedical revolution. 1999. Pines, Maya. *Mapping the Human Genome*. Howard Hughes Medical Institute, 1987 Pines, Maya. “Why so many errors in our DNA?” *Blazing a genetic trail*. Howard Hughes Medical Institute, 1991.
External Links	http://onlinebooks.library.upenn.edu/webbin/book/lookupname?key=Pines%2C%20Maya

10.2.15 Reilly, Philip

Entrepreneur and Author. Venture Partner, Third Rock Ventures. Trustee of Cornell University, former CEO of Interleukin Genetics. Founding fellow of the American College of Medical Genetics. Author of *Abraham Lincoln's DNA and Other Adventures in Genetics*, and *Orphan: The Quest to Save Children with Rare Genetic Disorders.*

Birth Date	
Gender	Male

10.2.16 Ridley, Matt

Author and journalist. As Viscount Ridley, elected to the British House of Lords in 2013. Columnist for *The Times* (London) and *Wall Street Journal*. Former science editor and American editor, *The Economist.* Ridley is the author of several best-selling books on evolution and genetics, including *Nature via Nurture*, *The Red Queen*, and *Genome: An Autobiography of a Species in 23 Chapters.*

Birth Date	1958
Gender	Male
Connections	• Genome: The Autobiography of a Species in 23 Chapters • Rational Optimist/Archives • Ridley, Matt
External Links	http://www.rationaloptimist.com/ http://www.mattridley.co.uk/ http://library.cshl.edu/oralhistory/speaker/matt-ridley/

10.2.17 Rifkin, Jeremy

Author, political advisor and acivitist. Author of 20 books including *The Biotech Century*. Outspoken critic of the biotech industry and genetic engineering. A 1989 profile in *Time* magazine called Rifkin "The most hated man in science."

Birth Date	1945
Gender	Male
Selected Publications	Rifikin, J. *The Biotech Century: Harnessing the Gene and Remaking the World.*
Connections	• Rifkin, Jeremy • The Biotech Century: Harnessing the Gene and Remaking the World
External Links	http://www.foet.org/JeremyRifkin.htm

10.2.18 Roberts, Leslie

Deputy News editor, *Science*, since 2000. Formerly senior writer at *Science* where she was widely known for her comprehensive coverage of the *Human Genome Project*

Awards include the Award for Excellence in Health Care Journalism from Association of Health CareJournalists, 2013, and the American Society for Microbiology Public Communications Award, 2005, 2008.

Birth Date	ca 1952
Gender	Female
Selected Publications	"BIOINFORMATICS: Private Pact Ends the DNA Data War," *Science*, 299 (5606), 487-489. [DOI: 10.1126/science.299.5606.487]. "GENOME RESEARCH: A Tussle Over the Rules for DNA Data Sharing," *Science*, 298 (5597), 1312-1313. L. Roberts, R. J. Davenport, E. Pennisi and E. Marshall, "A History of the Human Genome Project," *Science*, 291 (5507), 1195. [DOI: 10.1126/science.291.5507.1195]. "Controversial From The Start," *Science*, 291 (5507), 1182a-1188. E. Marshall, E. Pennisi and L. Roberts. "SCIENCE INTERVIEW: In the Crossfire: Collins on Genomes, Patents, and 'Rivalry'" *Science*, 287 (5462), 2396-2398. "HUMAN GENOME RESEARCH:SNP Mappers Confront Reality and Find It Daunting," *Science*, 287 (5460), 1898-1899. [DOI: 10.1126/science.287.5460.1898]. "Leroy Hood: thinking big in Seattle," *Science*, 264 (5156), 206-209. [DOI: 10.1126/science.8146649]. "Genome Diversity Project. Anthropologists climb (gingerly) on board," *Science*, 258 (5086), 1300-1301. [DOI: 10.1126/science.1455222]. "Gene patents. Scientists voice their opposition," *Science*, 256 (5061), 1273-1274. [DOI: 10.1126/science.1598565]. "Why Watson Quit as Project Head," *Science*, 256 (5055), 301-302. [DOI: 10.1126/science.256.5055.301]. "DNA Fingerprinting: Academy Reports: In its long-awaited report, the NAS crafts recommendations to shore up the scientific underpinnings of DNA fingerprinting and end the interminable courtroom debate" *Science*, 256 (5055), 300-301. [DOI: 10.1126/science.256.5055.300]. "NIH gene patents, round two," *Science*, 255 (5047), 912-913. [DOI: 10.1126/science.1546285]. "Sequencing venture sparks alarm," *Science*, 255 (5045), 677-678. [DOI: 10.1126/science.1738837]. "OSTP to wade into gene patent quagmire," *Science*, 254 (5035), 1104-1105. [DOI: 10.1126/science.1957160]. "Genome patent fight erupts," *Science*, 254 (5029), 184-186. [DOI: 10.1126/science.1925568]. "Gambling on a shortcut to genome sequencing," *Science*, 252 (5013), 1618-1619. [DOI: 10.1126/science.2047871]. "A genetic survey of vanishing peoples," *Science*, 252 (5013), 1614-1617. [DOI: 10.1126/science.2047869]. "Finding DNA sequencing errors," *Science*, 252 (5010), 1255-1256. [DOI: 10.1126/science.1925537]. "DOE's genome project comes of age," *Science*, 252 (5005), 498-501. [DOI: 10.1126/science.2020849]. "LBL genome center to try leadership by committee," *Science*, 252 (5005), 500-501. [DOI: 10.1126/science.2020850]. "Large-scale sequencing trials begin," *Science*, 250 (4986), 1336-1338. [DOI: 10.1126/science.2255904]. "A meeting of the minds on the genome project?" *Science*, 250 (4982), 756-757. [DOI: 10.1126/science.2237425]. "Tough times ahead for the genome project," *Science*, 248 (4963), 1600-1601. [DOI: 10.1126/science.2363046]. "The worm project," *Science*, 248 (4961), 1310-1313. [DOI: 10.1126/science.2356467].

	"An animal genome project?" *Science*, 248 (4955), 550-552. [DOI: 10.1126/science.2333506]. "Whatever happened to the genetic map?" *Science*, 247 (4940), 281-282. [DOI: 10.1126/science.2296718]. "Japan boosts genome research," *Science*, 246 (4929), 439-440. [DOI: 10.1126/science.2814473]. "Plan for genome centers sparks a controversy," *Science*, 246 (4927), 204-205. [DOI: 10.1126/science.2799383]. "New game plan for genome mapping," *Science*, 245 (4925), 1438-1440. [DOI: 10.1126/science.2781288]. "Genome mapping goal now in reach," *Science*, 244 (4903), 424-425. [DOI: 10.1126/science.2717935]. "Ethical questions haunt new genetic technologies," *Science*, 243 (4895), 1134-1136. [DOI: 10.1126/science.2922602]. "Genome project under way, at last," *Science*, 243 (4888), 167-168. [DOI: 10.1126/science.2911730]. "Carving up the human genome," *Science*, 242 (4883), 1244-1246. [DOI: 10.1126/science.2904174]. "Chromosomes: the ends in view," Science, 240 (4855), 982-983. [DOI: 10.1126/science.3368792]. "Watson may head genome office," *Science*, 240 (4854), 878-879. [DOI: 10.1126/science.3363368]. "Zeroing in on the sex switch," *Science*, 239 (4835), 21-23. [DOI: 10.1126/science.3336772]. "Flap arises over genetic map," *Science*, 238 (4828), 750-752. [DOI: 10.1126/science.3478811]. "New sequencers to take on the genome," *Science*, 238 (4825), 271-273. [DOI: 10.1126/science.3659916]. "Human genome: questions of cost," *Science*, 237 (4821), 1411-1412. [DOI: 10.1126/science.3629248]. "Agencies vie over human genome project," *Science*, 237 (4814), 486-488. [DOI: 10.1126/science.3603035]. "Who owns the human genome?" *Science*, 237 (4813), 358-361. [DOI: 10.1126/science.2885920].
Connections	• American Association for the Advancement of Sciences (AAAS)/Science magazine/Archives • Roberts, Leslie
External Links	http://news.sciencemag.org/author/leslie-roberts

10.2.19 Shreeve, James

Executive Editor for Science, *National Geographic magazine*, since 2006. Author, *The Genome War* (Knopf, 2003), an insider account of life at Celera Genomics during the period leading to the first draft of the human genome.

Birth Date	
Gender	Male
Selected Publications	Shreeve, J. The Genome War: How Craig Venter Tried to Capture the Code of Life and Save the World. (New York: Knopf 2004).

10.2.20 Sykes, Bryan

Professor of Human Genetics, Weatherall Institute of Molecular Medicine at University of Oxford;Fellow of Wolfson College. 2000: Founder and Chairman, Oxford Ancestors (aka Oxford Genetics)

Sykes was associated with the Oxford Genetic Atlas Project (OGAP)

Author of bestselling books on the investigation of human history and prehistory through studies of mitochondrial DNA, notably *The Seven Daughters of Eve*.

- Developed the method for recovering DNA from human remains thousands of years old and was the first person to prove that Polynesian peoples originated from Asia as opposed to South America as previously believed.
- In 2007, Bryan Sykes broke mitochondrial results into twelve haplogroups for various regions of the Isles. He has given maps and proposals concerning ancient migrations for Ireland, Scotland, Wales and England.
- Sykes and his team discovered a strong link between surnames and Y-chromosomes that has since become the mainstay of genetic genealogy.

Birth Date	1947
Gender	Male
Selected Publications	**Books:** Sykes, Bryan. DNA USA: A Genetic Biography of America New York: W. W. Norton & Company; 2011. Sykes, Bryan. Blood of the Isles. New York: Bantam; 2006. Sykes, Bryan. The Seven Daughters of Eve. New York: Corgi; 2002.
External Links	http://www.oxfordancestors.com/ http://bigthink.com/experts/bryan-sykes https://www.wolfson.ox.ac.uk/content/884-bryan-sykes-dna-usa-genetic-portrait-america

10.2.21 Tancredi, Laurence

Clinical Professor of Psychiatry at NYU School of Medicine. Previously Professor of Medicine and Director Health Law Program, University of Texas Medical School. Tancredi warned of the social power of biological information, especially genetics, which he said could follow the same path as eugenics, which he labeled as an inhumane science.

Birth Date	1940
Gender	Male
Selected Publications	**Books:** Nelkin, Dorothy; Tancredi, Laurence R. Dangerous Diagnostics: The Social power of biological Information. New York: Basic books, 1989.
Connections	• Dangerous diagnostics: The social power of biological information • Tancredi, Laurence
External Links	http://www.med.nyu.edu/biosketch/tancrl01 http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1809874/pdf/bullnyacadmed00002-0136.pdf

10.2.22 Tattersall, Ian

Curator Emeritus of Anthropology, American Museum of Natural History in New York City; Previously Curator and Chairman, Department of Anthropology, American Museum of Natural History.

Author of *Human Origins: What bones and Genomes Tell Us About Ourselves*, and *Bones, Brains and DNA: The Human Genome and Human Evolution*. Tattersall helped connect the Human Genome Project's accomplishments to paleontology.

Birth Date	1945
Gender	Male
Selected Publications	**Books:** DeSalle, R, and Tattersall, I. *Human Origins: What Bones and Genomes Tell Us About Ourselves*. College Station, TX: Texas A&M University Press; 2008. DeSalle, R., and Tattersall, I. *Bones, Brains and DNA: The Human Genome and Human Evolution*. Piermont, NH: Bunker Hill Publishing; 2007.
Connections	• American Museum of Natural History (AMNH)/Archives • Bones, brains and DNA: The human genome and human evolution • Human origins: What bones and genomes tell us about ourselves • Tattersall, Ian
External Links	http://www.iantattersall.com/ http://www.amnh.org/our-research/staff-directory/ian-tattersall http://www.scientificamerican.com/article/tattersall-paleoanthropologist-ian-tattersall-talks-about-what-makes-humans-special-video/

10.2.23 Wade, Nicholas

Author and journalist. Currently a freelance writer for the *New York Times.* Former reporter and editor for the New York Times' Science Section (1982-2012), from the Human Genome Project's formative years through its conclusion. Authored numerous stories about the Human Genome Project and the genomics industry. Wade broke the story of the formation of Celera Genomics in May 1998.

Author of two books on genetics and genomics: *Lifescript* (2001) and *A Troublesome Inheritance: Genes, Race and Human History* (2014)

Birth Date	1942
Gender	Male
Selected Publications	**Books:** Wade, Nicholas. *A Troublesome Inheritance: Genes, Race and Human History*. New York: Penguin Books; 2014. Wade, Nicholas: *Lifescript* New York: Simon & Schuster, 2001. **Articles (New York Times):** Wade, Nicholas. Rare Genetic Mutations May Underpin Diseases. The New York Times 18 May 2012: A22(L). Wade, Nicholas. A Decade Later, Gene Map Yields Few New Cures. The New York Times 13 June 2010: A1(L). Wade, Nicholas. Disease Cause Is Pinpointed With Genome. The New York Times 11 Mar. 2010: A1(L). Wade, Nicholas. Genome Study Provides a Census of Early Humans. The New York Times 19 Jan. 2010: D4(L). Wade, Nicholas. What's Next: Rare Hits and Heaps of Misses to Pay for. The New York Times 9 Nov. 2010: D1(L).

	Wade, Nicholas. A Genetics Company Fails, Its Research Too Complex. The New York Times 18 Nov. 2009: B2(L). Wade, Nicholas. Technology Lowers Cost of Decoding a Genome to $50,000. The New York Times 11 Aug. 2009: D3(L). Wade, Nicholas. Gene Identified As Risk Factor For Heart Ills. The New York Times 4 May 2007: A1(L). Wade, Nicholas. Genome of DNA Discoverer Is Deciphered. The New York Times 1 June 2007: A19(L). Wade, Nicholas. Genome Researchers Find New Indicators of Breast Cancer Risk. The New York Times 29 May 2007: A13(L). Wade, Nicholas. Researchers Detect Variations in DNA That Underlie Seven Common Diseases. The New York Times 7 June 2007: A32(L). Wade, Nicholas. Scientists Identify 7 New Diabetes Denes. The New York Times 27 Apr. 2007: A22(L). Wade, Nicholas. Atlas Squeaked: A Complete Map of the Brain of a Mouse. The New York Times 26 Sept. 2006: F4(L). Wade, Nicholas. The Quest for the $1,000 Human Genome. The New York Times 18 July 2006: F1(L). Wade, Nicholas. 2 New Methods to Sequence DNA Promise Vastly Lower Costs. The New York Times 9 Aug. 2005: F2(L). Wade, Nicholas. California Maps Strategy for Its $3 Billion Stem Cell Project. The New York Times 11 Oct. 2005: F2(L). Wade, Nicholas. Drug in Test Acts on Gene Tied to Heart. The New York Times 11 May 2005: A15(L). Wade, Nicholas. Explaining Differences In Twins. The New York Times 5 July 2005: F5(L). Wade, Nicholas. Genetic Catalog May Aid Search for Roots of Disease. The New York Times 27 Oct. 2005: A20(L). Wade, Nicholas. Genetic Find Stirs Debate On Race-Based Medicine. The New York Times 11 Nov. 2005: A16(L). Wade, Nicholas. Geographic Society Is Seeking A Genealogy of Humankind. The New York Times 13 Apr. 2005: A16(L). Wade, Nicholas. Race-Based Medicine Continued... The New York Times 14 Nov. 2004: WK12. Wade, Nicholas. DNA Changed the World. Now What? The New York Times 25 Feb. 2003: F1. Wade, Nicholas. Icelandic Company Says It Has Found Osteoporosis Gene. The New York Times 3 Nov. 2003: A1. Wade, Nicholas. Once Again, Scientists Say Human Genome Is Complete. The New York Times 15 Apr. 2003: F1. Wade, Nicholas. Scientists in Iceland Discover First Gene Tied to Stroke Risk. The New York Times 22 Sept. 2003: A1. Wade, Nicholas. Watson and Crick, Both Aligned and Apart, Reinvented Biology. The New York Times 25 Feb. 2003: F3. Wade, Nicholas. Comparing Mouse Genes to Man's and Finding a World of Similarity. The New York Times 5 Dec. 2002: A1. Wade, Nicholas. Experts Say They Have Key to Rice Genes; Discovery Is Seen Leading to Enhanced Nutrition in Many Crops. The New York Times 5 Apr. 2002: A21. Wade, Nicholas. Fish Genes Aid Human Discoveries. The New York Times 26 July 2002: A19. Wade, Nicholas. For Sale: A DNA Test to Measure Racial Mixture. The New York Times 1 Oct. 2002: F4. Wade, Nicholas. Gains in Understanding Human Cells; Researchers Give Detailed View of Complex Biological Circuitry. The New York Times 25 Oct. 2002: A18. Wade, Nicholas. Gene-mappers Take New Aim at Diseases. The New York Times 30 Oct. 2002: A23. Wade, Nicholas. A Genomic Treasure Hunt May Be Striking Gold. The New York Times 18 June 2002: F1. Wade, Nicholas. Human Genome Sequence Has Errors, Scientists Say; an Icelandic Paper Helps Refine a Rough Draft of the Genome. The New York Times 11 June 2002: F4.

Wade, Nicholas. Hunting for Disease Genes in Iceland's Genealogies. The New York Times 18 June 2002: F4.
Wade, Nicholas. Race Is Seen as Real Guide to Track Roots of Disease. The New York Times 30 July 2002: F1.
Wade, Nicholas. For Genome Mappers, the Tricky Terrain of Race Requires Some Careful Navigating. The New York Times 20 July 2001: A17.
Wade, Nicholas. Genome Project Rivals Trade Notes, Cordially. The New York Times 12 June 2001: F2.
Wade, Nicholas. Genome's Riddle: Few Genes, Much Complexity; Biologists See Ways Relatively Few Genes Can Do the Work of Many. The New York Times 13 Feb. 2001: F1.
Wade, Nicholas. Grad Student Becomes Gene Effort's Unlikely Hero. The New York Times 13 Feb. 2001: F1.
Wade, Nicholas. Human Genome Appears More Complicated. The New York Times 24 Aug. 2001: A1.
Wade, Nicholas. An Online Tour of the Human Genome Is Just a Few Clicks Away. The New York Times 13 Feb. 2001: F4.
Wade, Nicholas. The Silence Is Broken and the Genome Speaks. The New York Times 13 Feb. 2001: F5.
Wade, Nicholas. Superior Data on Mice DNA Is Being Cited as Attraction. The New York Times 10 July 2001: A1.
Wade, Nicholas. With Genome, a Radical Shift for Biology. The New York Times 25 Dec. 2001: F1.
Berenson, Alex, and Nicholas Wade. A Call for Sharing of Research Causes Gene Stocks to Plunge. The New York Times 15 Mar. 2000: A1.
Wade, Nicholas. An Adroit Director of an Unwieldy Team. The New York Times 27 June 2000: F3.
Wade, Nicholas. Battle of the Sexes Is Discerned in Sperm. The New York Times 22 Feb. 2000: F1.
Wade, Nicholas. DNA Data Suggest Sperm In Competition For Mating. The New York Times 21 Jan. 2000: 17.
Wade, Nicholas. Double Landmarks for Watson: Helix and Genome. The New York Times 27 June 2000: F5.
Wade, Nicholas. A Founder of Modern Biology Shapes the Genome Era, Too. The New York Times 7 Mar. 2000: F1.
Wade, Nicholas. The Four-letter Alphabet That Spells Life. The New York Times 2 July 2000: WK.
Wade, Nicholas. Frustration and Rivalry Fueled a Passion for Genetic Discovery. The New York Times 27 June 2000: F2.
Wade, Nicholas. Genetic Code of Human Life Is Cracked by Scientists; a Shared Success; 2 Rivals' Announcement Marks New Medical Era, Risks and All. The New York Times 27 June 2000: A1.
Wade, Nicholas. Genome Decoding Plan Is Derailed by Conflicts; a Plan for Cooperation Falls Victim to Clashing Interests and Egos. The New York Times 9 Mar. 2000: A20.
Wade, Nicholas. Now, the Hard Part: Putting the Genome to Work. The New York Times 27 June 2000: F1.
Wade, Nicholas. Race Is On To Decode Genome Of Mouse. The New York Times 6 Oct. 2000: A22.
Wade, Nicholas. Rivals in the Race to Decode Human DNA Agree to Cooperate. The New York Times 22 June 2000: A2.
Wade, Nicholas. Rivals on Offensive as They near Wire in Genome Race. The New York Times 7 May 2000: 26.
Wade, Nicholas. 10 Drug Makers Join in Drive to Find Diseases' Genetic Roots. The New York Times 15 Apr. 1999: n. pag.
Wade, Nicholas. After 10 Years' Effort, Genome Mapping Team Achieves Sequence of a Human Chromosome. The New York Times 2 Dec. 1999: n. pag.
Wade, Nicholas. Count of Human Genes Is Put at 140,000, a Significant Increase. The New York Times 23 Sept. 1999: n. pag.
Wade, Nicholas. Gains Are Reported in Decoding Genome. The New York Times 22 May 1999: n. pag.

	Wade, Nicholas. The Genome's Combative Entrepreneur. The New York Times 18 May 1999: n. pag. Wade, Nicholas. Human Genome May Be Longer Than Expected. The New York Times 1 Aug. 1999: n. pag. Wade, Nicholas. One of 2 Teams in Genome-Map Race Sets an Earlier Deadline. The New York Times 16 Mar. 1999: n. pag. Wade, Nicholas. Talk of Collaboration on Decoding of the Genome. The New York Times 14 Nov. 1999: n. pag. Wade, Nicholas. Animal's Genetic Program Decoded, in a Science First. The New York Times 11 Dec. 1998: n. pag. Wade, Nicholas. Beyond Sequencing of Human DNA. The New York Times 12 May 1998: n. pag. Wade, Nicholas. Cambridge Lab Keeps Britain Ahead in Genome Stakes. The New York Times 6 Oct. 1998: n. pag. Wade, Nicholas. Human or Chimp? 50 Genes Are the Key. The New York Times 20 Oct. 1998: n. pag. Wade, Nicholas. Ideas & Trends; Of Men and Mice: Here They Come to Save the Day. The New York Times 10 May 1998: n. pag. Wade, Nicholas. In Genome Race, Government Vows to Move Up Finish. The New York Times 15 Sept. 1998: n. pag. Wade, Nicholas. In the Hunt for Useful Genes, a Lot Depends on 'Snips' The New York Times 11 Aug. 1998: n. pag. Wade, Nicholas. International Gene Project Gets Lift. The New York Times 17 May 1998: n. pag. Wade, Nicholas. It's a Three-Legged Race to Decipher the Human Genome. The New York Times 23 June 1998: n. pag. Wade, Nicholas. Scientist at Work: James D. Watson; Impresario of the Genome Looks Back With Candor. The New York Times 7 Apr. 1998: n. pag. Wade, Nicholas. Scientist's Plan: Map All DNA Within 3 Years. The New York Times 10 May 1998: n. pag. Wade, Nicholas. The Struggle to Decipher Human Genes. The New York Times 10 Mar. 1998: n. pag. Wade, Nicholas. In the Hunt for Useful Genes, a Lot Depends on 'Snips' The New York Times 11 Aug.1998: n. pag. Wade, Nicholas. Gene Mutation Tied To Colon Cancers In Ashkenazi Jews. The New York Times 26 Aug. 1997: n. pag. Wade, Nicholas. Ideas & Trends; Testing Genes to Save a Life Without Costing You a Job. The New York Times 14 Sept. 1997: n. pag. Wade, Nicholas. Now Playing at a Nearby Lab: 'Revenge of the Fly People' The New York Times 20 May 1997: n. pag. Wade, Nicholas. Research Team Takes Big Stride In the Mapping of Human Genes. The New York Times 15 Mar. 1997: n. pag. Wade, Nicholas. Deep Sea Yields a Clue to Life's Origin. The New York Times 23 Aug. 1996: n. pag. Wade, Nicholas. Bacterium's Full Gene Makeup Is Decoded. The New York Times 26 May 1995: n. pag. Wade, Nicholas. SCIENTIST AT WORK: J. Craig Venter; A Bold Short Cut To Human Genes. The New York Times 22 Feb. 1994: n. pag.
Connections	• A troublesome inheritance: Genes, race and human history • Life script: How the human genome discoveries will transform medicine and enhance your health • Public vs Private: Human Genome Project 1998-2000 • Wade, Nicholas
External Links	http://library.cshl.edu/oralhistory/speaker/nicholas-wade/ http://www.americanscientist.org/bookshelf/pub/nicholas-wade

10.2.24 Waldholz, Michael

Senior editor with Inside Climate News, former science correspondent with the Wall Street Journal. Co-author with Jerry Bishop of *Genome*.

Birth Date	
Gender	Male
Selected Publications	**Content by label** There is no content with the specified labels
Connections	• The story of the most astonishing scientific adventure of our time-the attempt to map all the genes in the human body

10.2.25 Wingerson, Lois

Author of *Mapping Our Genes: The Genome Project and the Future of Medicine*

Gender	Female
External Links	http://www.loiswingerson.com/

10.3 Bioethicists

10.3.1 Andrews, Lori

Distinguished Professor of Law, Chicago-Kent College of Law, Illinois Institute of Technology. As an attorney and scholar, Andrews has helped formulate policy in the area of genetic technology and has advised the World Health Organization and the National Institutes of Health, among other bodies. During the Human Genome Project, she was chair of the U.S. federal government's Working Group on the Ethical, Legal, and Social Implications of the Human Genome Project.

Birth	1952
Gender	Female
Links	https://www.kentlaw.iit.edu/faculty/full-time-faculty/lori-b-andrews

10.3.2 Annas, George

William Fairfield Warren Distinguished Professor at Boston University; director, Center for Health Law, Ethics & Human Rights, Boston University School of Public Health. An accomplished bioethicist, Annas has written or edited 20 books on subjects like public health law and genomics. Annas was involved in ELSI issues during the Human Genome Project.

Gender	Male

Links	https://www.bu.edu/law/profile/george-j-annas-2/

10.3.3 Asch, Adrienne

Deceased. Was Edward and Robin Milstein Professor of Bioethics at Yeshiva University and Professor of Epidemiology and Population Health and Family and Social Medicine at Albert Einstein College of Medicine; co-editor of Prenatal Testing and Disability Rights and The Double-Edged Helix: Social Implications of Genetics in a Diverse Society; was a member of the board of the American Society for Bioethics and Humanities, the Clinton Task Force on Health Care Reform, and the Ethical, Legal, and Social Implications Policy Planning Group of the National Human Genome Research Institute.

Birth Date	1946
Death Date	2013
Gender	Female
Connections	• American Society for Bioethics and Humanities/Archives • Asch, Adrienne • National Human Genome Research Institute (NHGRI)/Archives
External Links	http://www.nytimes.com/2013/11/23/nyregion/adrienne-asch-bioethicist-and-pioneer-in-disability-studies-dies-at-67.html https://nfb.org/images/nfb/publications/bm/bm14/bm1401/bm140102.htm http://bancroft.berkeley.edu/collections/drilm/collection/items/asch.html http://deepblue.lib.umich.edu/handle/2027.42/55724

10.3.4 Barton, John

Deceased. Barton was the George E. Osborne Professor of Law, Emeritus, Stanford Law School. He was a CHP/PCOR associate. Barton taught at Stanford since 1969, focusing on international and technology law. Research focused on international research and cooperation, the relationship between intellectual property and antitrust, and the transfer of technology -- particularly vaccine production technology -- to developing countries.

Former Chair (1994-1996), National Genetic Resources Advisory Council; Member, National Academy Panel on Genetic Diversity; Member, Scientific Review Panel, Human Genetics Programme, World Health Organization.

Authored many articles on the intersection of patent law and antitrust in biotechnology, particularly in the context of sequential innovation. He suggested that improvers that make significant contributions be given a "dependency license," which requires only the payment of reasonable royalties.

Barton chaired the U.K. Commission on Intellectual Property Rights in 2001-2002. He was also a member of National Research Council's committees on intellectual property and on genetic resources; of the Nuffield Council on Bioethics committee on gene patenting; and of two working groups of the Sachs Commission on Macroeconomics and Health.

Birth Date	1937
Death Date	2009
Gender	Male
Selected Publications	Barton, John H. “Patents, Genomics, Research, and Diagnostics,” *Academic Medicine* 77:1339-1347 (December 2002).

	"United States Law of Genomic and Post-Genomic Patents," 33 *International Review of Industrial Property and Copyright Law* 779 (2002). John H. Barton, Kenneth S. Fischer, Gurdev S. Khush, Hei Leung and Ronald Cantrell, Genomics and Agriculture: Collaborations in Rice, 290:5490 Science 279-280 (October 13, 2000). John H. Barton, Rational Limits on Genomic Patents, 18 Nature Biotechnology 805-806 (August 2000). "The Impact of Contemporary Patent Law on Plant Biotechnology Research," Intellectual Property Rights III Global Genetic Resources: Access and Property Rights 1998. Madison, WI: Crop Science Society of America; American Society of Agronomy, 1998. John H. Barton, "The Human Genome Patent Applications", (March-April 1993) Practising Law Institute, 354 PLI/Pat 681
Connections	Stanford Law School
External Links	https://law.stanford.edu/directory/john-barton/ http://news.stanford.edu/news/2009/august3/john-barton-obit-080609.html https://law.stanford.edu/stanford-lawyer/articles/remembering-john-h-barton-george-e-osborne-professor-of-law-emeritus/

10.3.5 Capron, Alexander

First Director of Ethics, Trade, Human Rights and Health Law at the World Health Organization. Previously taught at Georgetown, Pennsylvania, Yale and the University of Southern California. From September 1979 to March 1983, served as the Executive Director of the President's Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research.

Gender	Male
Connections	• Capron, Alexander
External Links	http://weblaw.usc.edu/faculty/contactInfo.cfm?detailID=205 http://weblaw.usc.edu/portal/directory/photos/Capron%20Alexander%20CV%20Sept%202010.pdf http://www.tcf.org/experts/detail/alexander-morgan-capron http://www.asbh.org/uploads/files/meetings/meet%20the%20professor%20bios.pdf

10.3.6 Drell, Daniel

During the Human Genome Project, Drell managed ELSI issues at the U.S. Department of Energy. He was one of the DOE's leading scientists during the sequencing project and has been involved with the department's Microbial Genome Program as well.

Gender	Male
Connections	• Drell, Daniel
External Links	http://articles.mcall.com/2000-09-20/news/3315480_1_human-genome-genes-in-human-dna-insurance-discrimination

10.3.7 Eisenberg, Rebecca

Robert and Barbara Luciano Professor of Law. Eisenberg specializes in patent law, FDA law, and the regulation of biopharmaceutical innovation. She spent the 1999-2000 academic year as a visiting professor of

law, science, and technology at Stanford Law School and the spring of 2012 as a visiting scholar at the Berkeley Center for Law & Technology.

Eisenberg has played an active role in public policy debates concerning the role of intellectual property in biopharma research, advising the NIH and the National Academies of Science. She served as law clerk for the Hon. Robert F. Peckham of the U.S. District Court for the Northern District of California and then practiced law as a litigator in San Francisco. She joined the Michigan Law faculty in 1984.

Gender	Female
Connections	• Eisenberg, Rebecca • University of Michigan/Archives
External Links	https://www.law.umich.edu/library/guests/pubsfaculty/facultypages/Pages/eisenberg_rebecca.aspx https://repository.library.georgetown.edu/handle/10822/524437

10.3.8 Fletcher, John C.

Deceased. Biomedical ethicist, specializing in clinical bioethics. Professor emeritus of biomedical ethics in internal medicine, University of Virginia Medical School. Previously chief ethics officer at the NIH clinical center.

Birth Date	1932
Death Date	2004
Gender	Male
Connections	• Fletcher, John C. • Ismail, Sherille
External Links	http://www.washingtonpost.com/wp-dyn/articles/A8178-2004Jun1.html http://www.washingtonpost.com/wp-dyn/articles/A8178-2004Jun1.html http://www.dartmouth.edu/~montfell/biographies/a_f/fletcherj.html https://muse.jhu.edu/login?auth=0&type=summary&url=/journals/kennedy_institute_of_ethics_journal/v014/14.3walters.

10.3.9 Fujiki, Norio

Professor Emeritus, Fukui Medical School, Japan. Vice president, International Bioethics Committee, United Nations Educational (1993-98).

Birth Date	
Gender	Male
Connections	• Fujiki, Norio
External Links	http://www.eubios.info/MURSBOOK.htm http://www.eubios.info/EJ63/EJ63K.htm http://prabook.org/web/person-view.html?profileId=201457 http://www.nature.com/nature/journal/v389/n6652/full/389661b0.html

10.3.10 Gellman, Robert

Privacy and information consultant. Member, National Committee on Vital and Health Statistics, Department of Health and Human Services (1996-2000). Chair, Subcommittee on Privacy and Confidentiality 1996-1998. Staff Member, Subcommittee on Information, Justice, Transportation, and Agriculture, House Committee on Government Operations (1977-95).

Gender	Male
Connections	• Gellman, Robert
External Links	http://philpapers.org/rec/GELWDF http://www.bobgellman.com/

10.3.11 Juengst, Eric

Director of the UNC Center for Bioethics; Professor in the Department of Social Medicine and the Department of Genetics, University of North Carolina, Chapel Hill. Specializes in the ethical and social policy issues caused by the availability of genetic and genomic information.

Gender	Male
Selected Publications	• Juengst ET. (1991) The human genome project and bioethics. Kennedy Institute of Ethics journal • Juengst ET. (1996) Self-critical federal science? The ethics experiment within the U.S. Human genome project. Social Philosophy & Policy • Kaye J, et al. (2012) ELSI 2.0 for genomics and society
Connections	• Juengst, Eric
External Links	https://www.med.unc.edu/socialmed/people/eric-juengst http://philosophy.unc.edu/people/eric-juengst/ http://www.case.edu/med/bioethics/facultystaff/etj2.htm

10.3.12 Kemp, Evan

Deceased in 1997. Lifelong advocate for the disabled. As chairman of the Equal Employment Opportunity Commission, Kemp was influential in the formation of the Americans With Disabilities Act.

Birth	1937
Death	1997
Gender	Male
Links	http://www.nytimes.com/1997/08/14/us/evan-j-kemp-jr-60-champion-of-disabled.html

10.3.13 Kevles, Daniel

Stanley Woodward Professor Emeritus of History, History of Medicine & American Studies, Yale University. Authority on the history of science and genetics. Author of *In the Name of Eugenics*: *Genetics and the Uses of Human Heredity.*

Birth Date	1939
Gender	Male
Selected Publications	• Kevles DJ (1994) Ananda Chakrabarty wins a patent: Biotechnology, law, and society, 1972-1980
Connections	• Kevles, Daniel • Perilous Knowledge: The Human Genome Project and Its Implications • The Code of Codes: Scientific and Social Issues in the Human Genome Project
External Links	http://history.yale.edu/people/daniel-kevles http://hshm.yale.edu/people/daniel-kevles

10.3.14 King, Patricia

Carmack Waterhouse professor of Law, Medicine, Ethics and Public Policy, Georgetown University. Served on numerous government committees including the Ethics, Legal and Social Issues Working Group of the Human Genome Project.

Gender	Female
Connections	• King, Patricia • The Origins of ELSI
External Links	https://www.law.georgetown.edu/faculty/king-patricia-a.cfm http://www.law.nyu.edu/news/nelkin_king http://www.americanbar.org/content/dam/aba/directories/women_trailblazers/patricia_king_bio.pdf

10.3.15 Murray, Thomas

Retired. Professor Emeritus, The Hastings Center. Formerly the Director of the Center for Biomedical Ethics in the School of Medicine at Case Western Reserve University. With Mark Rothstein and Robert Murray, edited *The Human Genome Project and the Future of Health Care.*

Gender	Male
Selected Publications	Murray, T.H. *et al.* (eds). *The Human Genome Project and the Future of Health Care.* (Indiana University Press, 1996).
Connections	• Murray, Thomas • The Origins of ELSI
External Links	http://www.thehastingscenter.org/About/Staff/Detail.aspx?id=1298 http://homepage.usask.ca/~wjb289/PHIL236/pdf/15_Murray_Human_Genome_Research.pdf

10.3.16 Pellegrino, Edmund

Deceased. Professor Emeritus of Medicine and Medical Ethics at the Kennedy Institute of Ethics; founding director of the Center for Clinical Bioethics (renamed the Edmund D. Pellegrino Center for Clinical Bioethics in 2013), at Georgetown University Medical Center.

From 2005-2009 he served as Chairman of the President's Council on Bioethics. He was the John Carroll Professor of Medicine and Medical Ethics and the former director of the Kennedy Institute of Ethics, the Center for the Advanced Study of Ethics at Georgetown University, and the Center for Clinical Bioethics. Considered an icon of the field of bioethics.

Birth Date	1921
Death Date	2013
Gender	Male
Connections	• Pellegrino, Edmund
External Links	https://cbhd.org/content/edmund-pellegrino http://www.ncbi.nlm.nih.gov/pubmed/2203865 http://www.georgetown.edu/news/pioneering-bioethicist-edmund-pellegrino-dies.html

10.3.17 Rothstein, Mark

Herbert F. Boehl Chair of Law and Medicine and Founding Director of the Institute for Bioethics, Health Policy and Law, University of Louisville School of Medicine. Rothstein has concentrated his research on bioethics, genetics, health privacy, public health law, and employment law. From 1999-2008 he served as Chair of the Subcommittee on Privacy and Confidentiality of the National Committee on Vital Health Statistics. Past president of the American Society of Law, Medicine and Ethics.

Gender	Male
Connections	• Accomplishments of the ELSI Program • Rothstein, Mark
External Links	https://louisville.edu/bioethics/directory/mark-a.-rothstein https://louisville.edu/bucksforbrains/faculty/rothstein https://lifeboat.com/ex/bios.mark.a.rothstein

10.3.18 Walters, LeRoy

Former Director of the Kennedy Institute of Ethics (Georgetown University) from 1996 to 2000. Published widely on genetic ethics and the Holocaust. He has served for three terms—including three years as Chair—on the Recombinant DNA Advisory Committee of the NIH, which reviews human gene therapy protocols. A Fellow of the Hastings Center, member of the Bioethics Advisory Committee of the March of Dimes, and a member of the Noninvasive Prenatal Testing (NIPT) Study Advisory Board at the Cleveland Clinic.

Gender	Male
Selected Publications	Collins FS, et al. New goals for the U.S. Human Genome Project: 1998-2003
Connections	• Walters, LeRoy

External Links	https://kennedyinstitute.georgetown.edu/about/history/ http://www.c-span.org/person/?leroywalters

10.3.19 Wikler, Daniel

Mary B. Saltonstall Professor of Ethics and Population Health at Harvard School of Public Health since 2002. Served as "staff philosopher" for the President's Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research, and as the first "Staff Ethicist" for the World Health Organization.

Birth Date	1946
Gender	Male
External Links	http://www.hsph.harvard.edu/daniel-wikler/ http://bioethics.hms.harvard.edu/person/faculty-members/daniel-wikler http://medhist.wisc.edu/faculty/wikler/index.shtml

10.3.20 Yesley, Michael

Former manager, ethics, legal and social implications, Human Genome Project, U.S. Department of Energy.

Gender	Male
External Links	http://www.womensbioethics.org/index.php?p=Michael_Yesley,_JD&s=42 http://www.hhs.gov/ohrp/education/Belmont%20Anniversary%20Interviews/baimyesley.html

10.4 Politicians

10.4.1 Armstrong, William

Currently president of Colorado Christian University; former U.S. representative and senator from Colorado; strong pro-life advocate. Influential in the shaping of the congressional Biomedical Ethics Board and the Biomedical Ethics Advisory Committee (BEAC).

Birth Date	March 16, 1937
Gender	Male
Connections	• Armstrong, William • Colorado Christian University/Archives
External Links	http://bioguide.congress.gov/scripts/biodisplay.pl?index=A000219 https://www.govtrack.us/congress/members/william_armstrong/400927 https://www.govtrack.us/congress/members/william_armstrong/400926

10.4.2 Blair, Tony

Prime Minister of the UK from May 1997 to June 2007. In March 2000, issued a joint statement with U.S. President Bill Clinton, agreeing to help ensure that discoveries arising from knowledge of the human genome are used to improve human health; encouraging the open sharing human genome sequence data with the global scientific community; and calling for appropriate intellectual property protection for gene-based health care products. He participated in the White House ceremony on June 26, 2000, to mark the completion of the first draft of the human genome.

Birth Date	1953
Gender	Male
Connections	• Blair, Tony • Clinton, William J. • Sainsbury, David John
External Links	http://www.tonyblairoffice.org/pages/biography/ https://www.gov.uk/government/history/past-prime-ministers/tony-blair https://en.wikipedia.org/wiki/Tony_blair

10.4.3 Bush, George W.

43rd president of the U.S.; served from 2001 to 2009. In 2008, signed into law the Genetic Information Nondiscrimination Act (GINA), which protects Americans from discrimination in health insurance and employment based on their genetic information.

Birth Date	1946
Gender	Male
Connections	• Bush, George W. • Genetic Information Nondiscrimination Act (GINA) becomes law (2008)
External Links	http://www.bushcenter.org/people/george-w-bush http://georgewbush-whitehouse.archives.gov/president/biography.html https://www.whitehouse.gov/1600/presidents/georgewbush http://millercenter.org/president/gwbush http://www.georgewbushlibrary.smu.edu/The-President-and-Family/George-W-Bush.aspx http://www.history.com/topics/us-presidents/george-w-bush https://en.wikipedia.org/wiki/George_W._Bush

10.4.4 Chiles, Lawton

Introduced legislation into Senate on June 11, 1987, calling for the creation of a National Center for Biotechnology Information.

Birth Date	1930
Death Date	1998
Gender	Male
Connections	• Chiles, Lawton • Hall, Michael

	• Snell, Rand • U.S. Senate/Archives
External Links	http://bioguide.congress.gov/scripts/biodisplay.pl?index=c000356 http://chilesfoundation.org/lawton-chiles/gov-lawton-chiles-biography/ http://www.nga.org/cms/home/governors/past-governors-bios/page_florida/col2-content/main-content-list/title_chiles_lawton.html http://www.washingtonpost.com/wp-srv/politics/daily/dec98/13/chiles.htm http://www.nytimes.com/1998/12/14/nyregion/gov-lawton-chiles-of-florida-populist-and-former-senator-dies-at-68.html https://en.wikipedia.org/wiki/Lawton_Chiles

10.4.5 Chirac, Jacques

Prime minister of France, 1974-1976 and 1986-1988; Mayor of Paris, 1977-1995; President of France, 1995-2007. In 1987, Chirac designated human genome research as a new priority for France.

Birth Date	1932
Gender	Male
Connections	• Chirac, Jacques
External Links	http://www.fondationchirac.eu/en/foundation/jacques-chirac/ http://www.jacqueschirac-asso.fr/jacques-chirac-biographie/ https://en.wikipedia.org/wiki/Jacques_Chirac

10.4.6 Clinton, William J.

42nd president of the U.S.; served from 1993 to 2001. In March 2000, issued a joint statement with UK prime minister Tony Blair, agreeing to help ensure that discoveries arising from knowledge of the human genome are used to improve human health; encouraging the open sharing human genome sequence data with the global scientific community; and calling for appropriate intellectual property protection for gene-based health care products. He hosted the White House ceremony on June 26, 2000, to mark the completion of the first draft of the human genome.

Birth Date	1946
Gender	Male
Connections	• Clinton, William J. • William J. Clinton Presidential Library/Archives
External Links	https://www.whitehouse.gov/1600/presidents/williamjclinton http://clintonlibrary.gov/ https://www.clintonfoundation.org/about/president-clinton http://millercenter.org/president/clinton http://www.history.com/topics/us-presidents/bill-clinton

10.4.7 Dingell, John

Retired. Member of the U.S. House of Representatives (Democrat, Michigan) from 1955 until 2015. In 1987, as chairman of the House Energy and Commerce Committee, Dingell requested that the Office of Technology Assessment (OTA) conduct a study of how a human gene mapping project should be carried out.

Birth Date	1926
Gender	Male
Connections	• Dingell, John • University of Michigan/Archives
External Links	http://bioguide.congress.gov/scripts/biodisplay.pl?index=d000355 http://history.house.gov/People/Listing/D/DINGELL,-John-David,-Jr--%28D000355%29/ https://www.govtrack.us/congress/members/john_dingell/400110 http://www.nytimes.com/2014/02/25/us/politics/dingell-to-retire-from-congress.html?_r=0

10.4.8 Domenici, Pete

Retired. U.S. Republican Senator for New Mexico from 1973-2009. A key figure on the DOE authorization committee in the Senate. On July 21, 1987, Domenici introduced legislation into Congress to fund the Human Genome Project.

Birth Date	May 7, 1932
Gender	Male
Connections	• Domenici, Pete • New Mexico State University, Political Papers Archives/Archives • U.S. Senate • U.S. Senate/Archives
External Links	http://bioguide.congress.gov/scripts/biodisplay.pl?index=d000407 https://www.govtrack.us/congress/members/pete_domenici/300036 http://domenici.nmsu.edu/pete-v-domenici-bio/ https://en.wikipedia.org/wiki/Pete_Domenici

10.4.9 Ford, Wendell

Deceased. Senator (Democrat) for Kentucky for 24 years and a former Governor. A key figure on the DOE authorization committee in the Senate.

Birth Date	1924
Death Date	2015
Gender	Male
Connections	• Ford, Wendell • U.S. Senate/Archives
External Links	http://bioguide.congress.gov/scripts/biodisplay.pl?index=f000268 https://www.govtrack.us/congress/members/wendell_ford/404219

	http://www.nga.org/cms/home/governors/past-governors-bios/page_kentucky/col2-content/main-content-list/title_ford_wendell.html http://www.nytimes.com/2015/01/23/us/politics/wendell-h-ford-kentucky-governor-and-senator-dies-at-90.html http://www.kentucky.com/2015/01/22/3654522/kentucky-democratic-icon-wendell.html https://en.wikipedia.org/wiki/Wendell_H._Ford

10.4.10 Gorbachev, Mikhail

Served as the head of the Soviet Union from 1988 until 1991, when it dissolved. Gorbachev's perestroika and glasnost provided some impetus for the Human Genome Project: the resulting decline of the Cold War caused the U.S. DOE to look for new uses for its military research operations, particularly its powerful supercomputers.

The Russian HGP began in 1988, after Alexander Alexandrovich Bayev wrote a letter to Gorbachev, requesting support and initiation of the project.

Birth Date	1931
Gender	Male
Connections	• Gorbachev, Mikhail
External Links	http://www.gorby.ru/en/gorbachev/biography/ http://www.nobelprize.org/nobel_prizes/peace/laureates/1990/gorbachev-bio.html http://www.history.com/topics/cold-war/perestroika-and-glasnost https://en.wikipedia.org/wiki/Mikhail_Gorbachev

10.4.11 Gore, Albert, Jr.

45th vice president of the U.S.; served from 1993 to 2001 under President Bill Clinton. As a senator in the mid-1980s, Gore was instrumental in having 5% of the HGP's budget set aside for research on the ethical, legal, and social implications of the HGP. In 1991, Gore was also instrumental in moving through senate the High Performance Computing and Communications Act, which paved the way for the Internet.

Birth Date	1948
Gender	Male
Connections	• Biomedical Ethics Advisory Committee (BEAC) • Biomedical Ethics Board • Gore, Albert, Jr. • President's Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research • US/Archives
External Links	http://bioguide.congress.gov/scripts/biodisplay.pl?index=g000321 https://www.algore.com/about.html http://www.senate.gov/artandhistory/history/common/generic/VP_Albert_Gore.htm http://www.nobelprize.org/nobel_prizes/peace/laureates/2007/gore-bio.html

10.4.12 Hall, Michael

Member of Senator Lawton Chiles's staff who helped draft the 1989 appropriations conference report, urging the NIH and DOE to rapidly develop the best strategy for the HGP to meet the deadline for the 1991 budget cycle.

Gender	Male
Connections	• Hall, Michael

10.4.13 Harkin, Tom

Retired Senator from Iowa from 1985-2015. Harkin was enthusiastic about the HGP, but was unable to influence decisions strongly because of his relatively junior status at the time. Supported budget increases for the NIH, and in 1995, proposed the establishment of a special government trust fund for medical research.

Birth Date	1939
Gender	Male
Connections	• Harkin, Tom • U.S. Senate/Archives
External Links	http://bioguide.congress.gov/scripts/biodisplay.pl?index=h000206 https://www.congress.gov/member/thomas-harkin/H000206 https://www.govtrack.us/congress/members/thomas_harkin/300051

10.4.14 Hatch, Orrin

Republican Senator from Utah from 1977. Expressed concern that the HGP might lead to increased practice of abortion as a result of increased capabilities for prenatal diagnosis.

Birth Date	1934
Gender	Male
Connections	• Hatch, Orrin • U.S. Senate/Archives
External Links	https://www.orrinhatch.com/ http://www.hatch.senate.gov/public/ https://www.congress.gov/member/orrin-hatch/H000338 https://www.govtrack.us/congress/members/orrin_hatch/300052 https://en.wikipedia.org/wiki/Orrin_Hatch

10.4.15 Hatfield, Mark

Republican Senator from Oregon from 1967-97. Hatfield introduced into the Senate a resolution arguing against any form of gene therapy. Hatfield also introduced a bill imposing a 5-year moratorium on patenting animals, which was subsequently reconstituted as an amendment providing a 3-year moratorium on the patenting of both living organisms and genetic matter.

Birth Date	1922
Death Date	2011
Gender	Male
Connections	• Hatfield, Mark • U.S. Senate/Archives
External Links	http://bioguide.congress.gov/scripts/biodisplay.pl?index=h000343 http://sos.state.or.us/archives/pages/records/governors/guides/state/hatfield/index.html http://www.wheaton.edu/isae/hall-of-biography/mark-hatfield http://www.nytimes.com/2011/08/08/us/politics/08hatfield.html https://www.washingtonpost.com/local/obituaries/former-senator-mark-hatfield-of-oregon-dies-at-89/2011/06/14/gIQAj9ic1I_story.html https://en.wikipedia.org/wiki/Mark_Hatfield

10.4.16 Hoyer, Steny

House Democratic Whip who was instrumental in passing the Americans with Disabilities Act (ADA). The ADA did not consider the issue of genetic discrimination.

Birth Date	1939
Gender	Male
Connections	• Hoyer, Steny
External Links	http://hoyer.house.gov/ http://www.hoyerforcongress.com/ http://www.democraticwhip.gov/about/biography http://bioguide.congress.gov/scripts/biodisplay.pl?index=h000874 https://www.congress.gov/member/steny-hoyer/H000874 https://www.govtrack.us/congress/members/steny_hoyer/400189 https://en.wikipedia.org/wiki/Steny_Hoyer

10.4.17 Kennedy, Edward M.

Deceased. Democratic Senator from Massachusetts from 1962 to his death in 2009. In 1973, Senator Kennedy convened hearings to discuss proposed research on living human fetuses and the treatment of human subjects in scientific research, which ultimately led to the passing of the National Research Act. In 1985, with the Subcommittee on Health of the Committee on Labor and Public Welfare, Kennedy initiated the first public debates on recombinant DNA. In 2006, in partnership with Senator Gordon Smith, Kennedy introduced the Laboratory Test Improvement Act. Kennedy was a strong supporter of the Genetic Information Nondiscrimination Act (GINA).

Birth Date	1932
Death Date	2009
Gender	Male
Connections	• Kennedy, Edward M. • U.S. Senate/Archives

External Links	http://tedkennedy.org/ http://bioguide.congress.gov/scripts/biodisplay.pl?index=k000105 http://www.senate.gov/artandhistory/history/common/generic/Featured_Bio_KennedyEdwardTed.htm http://www.nytimes.com/2009/08/27/us/politics/27kennedy.html http://www.jfklibrary.org/JFK/The-Kennedy-Family/Edward-M-Kennedy.aspx https://en.wikipedia.org/wiki/Ted_Kennedy

10.4.18 Mikulski, Barbara

Democratic Senator from Maryland since 1987. Mikulski was concerned about the adverse social impacts of approaching the HGP more quickly than policies could be developed.

Birth Date	1936
Gender	Female
Connections	• Mikulski, Barbara • U.S. Senate/Archives
External Links	http://www.mikulski.senate.gov/ http://bioguide.congress.gov/scripts/biodisplay.pl?index=m000702 http://history.house.gov/People/Listing/M/MIKULSKI,-Barbara-Ann-%28M000702%29/ https://www.washingtonpost.com/news/post-politics/wp/2015/03/02/sen-mikulski-to-make-announcement-about-her-future/ https://en.wikipedia.org/wiki/Barbara_Mikulski

10.4.19 Murray, Matthew

Former student of Leroy Hood's at Caltech who did a short internship with Senator Pete Domenici. He helped Domenici arrange a 1990 hearing and a 1991 progress review meeting on the HGP.

Gender	Male
Connections	• Murray, Matthew • US Department of Energy (DOE)/DOE Joint Genome Institute (DOE JGI)/Archives
External Links	http://www.ncbi.nlm.nih.gov/books/NBK236721/https://repository.library.georgetown.edu/bitstream/handle/10822/55955 https://repository.library.georgetown.edu/bitstream/handle/10822/559559/HGPHoodTranscript.pdf?sequence=1

10.4.20 Natcher, William

Congressman from Kentucky who served from 1953 to 1994. Natcher was the member of the House Committee on Appropriations to which James D. Watson appealed in 1987 for funding to start the HGP. Natcher was the chairman of the House subcommittee that funds NIH.

Birth Date	1909
Death Date	1994
Gender	Male
Connections	• Natcher, William • Stephens, Michael

External Links	http://bioguide.congress.gov/scripts/biodisplay.pl?index=N000009 http://www.nytimes.com/1994/03/31/obituaries/william-h-natcher-dies-at-84-held-voting-record-in-congress.html https://en.wikipedia.org/wiki/William_Huston_Natcher

10.4.21 Nickles, Don

Former U.S. Senator from Oklahoma who served from 1981 until 2005. Along with fellow senator Gordon Humphrey, Nickles was responsible for doing away with the Biomedical Ethics Advisory Committee (BEAC).

Birth	1948
Gender	Male
Connections	• Nickles, Don • U.S. Senate/Archives
External Links	http://nicklesgroup.com/bios/don-nickles/ https://en.wikipedia.org/wiki/Don_Nickles

10.4.22 Obey, David

U.S. Representative from Wisconsin; from 1969 to 2011. Served as Chairman of House Appropriations Committee from 1994 to 1995; and from 2007 to 2011. In hearings about the proposed HGP, Obey questioned the reason why DOE was proposing to lead the project. He also emphasized the need to achieve practical results from the ELSI program, such as maintaining genetic privacy and protecting against discrimination based on genetic information.

Birth	1938
Gender	Male
Connections	• Obey, David • University of Wisconsin - Madison/Archives
External Links	http://bioguide.congress.gov/scripts/biodisplay.pl?index=o000007 https://www.govtrack.us/congress/members/david_obey/400300 http://www.nytimes.com/2010/05/06/us/politics/06obey.html https://en.wikipedia.org/wiki/Dave_Obey

10.4.23 Pepper, Claude

U.S. Senator from Florida; served from 1936 to 1951; and U.S. representative from Florida; from 1963 until his death in 1989. In 1987, as chair of the House Select Committee on Aging, introduced a bill to establish NCBI.

Birth Date	1900
Death Date	1989
Gender	Male

Connections	• Florida State University, Claude Pepper Library/Archives • Pepper, Claude • U.S. Senate/Archives
External Links	http://bioguide.congress.gov/scripts/biodisplay.pl?index=p000218 http://history.house.gov/People/Listing/P/PEPPER,-Claude-Denson-%28P000218%29/ http://claudepepperfoundation.org/about/507-2/ http://www.nytimes.com/learning/general/onthisday/bday/0908.html

10.4.24 Reagan, Ronald

40th president of the U.S.; served from 1981 to 1989. On November 4, 1988, signed into law a bill providing for the creation of a National Center for Biotechnology Information (NCBI), under the auspices of the National Library of Medicine (NLM).

Birth	February 6, 1911 – June 5, 2004
Gender	Male
Connections	• Reagan, Ronald • US/Archives
External Links	http://www.history.com/topics/us-presidents/ronald-reagan https://www.whitehouse.gov/1600/presidents/ronaldreagan http://millercenter.org/president/reagan http://www.reagan.utexas.edu/ https://en.wikipedia.org/wiki/Ronald_Reagan

10.4.25 Richardson, Bill

Governor of New Mexico from 2003 to 2011. Secretary of Energy under President Bill Clinton, 1998-2000. U. S. ambassador to the United Nations, 1997-1998; and U.S. representative from New Mexico; served from 1982-1996. As Energy Secretary, Richardson dedicated DOE Joint Genome Institute's Production Sequencing Facility (PSF) at Walnut Creek on April 19, 1999.

Birth	1947
Gender	Male
Connections	• Richardson, Bill
External Links	http://www.billrichardson.com/about-bill/biography http://bioguide.congress.gov/scripts/biodisplay.pl?index=r000229 https://www.congress.gov/member/bill-richardson/R000229 http://history.house.gov/People/Detail/20368?ret=True https://en.wikipedia.org/wiki/Bill_Richardson

10.4.26 Sainsbury, David John

David John Sainsbury, Baron Sainsbury of Turville, sits in the UK House of Lords. He served as the UK Minister for Science and Innovation (science advisor) from 1998 to 2006. Sainsbury, and his counterpart in the U.S., Neal Lane, were involved in discussions about the 2000 Clinton/Blair statement agreeing to help

ensure that genomic discoveries are used to improve human health; encouraging the open sharing human genome sequence data with the global scientific community; and calling for appropriate intellectual property protection for gene-based health care products.

In 2011, Sainsbury was elected Chancellor of the University of Cambridge.

Birth	1940
Gender	Male
Connections	• Sainsbury, David John
External Links	http://www.davidsainsbury.org.uk/ http://www.parliament.uk/biographies/lords/lord-sainsbury-of-turville/2161 https://en.wikipedia.org/wiki/David_Sainsbury,_Baron_Sainsbury_of_Turville

10.4.27 Scheuer, James H.

Deceased. U.S. representative from New York; served from 1983 to 1993. In 1987, as chair of the subcommittee of the House Committee on Science and Technology that authorized funding for the DOE life sciences program, Scheuer and his staff organized hearings about the DOE human genome program.

Birth Date	1920
Death Date	2005
Gender	Male
Connections	• Scheuer, James H.
External Links	http://bioguide.congress.gov/scripts/biodisplay.pl?index=S000124 http://www.nytimes.com/2005/08/31/nyregion/james-h-scheuer-13term-new-york-congressman-is-dead-at-85.html https://en.wikipedia.org/wiki/James_H._Scheuer

10.4.28 Snell, Rand

Rand Snell was a legislative aide to Lawton Chiles. He was involved in discussions and consultations about the DOE's leadership role in the HGP.

Gender	Male
Connections	• Snell, Rand • U.S. Senate/Archives
External Links	http://www.randsnell.com/biography.html http://www.nap.edu/read/1793/chapter/5#138

10.4.29 Stephens, Michael

Michael Stephens was an aide to congressman William Natcher, and on the staff of the House Appropriations Committee for 31 years, providing support to legislators making resource allocation decisions.

Gender	Male

Connections	• Stephens, Michael
External Links	http://www.prnewswire.com/ . . .

10.4.30 Weicker, Lowell

Served as a U.S. Representative from Connecticut, 1969-1971; U.S. senator from Connecticut, 1971-1989; and the 85th Governor of Connecticut, 1991-1995.

In 1985, Weicker sponsored the Protection and Advocacy for the Mentally Ill Act. In 1988, Weicker was the chairman of the Senate appropriations subcommittee for NIH. He was moderately enthusiastic about the HGP. In 1988, he introduced the legislation that became the Americans with Disabilities Act (ADA).

Weicker was a strong advocate for HIV/AIDS research. In 1989, he became the first president of Research!America, "the nation's largest not-for-profit public education and advocacy alliance working to make research to improve health a higher national priority."

Birth	1931
Gender	Male
Connections	• U.S. Senate/Archives • Weicker, Lowell
External Links	http://bioguide.congress.gov/scripts/biodisplay.pl?index=w000253 http://www.nga.org/cms/home/governors/past-governors-bios/page_connecticut/col2-content/main-content-list/title_weicker_lowell.html http://www.jfklibrary.org/Events-and-Awards/Profile-in-Courage-Award/Award-Recipients/Lowell-Weicker-Jr-1992.aspx https://en.wikipedia.org/wiki/Lowell_P._Weicker,_Jr.

10.4.31 Wise, Bob

33rd governor of West Virginia; served 2001–2005. U.S. representative from West Virginia; served 1983-1993. Also a member of the West Virginia Senate, 1980-1982.

At a 1991 hearing on the ethical, legal, and social implications of the HGP, Bob Wise expressed concern that knowledge of the human genome must not be used in a way "to create a new genetic underclass."

Birth	1948
Gender	Male
Connections	• Wise, Bob
External Links	http://www.wvencyclopedia.org/articles/1322 http://www.nytimes.com/1991/10/18/us/gene-experts-tell-of-possible-abuse.html

10.5 Scientists/Engineers

10.5.1 Adams, Mark

Currently Scientific Director at J. Craig Venter Institute. Former postdoc in Venter lab at NIH; developer of EST methodology; one of the founding scientists at The Institute for Genomic Research (TIGR).

Birth Date	
Gender	Male
Selected Publications	• Adams MD, et al. (1991) Complementary DNA sequencing: Expressed sequence tags and human genome project • Adams MD, et al. (2000) The genome sequence of Drosophila melanogaster • Bult CJ, et al. (1996) Complete genome sequence of the methanogenic archaeon, methanococcus jannaschii • Fleischmann RD, et al. (1995) Whole-genome random sequencing and assembly of Haemophilus influenzae rd • Fraser CM, et al. (1995) The minimal gene complement of Mycoplasma genitalium • Fraser CM, et al. (1997) Genomic sequence of a Lyme disease spirochaete, Borrelia burgdorferi • Kelley JM et al. (1999) High throughput direct end sequencing of BAC clones • Klenk HP, et al. (1997) The complete genome sequence of the hyperthermophilic, sulphate-reducing archaeon archaeoglobus fulgidus • Myers EW, et al. (2000) A whole-genome assembly of Drosophila • Nature (1995) The Genome Directory • Tomb JF, et al. (1997) The complete genome sequence of the gastric pathogen Helicobacter pylori • Venter JC, et al. (1998) Shotgun sequencing of the human genome
Connections	• Adams, Mark • Drosophila melanogaster genome sequence • ESTs (Expressed Sequence Tags) • J. Craig Venter Institute (JCVI)/Archives • National Institutes of Health (NIH)/Archives
External Links	http://www.jcvi.org/cms/about/bios/madams/ https://scholar.google.com/citations?user=hKV4ZD8AAAAJ

10.5.2 Alberts, Bruce M.

Served as Editor in Chief of Science (2009-2013); trustee of Carnegie Corporation of New York; former president of National Academy of Sciences; one of the authors of *Molecular Biology of the Cell*; former professor in Dept. of Biochemical Sciences, Princeton University; former professor and vice chair of of the Department of Biochemistry and Biophysics at the University of California, San Francisco; noted for his extensive study of the protein complexes that enable chromosome replication when living cells divide.

Chaired the NAS/NRC committee that formulated the scientific strategy for the HGP.

Birth Date	1938
Gender	Male
Selected Publications	• Burris J, Cook-Deegan R, Alberts B. (1998) The human genome project after a decade: Policy issues. Nature Genetics • Burris J, et al. (1998) The Human Genome Project after a decade: policy issues
Connections	• Alberts, Bruce M. • American Association for the Advancement of Sciences (AAAS)/Science magazine/Archives • National Academy of Sciences (NAS)/Archives • Princeton University/Archives • University of California San Francisco (UCSF) School of Medicine/Archives • University of California San Francisco (UCSF)/Archives • University of California, San Francisco
External Links	https://brucealberts.ucsf.edu/

10.5.3 Ashburner, Michael

Currently Emeritus Professor, Department of Genetics, University of Cambridge. Leading *Drosophila* geneticist and one of the leaders of the fruit fly genome jamboree organized by Celera in 2000.

Birth Date	1942
Gender	Male
Institution	University of Cambridge
Selected Publications	• Rubin GM, et al. (2000) Comparative genomics of the eukaryotes • Ashburner M, et al. (2000) Gene ontology: Tool for the unification of biology. The gene ontology consortium • Kaminker JS, et al. (2002) The transposable elements of the Drosophila melanogaster euchromatin: A genomics perspective • Adams MD, et al. (2000) The genome sequence of Drosophila melanogaster
Connections	• Ashburner, Michael • University of Cambridge/Cambridge University/Archives • The Biology of Genomes (2004-2012) • Public vs Private: Human Genome Project 1998-2000
External Links	http://www.gen.cam.ac.uk/research-groups/ashburner

10.5.4 Baltimore, David

Nobel laureate. Currently the Robert A. Millikan Professor of Biology at Caltech; was president of Caltech from 1997 to 2006. President of Rockefeller University from 1990 to 1991; president of the American Association for the Advancement of Science in 2007. Founding Director of the Whitehead Institute (MIT).

Played important role in genesis of the Human Genome Project, chairing a key NIH workshop in 1988. Author of the invited commentary that accompanied publication of the first draft of the human genome in Nature (February 2001). Chair of National Academy of Sciences panel on germline usage of CRISPR (December 2015).

Birth Date	1938
Gender	Male
Selected Publications	**Content by label** There is no content with the specified labels
Connections	• Baltimore, David • Caltech (California Institute of Technology)/Archives • Mapping the genome: The vision, the science, the implementation; What is the genome project? [A round-table discussion] (1992) • Rockefeller University/Archives
External Links	https://www.bbe.caltech.edu/content/david-baltimore

10.5.5 Bentley, David

Currently Chief Scientist at Illumina Inc. Managed development of Illumina's high-throughput next-generation sequencing platform following acquisition of Solexa in 2006.

His previous positions include Head of Human Genetics and founding Member of the Board of Management at the Wellcome Trust Sanger Institute.

Birth Date	
Gender	Male
Selected Publications	• Bentley DR, et al. (2008) Accurate whole human genome sequencing using reversible terminator chemistry • Deloukas P, et al. (1998) A physical map of 30,000 human genes • Deloukas P, et al. (2004) The DNA sequence and comparative analysis of human chromosome 10 • Dunham I, et al (1999) The DNA sequence of human chromosome 22 • Roberts RG, et al. (1993) Exon structure of the human dystrophin gene
Connections	• Bentley, David
External Links	http://library.cshl.edu/oralhistory/speaker/david-bentley/ http://www.biotechniques.com/BiotechniquesJournal/2006/September/Profile-of-David-Bentley-DPhil./biotechniques-40312.html

10.5.6 Berg, Paul

Nobel laureate (Chemistry, 1980). Professor emeritus at Stanford University. Chairman of Whitehead Institute Board of Advisory Scientists at MIT.

Father of recombinant DNA technology that gave rise to genetic engineering and biotechnology.

Birth Date	1926
Gender	Male
Selected Publications	• Berg P. (2006) Origins of the human genome project: Why sequence the human genome when 96% of it is junk?
Connections	• Berg, Paul • Stanford University • Stanford University/Archives
External Links	https://med.stanford.edu/profiles/paul-berg http://profiles.nlm.nih.gov/ps/retrieve/Narrative/CD/p-nid/257 http://www.nobelprize.org/nobel_prizes/chemistry/laureates/1980/berg-bio.html http://www.chemheritage.org/discover/online-resources/chemistry-in-history/themes/pharmaceuticals/preserving-health-with-biotechnology/berg-boyer-cohen.aspx

10.5.7 Birney, Ewan

Bioinformatician. Joint Director, EMBL-European Bioinformatics Institute (EMBL-EBI), Hinxton, UK. Co-founder, Ensembl project. Led the international consortium that conducted analysis for the ENCODE project.

Birth Date	1972
Gender	Male
Selected Publications	• Dunham I, et al (2012) An integrated encyclopedia of DNA elements in the human genome • Lander ES, et al. (2001) Initial sequencing and analysis of the human genome • Waterston RH, et al. (2002) Initial sequencing and comparative analysis of the mouse genome
Connections	• Birney, Ewan • Durbin, Richard
External Links	https://www.ebi.ac.uk/~birney/

10.5.8 Bodmer, Walter

Currently Head of the Cancer and Immunogenetics Laboratory in the Weatherall Institute of Molecular Medicine at the University of Oxford. Was the director of research and then Director General of the Imperial Cancer Research Fund. Also Chancellor of the University of Salford, England, and Principal of Hertford

College, Oxford. With Peter Donnelly led a £2.3 million project by the Wellcome Trust to examine the genetic makeup of the United Kingdom - the People of the British Isles project.

Birth Date	1936
Gender	Male
Selected Publications	• Solomon E, Bodmer WF (1979) Evolution of sickle variant gene
Connections	• Bodmer, Walter • The Book of Man: The Human Genome Project and the Quest to Discover Our Genetic Heritage
External Links	http://www.imm.ox.ac.uk/walter-bodmer-2 http://www.oncology.ox.ac.uk/research/walter-bodmer http://www.bodley.ox.ac.uk/dept/scwmss/wmss/online/modern/bodmer/bodmer.html http://www.peopleofthebritishisles.org/

10.5.9 Botstein, David

Currently chief scientific officer, Calico Genomics; Professor Emeritus, Princeton University.

Formerly Director of the Lewis-Sigler Institute for Integrative Genomics at Princeton University; Professor of Genetics at MIT; Chairman of the Department of Genetics at Stanford University. Also worked for Genentech, as Vice President - Science.

Co-developer of the strategy used in the mapping efforts that predated and enabled the sequencing phase of the Human Genome Project. Co-developed a statistical method and graphical interface that is widely used to interpret genomic data including microarray data.

Birth Date	1942
Gender	Male
Selected Publications	• Ashburner M, et al. (2000) Gene ontology: Tool for the unification of biology. The gene ontology consortium • Botstein D, et al. (1980) Construction of a genetic-linkage map in man using restriction fragment length polymorphisms • Donis-Keller H, et al. (1987) A genetic linkage map of the human genome • Olson M, et al. (1989) A common language for physical mapping of the human genome • Olson M, Hood L, Cantor C, Botstein D. (1989) A common language for physical mapping of the human genome. Science
Connections	• Botstein, David • Genentech • Human genome, genetic linkage map, average marker spacing 0.7 cM • Mapping the genome: The vision, the science, the implementation; What is the genome project? [A round-table discussion] (1992) • MIT (Massachusetts Institute of Technology)/Archives • Princeton University/Archives • Stanford University/Archives

External Links	http://www.princeton.edu/genomics/botstein/ http://www.calicolabs.com/david-botstein/

10.5.10 Boyer, Herbert

Retired. Co-founder of Genentech; served as Vice President of Genentech from 1976 through his retirement in 1991.

Birth Date	1936
Gender	Male
Selected Publications	**Content by label** There is no content with the specified labels
Connections	• Boyer, Herbert • University of California, San Francisco
External Links	http://www.gene.com/about-us/leadership/our-founders http://www.dnaftb.org/34/bio-2.html http://www.chemheritage.org/discover/online-resources/chemistry-in-history/themes/pharmaceuticals/preserving-health-with-biotechnology/berg-boyer-cohen.aspx http://www.whatisbiotechnology.org/people/Boyer

10.5.11 Branscomb, Elbert

Currently Affiliate Faculty, Department of Physics and Biocomplexity Theme, Carl R. Woese Institute for Genomic Biology (IGB), University of Illinois (2008-present)

Formerly Director (1996-2000) and Chief Scientist (2000-2004) of the DOE Joint Genome Institute. Assumed responsibility in 1986 for the computational and mathematical component of LLNL's human genome program

Birth Date	
Gender	Male
Selected Publications	• Ashworth LK, et al. (1995) An integrated metric physical map of human chromosome 19 • Grimwood J, et al. (2004) The DNA sequence and biology of human chromosome 19 • Lander ES, et al. (2001) Initial sequencing and analysis of the human genome • Martin J, et al. (2004) The sequence and analysis of duplication-rich human chromosome 16 • Schmutz J, et al. (2004) The DNA sequence and comparative analysis of human chromosome 5
Connections	• Branscomb, Elbert
External Links	astrobiology.illinois.edu/faculty/branscomb http://library.cshl.edu/oralhistory/speaker/elbert-branscomd/ https://astrobiology.nasa.gov/directory/people/branscomb-elbert/

10.5.12 Brenner, Sydney

Nobel laureate. Proposed the concept of a messenger RNA; with Francis Crick and Leslie Barnett, genetically demonstrated the triplet nature of the code of protein translation. Proposed random cDNA sequencing strategy that gave rise to expressed sequence tags. Used *Caenorhabditis elegans* as a model organism for the investigation of animal development including neural development. Promoted use of puffer fish as model organism with compact genome (little junk DNA). With Prof. Pieczenik, created the first computer matrix analysis of nucleic acids using TRAC. Founded the Molecular Sciences Institute and is currently associated with the Salk Institute, the Institute of Molecular and Cell Biology, the Singapore Biomedical Research Council and the Janelia Farm Research Campus, Howard Hughes Medical Institute.

Birth Date	1927
Gender	Male
Selected Publications	• Aparicio S, et al. (2002) Whole-genome shotgun assembly and analysis of the genome of Fugu rubripes • Brenner S. (1992) That lonesome grail: The code of codes: Scientific and social issues in the human genome project. Nature • Lewis BP, et al. (2003) Evidence for the widespread coupling of alternative splicing and nonsense-mediated mRNA decay in humans
Connections	• Biological Research/Methods Development • Brenner, Sydney • C. elegans (nematode) • Fugu • Junk DNA • Laboratory of Molecular Biology, Cambridge (LMB) • Louis Jeantet Foundation • Medical Research Council (MRC) • National Academy of Sciences (NAS) • Sydney Brenner starts a small genome initiative at MRC (1986) • Sydney Brenner urges the EU to undertake a concerted program to map and sequence the human genome (1986)
External Links	http://www.salk.edu/faculty/brenner.html http://www.nobelprize.org/nobel_prizes/medicine/laureates/2002/brenner-bio.html https://www.hhmi.org/scientists/sydney-brenner http://library.cshl.edu/personal-collections/sydney-brenner http://wellcomelibrary.org/collections/digital-collections/makers-of-modern-genetics/digitised-archives/sydney-brenner/

10.5.13 Caskey, C. Thomas

President of the Human Genome Organization (HUGO) from 1993-1995. Former president of the American Society of Human Genetics. Chair of the Board of Directors of Genome Canada. Director Emeritus, The Washington Advisory Group; Director and CEO of The Brown Foundation Institute of Molecular Medicine and the George & Cynthia Mitchell Distinguished Chair in the neurosciences, as well as Executive Vice President

of Molecular Medicine and Genetics of the University of Texas Health Science Center at Houston. Served as Chief Executive Officer and President of Cogene Ventures. Research with Nobel Laureate Marshall Nirenberg proved the universality of the genetic code. Professor (and former chair) of Molecular and Human Genetics at Baylor College of Medicine, where his group discovered genes for fragile X syndrome, myotonic dystrophy.

Gender	Male
Selected Publications	• Kunkel LM, et al. (1986) Analysis of deletions in DNA from patients with Becker and Duchenne muscular dystrophy ASHG Human Genome Committee Report, 1991
Connections	• Caskey, C. Thomas
External Links	https://www.bcm.edu/people/view/b2691b26-ffed-11e2-be68-080027880ca6

10.5.14 Chakrabarty, Ananda

Ananda Chakrabarty, a genetic engineer, was involved in a famous Supreme Court case related to molecular biology and biotechnology, Diamond v. Chakrabarty. This case examined whether genetically modified microorganisms could be patented; the court ruled in 1980 that such patenting was permissible.

The case had a profound impact on the future of the biological sciences, particularly in the controversy over patenting during the Human Genome Project.

Name	Chakrabarty, Ananda
Gender	Male

10.5.15 Chakravarti, Aravinda

Aravinda Chakravarti is professor of medicine at the Johns Hopkins School of Medicine. He is also the director of the Center for Complex Disease Genomics at the same institution.

As a scientist, Chakravarti's specialty has been data analysis, especially in studying the genetic basis of complex disorders. He has developed methodologies widely used by other researchers, and his work in these areas has been integral to the field of genomics in general and to the Human Genome Project in particular.

Birth	1954
Connections	http://www.the-scientist.com/?articles.view/articleNo/32967/title/The-Road-Less-Traveled/

10.5.16 Chen, Ellson

Ellson Chen is a specialist in large-scale DNA sequencing. During the Human Genome Project, he was Principal Scientist at Celera Genomics. Before that, from 1980 to 1992, he was a senior scientist at Genentech.

Chen completed part of his post-doctoral training with Fred Sanger, the father of DNA sequencing, at the MRC Laboratory at the University of Cambridge.

Gender	Male
Connections	Fred Sanger
Links	http://www.bloomberg.com/research/stocks/private/person.asp?personId=4099684&privcapId=241607919 https://www.washingtonpost.com/archive/lifestyle/wellness/1987/02/24/the-tedious-process-of-sequencing-a-gene/ca51d8ff-83b2-4be3-8efe-fdf51adbb643/

10.5.17 Church, George

Geneticist. Invented some of the first methods for direct genome sequencing, molecular multiplexing, barcoding, and gene editings. Founder of the Personal Genome Project.

Robert Winthrop Professor of Genetics at Harvard Medical School; Professor of Health Sciences and Technology at Harvard and MIT. Founding Member, Wyss Institute for Biologically Inspired Engineering at Harvard. Founding Director, Personal Genome Project

Birth Date	1954
Gender	Male
Selected Publications	• Church GM, Gilbert W. (1984) Genomic sequencing • Cohen BA, et al. (2000) A computational analysis of whole-genome expression data reveals chromosomal domains of gene expression • Lunshof JE et al. (2010) Personal genomes in progress: From the human genome project to the personal genome project. Dialogues in Clinical Neuroscience • Shendure J, et al. (2005) Accurate multiplex polony sequencing of an evolved bacterial genome
Connections	• Church, George • Harvard University • Human Genome Project (HGP) History (a personal account) • Multiplex (Polony) sequencing • Scientific/Technological • The Early Years 1990-1997
External Links	http://arep.med.harvard.edu/gmc/

10.5.18 Churcher, Carol

Carol Churcher is

Links

10.5.19 Cohen, Daniel

Chairman & Chief Executive Officer, Pharnext.

Professor of Medical Genetics, co-founder of CEPH, Genethon (France) and Millennium Pharmaceuticals. Developed tools and resources for physical genome mapping in the early 1990s.

Former CSO at Genset.

Birth Date	ca 1953
Gender	Male
Selected Publications	• Page:Albertsen HM, et al. (1990) Construction and characterization of a yeast artificial chromosome library containing seven haploid human genome equivalents • Page:Dausset J, et al. (1990) Centre d'etude du polymorphisme humain (ceph): Collaborative genetic mapping of the human genome • Page:Gemmill RM, et al. (1995) An integrated YAC contig map for human-chromosome-3
Connections	**Content by label** There is no content with the specified labels
External Links	http://www.prnewswire.com/news-releases/dr-daniel-cohen-receives-the-academy-of-achievements-golden-plate-award-for-his-contributions-to-medicine-74910412.html http://www.pharnext.com/about-us/people/founders

10.5.20 Cohen, Stanley

Medical researcher and teacher at the Albert Einstein College of Medicine. Collaborated with Herbert Boyer at UCSF on cloning experiments, and the two scientists created modern recombinant DNA technology.

Birth Date	1935
Gender	Male
Selected Publications	• Brennecke J, Cohen SM. (2003) Towards a complete description of the microRNA complement of animal genomes • Stark A, et al. (2003) Identification of Drosophila microRNA targets
Connections	• Cohen, Stanley • Stanford University
External Links	http://www.gene.com/about-us/leadership/our-founders

	http://www.chemheritage.org/discover/online-resources/chemistry-in-history/themes/pharmaceuticals/preserving-health-with-biotechnology/berg-boyer-cohen.aspx

10.5.21 Collins, Francis S.

Director of the National Institutes of Health (NIH).

Director of the National Human Genome Research Institute at the NIH, 1993-2008. Self-described “field marshal” of the Human Genome Project. Co-discoverer of genes for cystic fibrosis, neurofibromatosis type 1, and Huntington's disease, among others.

Previously he was a Howard Hughes Medical Institute investigator at the University of Michigan. Author of *The Language of God* and *The Language of Life.*

Birth Date	1950
Gender	Male
Books Published	1. Gelehrter TD, Collins FS, Ginsburg D. *Principles of Medical Genetics, 2nd Edition* (Williams & Wilkins, 1998). 2. Collins FS. *The Language of God: A Scientist Presents Evidence For Belief* (Free Press, 2006).3. Collins FS. *The Language of Life: DNA and the Revolution in Personalized Medicine* (HarperCollins,2010).4. Collins FS. *Belief: Readings on the Reason for Faith* (HarperCollins, 2010).5. Giberson KW, Collins FS. *The Language of Science and Faith* (IVP Books, 2011).
Selected Publications	• Altshuler D, et al. (2010) A map of human genome variation from population-scale sequencing • Collins F, Galas D. (1993) A new five-year plan for the U.S. Human Genome Project. Science • Collins F. (2010) Has the revolution arrived? Nature • Collins FS, et al. (1998) A DNA polymorphism discovery resource for research on human genetic variation • Collins FS, et al. (1998) New goals for the U.S. Human Genome Project: 1998-2003 • Collins FS, et al. (2003) A vision for the future of genomics research • Collins FS, et al. (2003) The human genome project: Lessons from large-scale biology • Collins FS, et al. (2004) Finishing the euchromatic sequence of the human genome • Collins FS, Mansoura MK. (2001) The human genome project. Revealing the shared inheritance of all humankind. Cancer • Collins FS, Patrinos A, Jordan E, Chakravarti A, Gesteland R, Walters L. (1998) New goals for the U.S. Human genome project: 1998-2003. Science • Collins FS. (1991) Medical and ethical consequences of the human genome project. The Journal of Clinical Ethics • Collins FS. (1995) Evolution of a vision: Genome project origins, present and future challenges, and far-reaching benefits. Part 2. Human Genome News • Collins FS. (1999) Shattuck Lecture--Medical and societal consequences of the human genome project. The New England Journal of Medicine • Fink L, Collins FS. (1997) The human genome project: View from the national institutes of health. Journal of the American Medical Women's Association • Green ED, et al. (2015) Human Genome Project: Twenty-five years of big biology 23 related results
Connections	• AAAS Meeting (2001) • Advances in Genetics Research and Technologies: Challenges for Public Policy, to the Senate Committee on Labor and Human Resources (1996)

	• Biological Research/Methods Development • Collins, Francis S. • Congressional Task Force on Health Records and Genetic Privacy Preventing Genetic Discrimination in Health Insurance (1997) • Healy, Bernadine • National Center for Human Genome Research (NCHGR) • National Institutes of Health (NIH) Office of History/Archives • Patrinos, Aristides • Positional cloning method described by Collins and Weissman • Public vs Private: Human Genome Project 1998-2000 • Questions and controversies • Scientific/Technological • Software/Database Development • The Early Years 1990-1997 • The Language of Life: DNA and the Revolution in Personalized Medicine • U.S. Senate • University of Michigan • Venter, J. Craig
External Links	http://www.nih.gov/about/director/ https://www.genome.gov/10001018 http://www.genome.gov/Pages/About/Organization/OD/Collins_CV_Through_07272015.pdf - Curriculum Vitae https://www.youtube.com/watch?v=slRyGLmt3qc

10.5.22 Coulson, Alan R.

Joined Fred Sanger at the MRC Laboratory of Molecular Biology (LMB) in Cambridge in 1967 as a lab technician.

With Sanger, developed the chain-termination, or dideoxy, method of DNA sequencing, which was adopted in the automated sequencing machines used in the Human Genome Project.

Gender	Male
Selected Publications	• Deloukas P, et al. (2004) The DNA sequence and comparative analysis of human chromosome 10 • Dunham A, et al (2004) The DNA sequence and analysis of human chromosome 13 • Gregory SG, et al. (2006) The DNA sequence and biological annotation of human chromosome 1 • Humphray SJ, et al. (2004) DNA sequence and analysis of human chromosome 9 • Lander ES, et al. (2001) Initial sequencing and analysis of the human genome • Mungall AJ, et al. (2003) The DNA sequence and analysis of human chromosome 6 • Ross MT, et al. (2005) The DNA sequence of the human X chromosome • Sanger F, et al. (1977) DNA sequencing with chain-terminating inhibitors • Sanger F, et al. (1977) Nucleotide sequence of bacteriophage φX174 DNA • Sanger F, Nicklen S, Coulson AR. (1977) DNA sequencing with chain-terminating inhibitors • Waterston RH, et al. (2002) Initial sequencing and comparative analysis of the mouse genome

Connections	• Coulson, Alan R. • Medical Research Council (MRC) • Sequencing Methods/Technology • Sequencing Methods/Technology Development
External Links	http://wellcomelibrary.org/collections/digital-collections/makers-of-modern-genetics/digitised-archives/alan-coulson/

10.5.23 Cox, David R.

Deceased. In 2008, joined Pfizer genomic medicine group.

1993–2003 – Faculty member in the Departments of Genetics and Pediatrics at Stanford University. With Richard Myers, codirected the UCSF and Stanford Human Genome Centers.

2001 – Co-founder Perlegen Sciences, which produced one of the first large-scale haplotype maps.

Developed and applied radiation hybrid mapping method.

Served on the National Bioethics Advisory Commission, the Health Sciences Policy Board of the Institute of Medicine of the National Academy of Sciences, the Board of the American Society for Human Genetics and the Council of the Human Genome Organization.

Birth Date	1946
Death Date	2013
Gender	Male
Selected Publications	• Deloukas P, et al. (1998) A physical map of 30,000 human genes • Hillier LW, et al. (2005) Generation and annotation of the DNA sequences of human chromosomes 2 and 4 • Lander ES, et al. (2001) Initial sequencing and analysis of the human genome
Connections	• Cox, David R. • Mapping the genome: The vision, the science, the implementation; What is the genome project? [A round-table discussion] (1992) • Pfizer
External Links	http://www.nature.com/ng/journal/v45/n7/full/ng.2679.html

10.5.24 Crick, Francis

Deceased. Nobel laureate (1962) in Physiology or Medicine with James Watson and Maurice Wilkins, "for their discoveries concerning the molecular structure of nucleic acids and its significance for information transfer in living material."

Was a faculty member at the Salk Institute in San Diego from 1977 to 2004.

During World War II, worked as a scientist for the Admiralty Research Laboratory.

1947 - Went to Cambridge, supported by a studentship from the Medical Research Council (MRC).

1949 - Joined the MRC Unit headed by Max Perutz, which later became the MRC Laboratory of Molecular Biology (LMB); obtained his PhD in 1954 for his work on the X-ray crystallography of proteins.

Birth Date	1916
Death Date	2004
Gender	Male
Selected Publications	• Watson JD, Crick FH (1953) Molecular structure of nucleic acids; a structure for deoxyribose nucleic acid
Connections	• Crick, Francis • Double helix, structure of DNA • University of California at San Diego (UCSD)/Archives • Watson, James D. • X-ray crystallography
External Links	http://wellcomelibrary.org/collections/digital-collections/makers-of-modern-genetics/digitised-archives/francis-crick/ http://profiles.nlm.nih.gov/SC/Views/Exhibit/narrative/doublehelix.html http://www.crick.ac.uk/about-us/francis-crick/

10.5.25 DeLisi, Charles

Metcalf Professor of Science and Engineering at Boston University; former Dean of the College of Engineering (1990-2000). Initiated first PhD program in Bioinformatics in 1999. Former Director of the U.S. Department of Energy's (DOE) Health and Environmental Research Programs. Played key role in conceiving the Human Genome Project.

Birth Date	1941
Gender	Male
Selected Publications	• Delisi C. (1988) The human genome project. American Scientist • Delisi C. (2001) Genomes: 15 years later. A perspective by Charles Delisi, HGP pioneer. Human Genome News • DeLisi C. (2008) Meetings that changed the world: Santa Fe 1986: Human genome baby-steps • DeLisi, C. (1988). The Human Genome Project: The ambitious proposal to map and decipher the complete sequence of human DNA. American Scientist, 76(5), 488-493.
Connections	• Biological Research/Methods Development • DeLisi, Charles • Los Alamos National Laboratory (LANL)/Archives • Office of Health and Environmental Research (OHER) • U.S. Department of Energy (DOE) • US Department of Energy (DOE)/DOE Joint Genome Institute (DOE JGI)/Archives
External Links	http://www.bu.edu/bme/people/primary/delisi/

	http://library.cshl.edu/personal-collections/charles-delisi http://library.cshl.edu/oralhistory/speaker/charles-delisi/ http://www.osti.gov/accomplishments/genomeDOEorigins.html

10.5.26 Donis-Keller, Helen

10.5.27 Dovichi, Norman

Grace Rupley Professor of Chemistry and Biochemistry, University of Notre Dame. In 1986, at the University of Alberta, he developed the multi-capillary detection method for automated sequencing DNA, which was commercially exploited by Applied Biosystems.

Gender	Male
Selected Publications	**Content by label** There is no content with the specified labels
Connections	• Capillary sequencing • Dovichi, Norman
External Links	http://njdgroup.nd.edu/DovichiGroup.html http://chemistry.nd.edu/people/norman-dovichi/

10.5.28 Dulbecco, Renato

Deceased. Nobel laureate (1975, Physiology or Medicine) for work on oncoviruses. Authored influential commentary in Science in 1987 on the future of cancer research that helped galvanize support for the Human Genome Project.

Birth Date	1914
Death Date	2012
Gender	Male
Selected Publications	• Dulbecco R. (1986) A turning point in cancer research: sequencing the human genome
Connections	• Biological Research/Methods Development • Dulbecco, Renato • Salk Institute
External Links	http://www.nytimes.com/2012/02/21/us/dr-renato-dulbecco-nobel-laureate-dies-at-97.html?_r=0 https://www.washingtonpost.com/national/health-science/renato-dulbecco-who-won-a-nobel-for-virus-research-dies-at-97/2012/02/20/gIQAU9e8PR_story.html http://www.nobelprize.org/nobel_prizes/medicine/laureates/1975/dulbecco-bio.html

	http://www.salk.edu/insidesalk/articlew.php?id=334 http://library.cshl.edu/oralhistory/speaker/renato-dulbecco/

10.5.29 Dunham, Ian

Staff scientist, European Bioinformatics Institute/EMBL. Previously senior investigator at the Wellcome Trust Sanger Institute, where he led the sequencing of human chromosome 22.

Gender	Male
Selected Publications	• Dunham I, et al (1999) The DNA sequence of human chromosome 22 • Dunham I, et al (2012) An integrated encyclopedia of DNA elements in the human genome • Humphray SJ, et al. (2004) DNA sequence and analysis of human chromosome 9 • Lander ES, et al. (2001) Initial sequencing and analysis of the human genome • Mungall AJ, et al. (2003) The DNA sequence and analysis of human chromosome 6
Connections	• Chromosome 13, sequence • Chromosome 22, complete sequence • Dunham, Ian • Public vs Private: Human Genome Project 1998-2000 • Wellcome Trust Sanger Institute/Archives
External Links	http://www.ebi.ac.uk/about/people/ian-dunham http://www.targetvalidation.org/leadership/dr-ian-dunham http://library.cshl.edu/oralhistory/speaker/ian-dunham/

10.5.30 Durbin, Richard

Richard Durbin is Senior Group Leader at the Wellcome Trust Sanger Institute, where he specializes in computational genomics.

In the past, he worked on the *C. elegans* genome at the MRC Laboratory of Molecular Biology and, after joining the Sanger Institute in 1992, contributed to the Human Genome Project. On coming to the institute, he held various titles, such as deputy director and acting head of computational genomics.

Durbin has been an important figure in developing technologies for computational sequence analysis. In particular, he worked with Ewan Birney to create GeneWise.

He has also worked on the 1000 Genomes Project.

Birth	1960
Gender	Male
Keywords	computational genomics, sequence analysis
Connections	Ewan Birney
Links	https://dovetailgenomics.com/company/advisory-board/

10.5.31 Eichler, Evan

Professor of Genome Sciences at the University of Washington and an HHMI investigator.

In 2008, Eichler was the co-author of a study arguing that the reference genome produced by the Human Genome Project contained many inaccuracies. In 2002, while a scientist at Case Western Reserve University, Eichler was finding errors before the HGP's reference sequence was even completed.

Birth	1968
Institution	University of Washington
Links	https://eichlerlab.gs.washington.edu/evan.html http://www.scientificamerican.com/article/are-there-missing-pieces/ http://www.bio-itworld.com/2014/6/30/hunt-new-human-reference-genome.html

10.5.32 Fraser, Claire

Director of the Institute for Genome Sciences and Professor of Medicine at the University of Maryland School of Medicine in Baltimore, Maryland. Former president and director, The Institute for Genomic Research (TIGR). A leader in the sequencing of human, plant, animal and bacterial genomes. Led teams that completed whole-genome shotgun sequencing of several bacterial species.

Birth Date	1955
Gender	Female
Selected Publications	• Bult CJ, et al. (1996) Complete genome sequence of the methanogenic archaeon, methanococcus jannaschii • Fleischmann RD, et al. (1995) Whole-genome random sequencing and assembly of Haemophilus influenzae rd • Fraser CM, et al. (1995) The minimal gene complement of Mycoplasma genitalium • Hutchison CA, et al. (1999) Global transposon mutagenesis and a minimal mycoplasma genome • Kaul S, et al. (2000) Analysis of the genome sequence of the flowering plant arabidopsis thaliana • Nature (1995) The Genome Directory • Turnbaugh PJ, et al. (2007) The human microbiome project
Connections	• Fraser, Claire • The Early Years 1990-1997 • Women in Sequencing
External Links	http://medschool.umaryland.edu/FACULTYRESEARCHPROFILE/viewprofile.aspx?id=20004

10.5.33 Frazer, Kelly

10.5.34 Gabriel, Stacey

10.5.35 Gibbs, Richard

Founder and director of the Human Genome Sequencing Center, the Wofford Cain Chair and Distinguished Service Professor in Molecular and Human Genetics at the Baylor College of Medicine. Led one of the five U.S. genome centers selected in 1996 to drive the Human Genome Project. Awarded Companion of the Order of Australia (2014).

Gender	Male
Selected Publications	• Adams MD, et al. (2000) The genome sequence of Drosophila melanogaster • Altshuler D, et al. (2010) A map of human genome variation from population-scale sequencing • Lander ES, et al. (2001) Initial sequencing and analysis of the human genome • Muzny DM, et al. (2006) The DNA sequence, annotation and analysis of human chromosome 3 • Ross MT, et al. (2005) The DNA sequence of the human X chromosome • Scherer SE, et al. (2006) The finished DNA sequence of human chromosome 12 • Waterston RH, et al. (2002) Initial sequencing and comparative analysis of the mouse genome
Connections	• Baylor College of Medicine/Archives • Genome Mapping, Sequencing, and Biology (1998) • Genome Sequencing and Biology (1999-2002) • Gibbs, Richard
External Links	https://www.bcm.edu/people/view/b1560782-ffed-11e2-be68-080027880ca6 https://www.hgsc.bcm.edu/content/richard-gibbs-phd

10.5.36 Gilbert, Walter

Nobel laureate (1980 in chemistry) shared with colleague Allan Maxam for chemical cleavage method of DNA sequencing. Physicist by training, professor at Harvard University; co-founder of Biogen Inc. and Myriad Genetics. Proposed $3 billion price tag for Human Genome Project ($1/base).

Birth Date	1932
Gender	Male
Selected Publications	• Bork P, et al. (1995) Exploring the mycoplasma capricolum genome: A minimal cell reveals its physiology • Church GM, Gilbert W. (1984) Genomic sequencing • Gilbert W (1981) DNA sequencing and gene structure Nobel lecture • Gilbert W, Muller-Hill B (1966) Isolation of the lac repressor • Maxam AM, Gilbert W (1977) A new method for sequencing DNA

Connections	• Biological Research/Methods Development • Genome Corporation • Gilbert, Walter • Maxam, Allan M. • Maxam-Gilbert DNA sequencing method • Sequencing Methods/Technology • Sequencing Methods/Technology Development • Witunski, Michael
External Links	http://www.bioventuresinvestors.com/bioventures/Walter%20Gilbert http://www.nobelprize.org/nobel_prizes/chemistry/laureates/1980/gilbert-bio.html http://library.cshl.edu/personal-collections/walter-gilbert

10.5.37 Green, Eric

Since 2009, Eric Green has been the director of the National Human Genome Research Institute at the National Institutes of Health.

Before holding that position, Green was the NHGRI's scientific director from 2002 to 2009. Previously he was head of the NHGRI Genome Technology Branch from 1996 to 2009 and director of the NIH Intramural Sequencing Center from 1997 to 2009.

Green was heavily involved in the Human Genome Project from its earliest years, conducting significant research in mapping and sequencing eukaryotic genomes.

Birth Date	1959
Gender	Male
Selected Publications	• Altshuler D, et al. (2010) A map of human genome variation from population-scale sequencing • Collins FS, et al. (2003) A vision for the future of genomics research • Dunham I, et al (2012) An integrated encyclopedia of DNA elements in the human genome • Hillier LW, et al (2003) The DNA sequence of human chromosome 7 • Waterston RH, et al. (2002) Initial sequencing and comparative analysis of the mouse genome
Connections	• Genome Mapping and Sequencing (1988-1997) • Green, Eric
External Links	http://www.genome.gov/27535200 http://www.biotechniques.com/BiotechniquesJournal/2011/February/Profile-of-Eric-Green/biotechniques-308915.html http://www.peoplebehindthescience.com/dr-eric-green/ http://library.cshl.edu/oralhistory/speaker/eric-green/ https://www.youtube.com/watch?v=drXixcR8Zjo

10.5.38 Green, Philip

Bioinformatician at the University of Washington. Developed Phred and Phrap software for quality assessment of DNA sequencing data.

Gender	Male
Selected Publications	• Ewing B, et al. (1998) Base-calling of automated sequencer traces using phred • Green P (1999) Documentation for phrap and cross_match
Connections	• Green, Philip • PHRAP • PHRED • STS (Sequence-Tagged Sites) • Whole-genome shotgun method
External Links	http://www.phrap.org/ http://www.gs.washington.edu/faculty/green.htm http://www.pnas.org/content/101/39/13991.full http://library.cshl.edu/oralhistory/interview/genome-research/involvement-genomics/green-involvement-genomics/

10.5.39 Guyer, Mark

Retired. Founding member of the Office of Human Genome Research (OHGR), the forerunner of NHGRI. Director NHGRI Division of Extramural Research (2002-2014). Played key administrative roles in the Human Genome Project.

Gender	Male
Selected Publications	• Altshuler D, et al. (2010) A map of human genome variation from population-scale sequencing • Collins FS, et al. (2003) A vision for the future of genomics research • Green ED, Guyer MS. (2011) Charting a course for genomic medicine from base pairs to bedside. • Guyer MS, Collins FS. (1993) The human genome project and the future of medicine. American Journal of Diseases of Children • Lander ES, et al. (2001) Initial sequencing and analysis of the human genome • NIH/CEPH Collaborative Mapping Group (1992) A comprehensive genetic-linkage map of the human genome • Peterson J, et al. (2009) The NIH human microbiome project • Waterston RH, et al. (2002) Initial sequencing and comparative analysis of the mouse genome • Wolfsberg TG et al. (2002) A user's guide to the human genome. Nature Genetics
Connections	• Guyer, Mark
External Links	https://www.genome.gov/27558113

10.5.40 Handelsman, Jo

10.5.41 Haussler, David

UC Santa Cruz Distinguished Professor of Biomolecular Engineering; HHMI investigator. Co-founder Genome 10K Project. Leading bioinformatician who helped develop the first human genome browser in 2000.

Birth Date	1953
Gender	Male
Selected Publications	• Altshuler D, et al. (2010) A map of human genome variation from population-scale sequencing • Dunham I, et al (2012) An integrated encyclopedia of DNA elements in the human genome • Karolchik D, et al. (2003) The UCSC genome browser database • Kundaje A, et al. (2015) Integrative analysis of 111 reference human epigenomes • Lander ES, et al. (2001) Initial sequencing and analysis of the human genome • Waterston RH, et al. (2002) Initial sequencing and comparative analysis of the mouse genome
Connections	• Haussler, David • Public vs Private: Human Genome Project 1998-2000 • Software/Database Development • UCSC Golden Path • University of California, Santa Cruz
External Links	https://genomics.soe.ucsc.edu/haussler https://www.soe.ucsc.edu/people/haussler

10.5.42 Hood, Leroy E.

Founder and Director, Institute of Systems Biology, Seattle; founder and chairman, P4 Medicine Institute, Seattle. Previously at the University of Washington and Caltech. Visionary developer of automated technologies for synthesizing and sequencing both proteins and DNA. Co-founder of Applied Biosystems and many other biotech companies.

Birth Date	1938
Gender	Male
Selected Publications	• Aparicio S, et al. (2002) Whole-genome shotgun assembly and analysis of the genome of Fugu rubripes • Heilig R, et al. (2003) The DNA sequence and analysis of human chromosome 14 • Hood L, Rowen L. (2013) The human genome project: Big science transforms biology and medicine. Genome Medicine

	• Hunkapiller T, et al. (1991) Large-scale and automated DNA sequence determination • Lander ES, et al. (2001) Initial sequencing and analysis of the human genome • Maugh II TH (1986) Caltech scientists develop super-fast DNA analyzer • Olson M, et al. (1989) A common language for physical mapping of the human genome • Olson M, Hood L, Cantor C, Botstein D. (1989) A common language for physical mapping of the human genome. Science • Rowen L, et al. (1996) The complete 685-kilobase DNA sequence of the human beta t cell receptor locus • Smith LM, et al. (1985) The synthesis of oligonucleotides containing an aliphatic amino group at the 5' terminus: synthesis of fluorescent DNA primers for use in DNA-sequence analysis • Smith LM, et al. (1986) Fluorescence detection in automated DNA sequence analysis • Venter JC, et al. (1996) A new strategy for genome sequencing • Zody MC, et al. (2006) Analysis of the DNA sequence and duplication history of human chromosome 15
Connections	• Automated sequencing • Biological Research/Methods Development • California Institute of Technology • Hood, Leroy E. • Hunkapiller, Michael • Hunkapiller, Tim • Institute for Systems Biology (Seattle) • Mapping the genome: The vision, the science, the implementation; What is the genome project? [A round-table discussion] (1992) • Microsoft Corporation • Murray, Matthew • National Academy of Sciences (NAS) • Protein sequencing • Rosetta Inpharmatics • Sequencing Methods/Technology Development • Smith, Lloyd M. 19 related results
External Links	https://www.systemsbiology.org/bio/leroy-hood/ http://p4mi.org/leroy-hood-md-phd

10.5.43 Horvitz, H. Robert (Bob)

Nobel laureate (Physiology or Medicine, 2002) shared with Sydney Brenner and Sir John Sulston for studies on organ development and programmed cell death in C. elegans. David H. Koch Professor Biology, MIT; member, McGovern Institute for Brain Research; HHMI investigator. Pioneer in nematode genetics and biology.

Birth Date	1947
Gender	Male
Selected Publications	**Content by label** There is no content with the specified labels
Connections	• Horvitz, H. Robert (Bob)

External Links	http://web.mit.edu/horvitz/www/ http://www.nobelprize.org/nobel_prizes/medicine/laureates/2002/horvitz-bio.html https://www.hhmi.org/scientists/h-robert-horvitz

10.5.44 Hudson, Jim

A scientist and businessman, Jim Hudson founded Research Genetics in 1987. The company was a major player in the Human Genome Project, producing important genetic linkage products and also synthetic DNA. Research Genetics was acquired by Invitrogen in late 1999/early 2000.

Hudson was also a co-founder of the HudsonAlpha Institute in Huntsville, Alabama.

Birth Date	1942
Gender	Male
Selected Publications	• Deloukas P, et al. (1998) A physical map of 30,000 human genes
Connections	• Hudson, Jim • Research Genetics
External Links	http://library.cshl.edu/oralhistory/speaker/jim-hudson/

10.5.45 Hunkapiller, Michael

CEO, Pacific Biosciences. Former president, Applied Biosystems (1995-2004). Co-developer of automated DNA sequencing technology with Lee Hood and coworkers at Caltech.

Gender	Male
Selected Publications	• Smith LM, et al. (1985) The synthesis of oligonucleotides containing an aliphatic amino group at the 5' terminus: synthesis of fluorescent DNA primers for use in DNA-sequence analysis • Venter JC, et al. (1998) Shotgun sequencing of the human genome
Connections	• Hunkapiller, Michael • Protein sequencing
External Links	http://www.pacificbiosciences.com/aboutus/executives/list.html http://www.pacb.com/company/leadership/board-of-directors/ https://www.dnalc.org/view/15656-Frederick-Sanger-Michael-Hunkapiller-and-Leroy-Hood.html

10.5.46 Hunkapiller, Tim

President, Discovery Biosciences Corporation. Senior consultant for Life Technologies (1982-2014). Co-developer of automated DNA sequencing technology with Lee Hood and colleagues while at Caltech (1986).

Gender	Male
Selected Publications	• Hunkapiller T, et al. (1991) Large-scale and automated DNA sequence determination • Smith LM, et al. (1985) The synthesis of oligonucleotides containing an aliphatic amino group at the 5' terminus: synthesis of fluorescent DNA primers for use in DNA-sequence analysis
Connections	• Caltech (California Institute of Technology)/Archives • Hunkapiller, Tim
External Links	http://www.stratosgenomics.com/about/management/Tim%20Hunkapiller,%20Ph.D. https://www.genomeweb.com/pillar-genomics

10.5.47 Illig, Jeannine Gocayne

Lab technician. Educated in molecular biology at SUNY Buffalo, Illig began working at the National Institutes of Health, specifically the National Institute of Neurological Disorders and Stroke, in 1986.

According to Craig Venter, Illig "had worked alongside me in getting the very first DNA sequencer to work while at NIH in 1987." In assisting Venter, Illig was integral to a 1987 paper of Venter's that sequenced two neurotransmitter receptors. This was the first paper demonstrating that the automated sequencing machine could yield reliable data.

Venter recruited Illig to Celera in the 1990s.

Birth Date	1961
Death Date	2014
Gender	Female
Institution	NIH, NINDS, Celera Genomics
Connections	Venter, J. Craig

10.5.48 Kent, Jim

Research scientist, Center for Biomolecular Science and Engineering, University of California, Santa Cruz. Wrote the first human genome web browser, the UCSC Genome Browser, in 2000.

Birth Date	1960
Gender	Male
Selected Publications	• Dunham I, et al (2012) An integrated encyclopedia of DNA elements in the human genome • Hillier LW, et al (2003) The DNA sequence of human chromosome 7 • Lander ES, et al. (2001) Initial sequencing and analysis of the human genome

Connections	• Kent, Jim • Public vs Private: Human Genome Project 1998-2000 • Software/Database Development • UCSC Golden Path • University of California, Santa Cruz
External Links	https://cbse.soe.ucsc.edu/people/kent https://users.soe.ucsc.edu/~kent/ http://www.kentinformatics.com/about-us.html

10.5.49 King, Mary-Claire

Mary-Claire King is Professor of Genome Sciences and Medicine (Medical Genetics) at the University of Washington. She is notable for identifying BRCA1, the gene linked to the inherited susceptibility to breast cancer.

Birth	1946
Gender	Female
Keywords	BRCA1, breast cancer, women
Links	http://www.gs.washington.edu/faculty/king.htm

10.5.50 Lander, Eric

Founding Director, Broad Institute. Former Director, Whitehead Institute Center for Genome Research. Led one of major sequencing centers in the Human Genome Project, as well as the mouse genome project; first author on paper describing first draft of the human genome. Filed an important amicus brief in the landmark U.S. Supreme Court decision that overturned gene patents.

Lander is co-chair of President Obama's Council of Advisors on Science and Technology. Co-founder of Millennium Pharmaceuticals, Verastem and Foundation Medicine.

Birth Date	1957
Gender	Male
Selected Publications	• Altshuler D, et al. (2010) A map of human genome variation from population-scale sequencing • Bell CJ, et al. (1995) Integration of physical, breakpoint and genetic maps of chromosome 22. Localization of 587 yeast artificial chromosomes with 238 mapped markers • Collins FS, et al. (2004) Finishing the euchromatic sequence of the human genome • Deloukas P, et al. (1998) A physical map of 30,000 human genes • Dietrich W, et al. (1992) A genetic map of the mouse suitable for typing intraspecific crosses • Donis-Keller H, et al. (1987) A genetic linkage map of the human genome • Hudson TJ, et al. (1995) An STS-based map of the human genome • Jacob HJ, et al. (1995) A genetic linkage map of the laboratory rat, rattus norvegicus

	• Lander ES, et al. (2001) Initial sequencing and analysis of the human genome • Lander ES. (1998) Scientific commentary: The scientific foundations and medical and social prospects of the human genome project. The Journal of Law, Medicine & Ethics • Nadeau JH, et al. (2000) Analysing complex genetic traits with chromosome substitution strains • Nusbaum C, et al. (2005) DNA sequence and analysis of human chromosome 18 • Nusbaum C, et al. (2006) DNA sequence and analysis of human chromosome 8 • Ober C, et al. (1998) Genome-wide search for asthma susceptibility loci in a founder population. The collaborative study on the genetics of asthma • Sabeti PC, et al. (2002) Detecting recent positive selection in the human genome from haplotype structure 21 related results
Connections	• Biological Research/Methods Development • Broad Institute • Castro, Jose • Human genome, complete sequence draft and preliminary analysis • Lander, Eric • Scientific/Technological • The Early Years 1990-1997 • The Human Genome at 10: An Overview, Eric Lander • Whitehead Institute • Whitehead Institute, MIT/Archives
External Links	https://www.broadinstitute.org/about/bios/bio-lander.html https://biology.mit.edu/people/eric_lander https://sysbio.med.harvard.edu/facultys/eric-s-lander-phd

10.5.51 Lane, David

David Lane is Scientific Director at the Ludwig Institute for Cancer Research. Along with Lionel Crawford, Lane founded the p53 protein in 1979 – a suppressor of cell growth whose mutation is often linked to cancer.

Birth Date	
Gender	Male
Selected Publications	**Content by label** There is no content with the specified labels
Connections	• Lane, David

10.5.52 Levy, Samuel

Executive Director, Genomic Sciences at Celgene Quanticel Research. Formerly senior scientist and Director Human Genomics, J. Craig Venter Institute (2002-09), and previously senior scientist at Celera Genomics (1999-2002). Levy led the sequencing and analysis of numerous genome studies including the Venter genome, published in 2007.

Gender	Male
Selected Publications	• Dunham I, et al (2012) An integrated encyclopedia of DNA elements in the human genome
Connections	• Levy, Samuel
External Links	https://www.scripps.org/news_items/3519-samuel-levy-joins-scripps-health-as-director-of-genomic-sciences https://www.edgebio.com/scientific-advisory-board http://www.bio-itworld.com/04-16-08-webcast-samuel-levy/

10.5.53 Linton, Lauren

10.5.54 Lipman, David

Director, National Center for Biotechnology Information, NIH. Co-developer of BLAST algorithm for sequence homology searches. Oversees hosting and improvements to multiple biological databases, including Genbank.

Gender	Male
Selected Publications	• Altschul SF, et al. (1990) Basic local alignment search tool
Connections	• BLAST • GenBank database • Lipman, David • The Early Years 1990-1997
External Links	http://www.ncbi.nlm.nih.gov/research/staff/lipman/ http://irp.nih.gov/pi/david-lipman

10.5.55 Maniatis, Tom

Professor of Molecular and Cellular Biology, Columbia University, New York. Former Professor, Harvard University. Co-founder, New York Genome Center, Genetics Institute. Lead author of *Molecular Cloning: A Laboratory Manual.*

Birth Date	1943
Gender	Male
Selected Publications	**Content by label** There is no content with the specified labels

Connections	• Harvard University/Archives • Maniatis, Tom
External Links	http://www.maniatislab.columbia.edu/ http://cumc.columbia.edu/dept/gsas/biochem/faculty/maniatis.htm

10.5.56 Mardis, Elaine

Professor of Genetics, Washington University School of Medicine, St Louis; co-director McDonnell Genome Institute. With Richard Wilson, leads major U.S. genome center that has made numerous contributions especially in cancer genomics.

Birth Date	1962
Gender	Female
Selected Publications	• Altshuler D, et al. (2010) A map of human genome variation from population-scale sequencing • Dunham I, et al (1999) The DNA sequence of human chromosome 22 • Hillier LW, et al (2003) The DNA sequence of human chromosome 7 • Hillier LW, et al. (2005) Generation and annotation of the DNA sequences of human chromosomes 2 and 4 • Lander ES, et al. (2001) Initial sequencing and analysis of the human genome • Ley TJ, et al. (2008) DNA sequencing of a cytogenetically normal acute myeloid leukaemia genome • Mardis, ER. (2011) A decade's perspective on DNA sequencing technology • Skaletsky H, et al. (2003) The male-specific region of the human Y chromosome is a mosaic of discrete sequence classes • Waterston RH, et al. (2002) Initial sequencing and comparative analysis of the mouse genome
Connections	• Mardis, Elaine • Sequencing Methods/Technology Development • Washington University in St. Louis/Archives • Wilson, Richard • Women in Sequencing
External Links	http://genome.wustl.edu/people/individual/elaine-mardis/ http://genome.wustl.edu/people/groups/detail/mardis-wilson-lab/ https://www.siteman.wustl.edu/ResearcherProfile.aspx?id=1006&memid=2498

10.5.57 Maxam, Allan M.

Nobel laureate (1980, chemistry). Working with Walter Gilbert at Harvard University, he developed chemical method for DNA sequencing.

Birth Date	1942
Gender	Male
Selected Publications	• Gilbert W (1981) DNA sequencing and gene structure Nobel lecture • Maxam AM, Gilbert W (1977) A new method for sequencing DNA
Connections	• Gilbert, Walter • Harvard University/Archives • Maxam, Allan M. • Sequencing Methods/Technology • Sequencing Methods/Technology Development
External Links	http://www.nobelprize.org/nobel_prizes/chemistry/laureates/1980/gilbert-lecture.pdf https://en.wikipedia.org/wiki/Allan_Maxam

10.5.58 McCombie, W. Richard (Dick)

Professor at Cold Spring Harbor Laboratory. Pioneer of automated DNA sequencing, dating back to his early career in J. Craig Venter's lab at NIH.

Birth Date	ca 1955
Gender	Male
Selected Publications	• Adams MD, et al. (1991) Complementary DNA sequencing: Expressed sequence tags and human genome project • Kaul S, et al. (2000) Analysis of the genome sequence of the flowering plant arabidopsis thaliana • Lander ES, et al. (2001) Initial sequencing and analysis of the human genome • Martin-Gallardo A, et al. (1992) Automated DNA sequencing and analysis of 106 kilobases from human chromosome 19q13.3 • McCombie WR, et al. (1992) Expressed genes, Alu repeats and polymorphisms in cosmids sequenced from chromosome 4p16.3 • Waterston RH, et al. (2002) Initial sequencing and comparative analysis of the mouse genome
Connections	• ABI 370 (373) DNA sequencing instruments • Cold Spring Harbor Laboratory (CSHL)/Archives • McCombie, W. Richard (Dick)
External Links	http://mccombielab.labsites.cshl.edu/ http://www.cshl.edu/Faculty/Richard-W-McCombie.html https://youtu.be/uqEdFyymfbY

10.5.59 McKusick, Victor

Deceased. Medical geneticist. Former University Professor of Medical Genetics and Professor of Medicine at the Johns Hopkins Hospital. Founded and edited Mendelian Inheritance in Man, the essential catalog of human genetic traits and disorders.

Birth Date	1921
Death Date	2008
Gender	Male
Selected Publications	• Hamosh A, et al. (2000) Online Mendelian inheritance in man (OMIM) • Hamosh A, et al. (2002) Online Mendelian Inheritance in Man (OMIM), a knowledgebase of human genes and genetic disorders • McKusick VA. (1989) Hugo news. The human genome organisation: History, purposes, and membership. Genomics • McKusick VA. (1991) Current trends in mapping human genes. FASEB journal
Connections	• Biological Research/Methods Development • Cold Spring Harbor Symposia on Quantitative Biology: Human Genetics, Vol. XXIX (1964) • March of Dimes • McKusick, Victor • Online Mendelian Inheritance in Man (OMIM) • The Origins of ELSI
External Links	http://www.hopkinsmedicine.org/news/media/releases/victor_a_mckusick_md_father_of_medical_genetics_1921_2008 http://www.medicalarchives.jhmi.edu/papers/mckusick.html http://profiles.nlm.nih.gov/JQ/ http://www.nytimes.com/2008/07/24/health/24mckusick.html

10.5.60 McPherson, John

John McPherson is an associate researcher at the Ontario Institute for Cancer Research. His specialty is genome technologies.

In addition to many other posts, from 1993 to 1996, he was co-director of the National Human Genome Research Center at the University of California at Irvine. There, he worked on the Human Genome Project.

Gender	Male
Links	https://oicr.on.ca/person/oicr-investigator/john-mcpherson http://oicr.on.ca/news/portal-news/human-genome-cancer-genome

10.5.61 Mirzabekov, Andrei

Professor, Institute of Molecular Biology of the Academy of Science, Moscow, USSR. Instigator of Soviet genome program.

Birth Date	
Gender	Male
Selected Publications	**Content by label** There is no content with the specified labels
Connections	• Argonne National Laboratory/Archives • Mirzabekov, Andrei
External Links	http://www.akonni.com/pop_andrei.htm http://www.nature.com/nature/journal/v412/n6850/full/412845a0.html

10.5.62 Morgan, Michael

Retired. Former science advisor for The Wellcome Trust. Instrumental in increasing funding for UK genome sequencing research (1998-2000).

Gender	Male
Selected Publications	• Charlesworth D, et al. (1995) The pattern of neutral molecular variation under the background selection model • Collins FS, et al. (2003) The human genome project: Lessons from large-scale biology • Ross MT, et al. (2005) The DNA sequence of the human X chromosome • Waterston RH, et al. (2002) Initial sequencing and comparative analysis of the mouse genome
Connections	• Morgan, Michael • Public vs Private: Human Genome Project 1998-2000 • Wellcome Trust Sanger Institute/Archives
External Links	http://blog.wellcome.ac.uk/2010/06/24/michael-morgan-on-a-decade-of-the-human-genome/ http://library.cshl.edu/oralhistory/interview/genome-research/challenges-hgp/morgan-hgp-competition/ https://www.sanger.ac.uk/about/history/hgp/ http://dukespace.lib.duke.edu/dspace/handle/10161/7700

10.5.63 Myers, Eugene

Director, Max Planck Institute of Molecular Cell Biology and Genetics, Dresden, Germany. Co-inventor of BLAST algorithm. As vice president of Bioinformatics at Celera Genomics, wrote Celera Assembler for mapping the human genome. Early proponent of shotgun sequencing approach for human genome with Jim Weber.

Birth Date	1953
Gender	Male
Selected Publications	• Adams MD, et al. (2000) The genome sequence of Drosophila melanogaster

	• Altschul SF, et al. (1990) Basic local alignment search tool • Myers EW, et al. (2000) A whole-genome assembly of Drosophila
Connections	• BLAST • Marshfield Medical Research Foundation • Myers, Eugene • Physical mapping • Scientific/Technological • Software/Database Development • The Early Years 1990-1997 • Whole-genome shotgun method
External Links	https://www.mpi-cbg.de/research-groups/current-groups/gene-myers/group-leader/ https://www.janelia.org/myers-lab https://www.mpg.de/6860096/Source_of_Life

10.5.64 Myers, Rick

Director, HudsonAlpha Institute, Huntsville AL. Former Professor Genetics, Stanford University (1993-2008). Multiple contributions to human disease gene identification and genome sequencing.

Birth Date	1954
Gender	Male
Selected Publications	• Deloukas P, et al. (1998) A physical map of 30,000 human genes • Dunham I, et al (2012) An integrated encyclopedia of DNA elements in the human genome • Grimwood J, et al. (2004) The DNA sequence and biology of human chromosome 19 • Hillier LW, et al. (2005) Generation and annotation of the DNA sequences of human chromosomes 2 and 4 • Lander ES, et al. (2001) Initial sequencing and analysis of the human genome • MacDonald ME, et al. (1993) A novel gene containing a trinucleotide repeat that is expanded and unstable on Huntingtons-disease chromosomes • Martin J, et al. (2004) The sequence and analysis of duplication-rich human chromosome 16 • Schmutz J et al. (2004) Quality assessment of the human genome sequence. Nature • Schmutz J, et al. (2004) The DNA sequence and comparative analysis of human chromosome 5
Connections	• Cox, David R. • Genome Mapping and Sequencing (1988-1997) • Holtzman, Neil Anton “Tony” • Myers, Rick • Stanford University/Archives
External Links	http://research.hudsonalpha.org/Myers/ http://www.nature.com/naturejobs/science/articles/10.1038/nj7170-758a http://hudsonalpha.org/faculty/richard-myers http://whnt.com/2015/02/14/richard-myers-of-hudsonalpha-talks-genetics-and-genomics/

10.5.65 Nickerson, Debbie

10.5.66 Noller, Harry

Harry Noller is Professor of Molecular, Cellular, and Developmental Biology at the University of California, Santa Cruz. He was at UCSC in the mid-1980s, when discussions sequencing the human genome were first taking place.

In late 1984, he was called by a UCSC colleague, Robert Sinsheimer, about getting him involved in pushing for large-scale genome sequencing. Noller was therefore involved in one of the earliest discussions on the possibility of sequencing the genome, a workshop at UC Santa Cruz on the project's feasibility.

Birth Date	1939
Gender	Male
Selected Publications	**Content by label** There is no content with the specified labels
Connections	• Hoffman Foundation • Noller, Harry • University of California Santa Cruz (UCSC)/Archives
	http://rna.ucsc.edu/rnacenter/noller_lab.html http://mcd.ucsc.edu/faculty/noller.html http://www.asbmb.org/asbmbtoday/asbmbtoday_article.aspx?id=49748 http://library.cshl.edu/oralhistory/interview/cshl/memories/harry-noller-and-ribosome/ http://genomesymposium.ucsc.edu/fs-1985SCW.html

10.5.67 Olson, Maynard

Professor of Genome Science, University of Washington. Distinguished researcher and commentator on the Human Genome Project. Before moving to Seattle, he conducted groundbreaking research at Washington University in St. Louis, where he led the development of the physical map of the yeast genome and (with David Burke) yeast artificial chromosomes for cloning large DNA fragments and genetic mapping. Served on Bruce Alberts' Committee of the National Research Council.

Olson won the Gruber Prize in Genetics in 2007. Said David Botstein: "Maynard was one of the top two or three key brains behind the Human Genome Project. And he is a mentor—not just for his students, but for whole institutes." Olson is an articulate commentator on a broad range of issues in genome science, from technology to social ramifications.

Birth Date	1943
Gender	Male
Selected Publications	• Burke DT, et al. (1987) Cloning of large segments of exogenous DNA into yeast by means of artificial chromosome vectors

	• Gregory SG, et al. (2006) The DNA sequence and biological annotation of human chromosome 1 • Hillier LW, et al (2003) The DNA sequence of human chromosome 7 • Kidd JM, et al. (2008) Mapping and sequencing of structural variation from eight human genomes • Lander ES, et al. (2001) Initial sequencing and analysis of the human genome • Olson M, et al. (1989) A common language for physical mapping of the human genome • Olson M, Hood L, Cantor C, Botstein D. (1989) A common language for physical mapping of the human genome. Science • Stover CK, et al. (2000) Complete genome sequence of Pseudomonas aeruginosa pao1, an opportunistic pathogen
Connections	• Biological Research/Methods Development • Genome Mapping and Sequencing (1988-1997) • Mapping the genome: The vision, the science, the implementation; What is the genome project? [A round-table discussion] (1992) • National Academy of Sciences (NAS) • National Research Council (NRC) • Olson, Maynard • Public vs Private: Human Genome Project 1998-2000 • STS (Sequence-Tagged Sites) • The Early Years 1990-1997
External Links	http://www.gs.washington.edu/faculty/olson.htm http://depts.washington.edu/medgen/faculty/Maynard_Olson.shtml http://library.cshl.edu/oralhistory/speaker/maynard-olson/ https://www.genome.gov/27542739 https://www.princeton.edu/csdp/events/Biomedical2003/olson.pdf

10.5.68 Paabo, Svante

Swedish geneticist and pioneer of paleogenetics. Director Department of Genetics, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany, since 1997. Paabo pioneered methods for analyzing ancient DNA, with his greatest accomplishment the sequencing of the Neanderthal genome. (The early part of that project was conducted in collaboration with 454 Life Sciences.) Paabo's team initially focused on sequencing Neanderthal mitochondrial DNA, then moved to nuclear DNA as next-generation sequencing methods advanced. His team has also produced a draft sequence of the Denisovan genome. These projects have profound implications for our understanding of human evolutionary history.

Paabo won the Breakthrough Prize in 2015. He is the author of one of Amazon's top 100 books of 2014: *Neanderthal Man: In Search of Lost Genomes.*

Birth Date	1955
Gender	Male
Selected Publications	**Content by label** There is no content with the specified labels
Connections	• Paabo, Svante • Paleontology, use of DNA sequencing in • The Biology of Genomes (2004-2012)

External Links	http://www.eva.mpg.de/genetics/staff/paabo/index.html https://www.ted.com/talks/svante_paeaebo_dna_clues_to_our_inner_neanderthal?language=en http://www.nytimes.com/2014/04/20/books/review/neanderthal-man-by-svante-paabo.html http://www.newyorker.com/magazine/2011/08/15/sleeping-with-the-enemy

10.5.69 Page, David

Director, The Whitehead Institute, Professor Biology at MIT, and an HHMI investigator. Expert on mammalian genetics and reproduction, particularly the structure, function and evolutionary history of the sex chromosomes. Painstakingly determined the sequence of the human Y chromosome (with the Genome Institute, Washington University), completed in 2003. Discovered that the X and Y chromosomes evolved from a pair of ordinary autosomes.

Birth Date	
Gender	Male
Selected Publications	• Skaletsky H, et al. (2003) The male-specific region of the human Y chromosome is a mosaic of discrete sequence classes • Vollrath D, et al. (1992) The human Y chromosome: A 43-interval map based on naturally occurring deletions
Connections	• Page, David • Whitehead Institute, MIT/Archives
External Links	http://wi.mit.edu/people/faculty/page https://www.hhmi.org/research/origins-sexual-dimorphism-mammalian-genome-and-germline

10.5.70 Patrinos, Aristides

Deputy Director, NYU Center for Urban Science and Progress. He was previously president for Synthetic Genomics, a company co-founded by J. Craig Venter, from 2006-12. Before that, he enjoyed a long career at the Department of Energy. In 1993, he succeeded David Galas as the Director of the DOE's Office of Biological and Environmental Research, leading the agency's sequencing effort. Patrinos enjoyed good relations with the leaders on both sides of the genome race, and helped engineer the pact that brought about the White House declaration in June 2000. The key meeting between Francis Collins and Venter took place at Patrinos' house over pizza and beer.

Birth Date	1947
Gender	Male
Selected Publications	• Collins FS, et al. (1998) New goals for the U.S. Human Genome Project: 1998-2003 • Collins FS, et al. (2003) The human genome project: Lessons from large-scale biology • Collins FS, Patrinos A, Jordan E, Chakravarti A, Gesteland R, Walters L. (1998) New goals for the U.S. Human genome project: 1998-2003. Science • Patrinos A, Drell DW. (1997) The human genome project: View from the Department of Energy. Journal of the American Medical Women's Association

	• Patrinos AA. (2000) The human genome project: Interaction of the physical sciences with biology. The Journal of Law, Medicine & Ethics
Connections	• Patrinos, Aristides • US Department of Energy (DOE)/DOE Joint Genome Institute (DOE JGI)/Archives
External Links	http://www.neuroeconomics.nyu.edu/people/aristides-a-n-patrinos/ http://www.if-gr.org/content/ifg-awards/2-ifg-awards-2013?fdl=24 http://www.prnewswire.com/news-releases/dr-aristides-patrinos-named-president-of-synthetic-genomics-inc-55190352.html

10.5.71 Pearson, Mark L.

Mark Pearson was director of molecular biology at DuPont from 1983 to 1990 and sat on the Human Genome Project's national advisory board. He also co-founded the company Darwin Molecular Corporation, an early genomics start-up of which he was president and CEO. Darwin was acquired by Chiroscience in 1996.

Birth Date	
Gender	Male
Selected Publications	**Content by label** There is no content with the specified labels
Connections	• Pearson, Mark L.
External Links	http://www.nytimes.com/1994/01/30/us/mining-genome-big-science-big-business-special-report-profits-ethics-clash.html?pagewanted=all https://www.linkedin.com/in/mark-l-pearson-ph-d-17209a9 https://www.linkedin.com/pub/mark-l-pearson-ph-d/9/9a/172 http://libgallery.cshl.edu/items/show/46274

10.5.72 Peltonen, Leena

10.5.73 Roberts, Richard

Nobel laureate (physiology or medicine, 1993). Shared with Phil Sharp for the discovery of introns in eukaryotes (“split genes”). Chief scientific officer, New England Biolabs. Formerly chairman of Celera's scientific advisory board during its effort to privately sequence the human genome.

Birth Date	1943
Gender	Male
Selected Publications	• Berget SM,et al. (1978) Spliced segments at the 5' termini of adenovirus-2 late mRNA: a role for heterogeneous nuclear RNA in mammalian cells • Broker TR, et al. (1978) Adenovirus-2 messengers--an example of baroque molecular architecture

	• Chow LC, et al (1977) An amazing sequence arrangement at the 5' ends of adenovirus 2 messenger RNA • Harrison TJ (2000) Spliced segments at the 5′ terminus of Adenovirus 2 late mRNA
Connections	• Genome Mapping and Sequencing (1988-1997) • Harvard University/Archives • New England Biolabs • Roberts, Richard
External Links	http://www.nobelprize.org/nobel_prizes/medicine/laureates/1993/roberts-bio.html https://www.neb.com/tools-and-resources/feature-articles/a-modern-day-gene-genie-sir-richard-roberts-on-rebase http://www.northeastern.edu/cos/faculty/sir-richard-john-roberts/

10.5.74 Roderick, Thomas H.

Deceased. Geneticist at the Jackson Laboratory, Bar Harbor, Maine. Coined the term “genomics” in 1986 for the title of a new journal edited by Frank Ruddle and Victor McKusick.

Birth Date	1930
Death Date	2013
Gender	Male
Selected Publications	**Content by label** There is no content with the specified labels
Connections	• Roderick, Thomas H.
External Links	http://obituaries.bangordailynews.com/obituaries/bdnmaine/obituary.aspx?pid=166834450 http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2392988/ http://jnci.oxfordjournals.org/content/90/2/93.full.pdf

10.5.75 Roe, Bruce

George Lynn Cross Research Professor of chemistry and biochemistry at the University of Oklahoma. Founding director of the Advanced Center for Genomic Technology. Directed sequencing of the chromosome 22, the first completed human chromosome. Helped develop dideoxy sequencing with Fred Sanger on sabbatical in Cambridge.

Birth Date	1942
Gender	Male
Selected Publications	• Anderson S, et al. (1981) Sequence and organization of the human mitochondrial genome • Dunham I, et al (1999) The DNA sequence of human chromosome 22 • Lander ES, et al. (2001) Initial sequencing and analysis of the human genome • Waterston RH, et al. (2002) Initial sequencing and comparative analysis of the mouse genome

Connections	• Roe, Bruce
External Links	http://www.ou.edu/microarray/ http://library.cshl.edu/oralhistory/speaker/bruce-roe/ https://www.genomeweb.com/sequencing/university-oklahomas-bruce-roe-running-sequencers-without-covers http://solgenomics.net/static_content/homepage/tomato_genome_press_releases/us_university_oklahoma_press_relea http://www.genome.ou.edu/personnel/broe/roe_vitae.html http://www2.mrc-lmb.cam.ac.uk/about-lmb/archive-and-alumni/alumni/

10.5.76 Rogers, Jane

Genomics consultant. Founding scientist and former head of sequencing, Wellcome Trust Sanger Institute, UK, where she worked from 1993-2007. Former director of The Genome Analysis Centre, Norwich, UK. Leading role in delivering UK contribution to the Human Genome Project. Worked with wheat genome sequencing consortium.

Gender	Female
Selected Publications	• Adams MD, et al. (2000) The genome sequence of Drosophila melanogaster • Bentley DR, et al. (2008) Accurate whole human genome sequencing using reversible terminator chemistry • Cole ST, et al. (1998) Deciphering the biology of mycobacterium tuberculosis from the complete genome sequence • Collins FS, et al. (2004) Finishing the euchromatic sequence of the human genome • Deloukas P, et al. (2004) The DNA sequence and comparative analysis of human chromosome 10 • Dunham A, et al (2004) The DNA sequence and analysis of human chromosome 13 • Dunham I, et al (1999) The DNA sequence of human chromosome 22 • Gregory SG, et al. (2006) The DNA sequence and biological annotation of human chromosome 1 • Grimwood J, et al. (2004) The DNA sequence and biology of human chromosome 19 • Humphray SJ, et al. (2004) DNA sequence and analysis of human chromosome 9 • Lander ES, et al. (2001) Initial sequencing and analysis of the human genome • Mungall AJ, et al. (2003) The DNA sequence and analysis of human chromosome 6 • Rogers J (1977) Atomic Structure of a Living Organism • Ross MT, et al. (2005) The DNA sequence of the human X chromosome • Schmutz J, et al. (2004) The DNA sequence and comparative analysis of human chromosome 5 18 related results
Connections	• Genome Sequencing and Biology (1999-2002) • Rogers, Jane • Sequencing Methods/Technology Development • The Biology of Genomes (2004-2012) • Women in Sequencing
External Links	http://cnrgv.toulouse.inra.fr/Communication/Plant-Genomes-Day-2014/Scientific-Program/Jane-Rogers http://www.wheatgenome.org/People/Leadership-Award/2014-Awardees/Jane-Rogers

	https://www.genomeweb.com/sequencing/qa-jane-rogers-expanding-uks-sequencing-prowess-beyond-sanger-institute-and-medi http://www.sanger.ac.uk/about/who-we-are/sanger-institute/history-sanger-institute/human-genome-project-and-sanger-institute http://selectbiosciences.com/conferences/biographies.aspx?speaker=969979&conf=PG2014

10.5.77 Rubin, Edward

Director, DOE Joint Genome Institute. Previously head of Genome Sciences department (1988-2002). Under his leadership, the JGI completed sequencing of chromosomes 5, 16 and 19 – about 13% of the human genome.

Gender	Male
Selected Publications	• Boffelli D, et al. (2003) Phylogenetic shadowing of primate sequences to find functional regions of the human genome • Chiang SL, Rubin EJ. (2002) Construction of a mariner-based transposon for epitope-tagging and genomic targeting • Couronne O, et al. (2003) Strategies and tools for whole-genome alignments • Grimwood J, et al. (2004) The DNA sequence and biology of human chromosome 19 • Loots GG, et al. (2002) rVista for comparative sequence-based discovery of functional transcription factor binding sites • Martin J, et al. (2004) The sequence and analysis of duplication-rich human chromosome 16 • Pennacchio LA, Rubin EM. (2001) Genomic strategies to identify mammalian regulatory sequences • Schmutz J, et al. (2004) The DNA sequence and comparative analysis of human chromosome 5 • Smith DJ, Rubin EM. (1997) Functional screening and complex traits: Human 21q22.2 sequences affecting learning in mice • Waterston RH, et al. (2002) Initial sequencing and comparative analysis of the mouse genome
Connections	• Lawrence Berkeley National Laboratory/Archives • Rubin, Edward • The Biology of Genomes (2004-2012) • US Department of Energy (DOE)/DOE Joint Genome Institute (DOE JGI)/Archives
External Links	http://jgi.doe.gov/about-us/organization/strategic-management/eddy-rubin/ http://biosciences.lbl.gov/profiles/eddy-rubin/ http://www.gs.washington.edu/news/retreat09/rubin_bio.pdf

10.5.78 Rubin, Gerry

Executive Director, Janelia Research Campus, and vice president, HHMI. Former John D. MacArthur Professor of Genetics, UC Berkeley. Leading Drosophila geneticist, who forged collaboration with Craig Venter to expedite and complete the sequencing of the Drosophila genome in 2000.

Gender	Male
Selected Publications	• Adams MD, et al. (2000) The genome sequence of Drosophila melanogaster • Ashburner M, et al. (2000) Gene ontology: Tool for the unification of biology. The gene ontology consortium • Berman BP, et al. (2002) Exploiting transcription factor binding site clustering to identify cis-regulatory modules involved in pattern formation in the drosophila genome • Brodsky MH, et al. (2000) Mus304 encodes a novel DNA damage checkpoint protein required during drosophila development • De Gregorio E, et al. (2002) The Toll and Imd pathways are the major regulators of the immune response in Drosophila • Florea L, et al. (1998) A computer program for aligning a cDNA sequence with a genomic DNA sequence • Kaminker JS, et al. (2002) The transposable elements of the Drosophila melanogaster euchromatin: A genomics perspective • Lai EC, et al. (2003) Computational identification of Drosophila microrna genes • Liao GC, et al. (2000) Insertion site preferences of the P transposable element in Drosophila melanogaster • Miklos GL, Rubin GM. (1996) The role of the genome project in determining gene function: Insights from model organisms • Mlodzik M, et al. (1990) The Drosophila seven-up gene, a member of the steroid receptor gene superfamily, controls photoreceptor cell fates • Myers EW, et al. (2000) A whole-genome assembly of Drosophila • Ohler U, et al. (2002) Computational analysis of core promoters in the Drosophila genome • Rubin GM, et al. (2000) Comparative genomics of the eukaryotes • Rubin GM, Lewis EB. (2000) A brief history of Drosophila's contributions to genome research 18 related results
Connections	• Rubin, Gerry
External Links	https://www.janelia.org/lab/rubin-lab http://www.ncbi.nlm.nih.gov/pubmed/10731132

10.5.79 Sanger, Frederick

Deceased. Double Nobel Laureate (1960, 1980 in chemistry for his work in protein and DNA sequencing). Scientist, University of Cambridge, UK. Developed dideoxy chain-termination method for DNA sequencing that became mainstay of automated sequencing technology for Human Genome Project.

Birth Date	1918
Death Date	2013
Gender	Male
Selected Publications	• Anderson S, et al. (1981) Sequence and organization of the human mitochondrial genome • Sanger F (1981) Determination of nucleotide sequences in DNA • Sanger F (1988) Sequences, sequences, and sequences • Sanger F, et al. (1977) DNA sequencing with chain-terminating inhibitors • Sanger F, et al. (1977) Nucleotide sequence of bacteriophage φX174 DNA

	• Sanger F, Nicklen S, Coulson AR. (1977) DNA sequencing with chain-terminating inhibitors • Sanger F, Tuppy H (1951) The amino-acid sequence in the phenylalanyl chain of insulin. 2. The investigation of peptides from enzymic hydrolysates • Sanger F, Tuppy H (1951) The amino-acid sequence in the phenylalanyl chain of insulin. I. The identification of lower peptides from partial hydrolysates • Wellcome Trust (2010) History of the Sanger Institute
Connections	• Automated sequencing • Bacteriophage φX174 DNA (virus) • Chain termination • Chen, Ellson • Coulson, Alan R. • DNA sequencing • Gilbert, Walter • High-throughput sequencing • Insulin sequence • Laboratory of Molecular Biology, Cambridge (LMB) • Maxam-Gilbert DNA sequencing method • MRC Laboratory of Molecular Biology/ British Medical Research Council (MRC) Laboratory of Molecular Biology/Archives • Protein sequencing • Roe, Bruce • Sanger Centre/Wellcome Trust Sanger Institute/Archives 27 related results
External Links	http://www.nobelprize.org/nobel_prizes/chemistry/laureates/1958/sanger-bio.html http://www.sanger.ac.uk/about/people/biographies/fsanger.html http://www.dnaftb.org/23/bio.html http://www.nytimes.com/2013/11/21/science/frederick-sanger-two-time-nobel-winning-scientist-dies-at-95.html?_r=0 http://www.nature.com/scitable/topicpage/frederick-sanger-method-man-problem-solver-6537485 http://wellcomelibrary.org/collections/digital-collections/makers-of-modern-genetics/digitised-archives/fred-sanger/

10.5.80 Smith, Hamilton O.

Nobel laureate. Distinguished Professor at the J. Craig Venter Institute. He shared the Nobel Prize in Physiology or Medicine in 1978 for co-discovering restriction enzymes. He worked with Venter during the Human Genome Project, helping produce the Celera draft genome assembly based on whole-genome shotgun sequencing. Smith also played key roles in establishing shotgun sequencing in the first published microbial genome sequences.

Birth Date	1931
Gender	Male
Selected Publications	• Adams MD, et al. (2000) The genome sequence of Drosophila melanogaster • Bult CJ, et al. (1996) Complete genome sequence of the methanogenic archaeon, methanococcus jannaschii

	• Fleischmann RD, et al. (1995) Whole-genome random sequencing and assembly of Haemophilus influenzae rd • Fraser CM, et al. (1995) The minimal gene complement of Mycoplasma genitalium • Fraser CM, et al. (1997) Genomic sequence of a Lyme disease spirochaete, Borrelia burgdorferi • Fraser CM, et al. (1998) Complete genome sequence of treponema pallidum, the syphilis spirochete • Heidelberg JF, et al. (2000) DNA sequence of both chromosomes of the cholera pathogen vibrio cholerae • Hutchison CA, et al. (1999) Global transposon mutagenesis and a minimal mycoplasma genome • Kelly TJ, Smith HO (1970) A restriction enzyme from Hemophilus-influenzae 2. Base sequence of recognition site • Klenk HP, et al. (1997) The complete genome sequence of the hyperthermophilic, sulphate-reducing archaeon archaeoglobus fulgidus • Nelson KE, et al. (1999) Evidence for lateral gene transfer between archaea and bacteria from genome sequence of Thermotoga maritima • Smith HO (1979) Nucleotide sequence specificity of restriction endonucleases • Smith HO, et al. (1995) Frequency and distribution of DNA uptake signal sequences in the Haemophilus influenzae rd genome • Smith HO, et al. (2003) Generating a synthetic genome by whole genome assembly: Phix174 bacteriophage from synthetic oligonucleotides • Smith HO, Wilcox KW (1970) A restriction enzyme from Hemophilus influenzae. I. Purification and general properties 21 related results
Connections	• Johns Hopkins University • Smith, Hamilton O. • The Early Years 1990-1997
External Links	http://www.jcvi.org/cms/about/bios/hsmith/ http://www.nobelprize.org/nobel_prizes/medicine/laureates/1978/smith-bio.html

10.5.81 Smith, Lloyd M.

Professor of Chemistry at the University of Wisconsin-Madison. A chemist, Smith played a crucial role in developing the first automated DNA sequencing machine in 1986 with Leroy Hood and colleagues, devising a way to fluorescently tag DNA. This formed the bases of the automated sequencing methods that would be used during the Human Genome Project.

Birth Date	1954
Gender	Male
Selected Publications	• Griffin TJ, et al. (1997) Genetic analysis by peptide nucleic acid affinity maldi-tof mass spectrometry • Griffin TJ, et al. (1999) Direct genetic analysis by matrix-assisted laser desorption/ionization mass spectrometry • Smith LM, et al. (1985) The synthesis of oligonucleotides containing an aliphatic amino group at the 5' terminus: synthesis of fluorescent DNA primers for use in DNA-sequence analysis • Smith LM, et al. (1986) Fluorescence detection in automated DNA sequence analysis

	• Smith LM. (1991) High-speed DNA sequencing by capillary gel electrophoresis • Smith LM. (1993) The future of DNA sequencing
Connections	• Automated sequencing • California Institute of Technology • Caltech (California Institute of Technology)/Archives • Capillary sequencing • DNA sequencing • Hunkapiller, Tim • Sequencing Methods/Technology Development • Smith, Lloyd M.
External Links	http://smith.chem.wisc.edu/ https://www.chem.wisc.edu/users/smith http://www.chemheritage.org/discover/collections/oral-histories/details/smith-lloyd-m.aspx

10.5.82 Stein, Lincoln

Lincoln Stein is program director in informatics and bio-computing at the Ontario Institute for Cancer Research. During the 1990s, he worked at the Whitehead Institute MIT Genome Center, focusing on bioinformatics, and he was also an investigator and professor at Cold Spring Harbor Laboratory. He developed user interfaces and database technology for the Human Genome Project.

Birth Date	1960
Gender	Male
External Links	https://oicr.on.ca/person/oicr-investigator/lincoln-stein

10.5.83 Sulston, John

John Sulston is Professor and Chair of the Institute for Science, Ethics and Innovation at the University of Manchester. He shared the Nobel Prize in Physiology or Medicine in 2002 for his work on the “genetic regulation of organ development and programmed cell death.”

From 1992 to 2000, Sulston was director of the Sanger Centre, now known as the Sanger Institute, where one third of the human genome was sequenced. During this time, Sulston was a contributor to the project; he was also a major figure in the sequencing of the genome of C. elegans.

Birth Date	1942
Gender	Male

Selected Publications	• C. elegans Sequencing Consortium (1998) Genome sequence of the nematode C. elegans: A platform for investiga • Cole ST, et al. (1998) Deciphering the biology of mycobacterium tuberculosis from the complete genome sequence • Dunham A, et al (2004) The DNA sequence and analysis of human chromosome 13 • Dunham I, et al (1999) The DNA sequence of human chromosome 22 • Gitschier, Jane. (2006) Knight in Common Armor: An Interview with Sir John Sulston • Gregory SG, et al. (2006) The DNA sequence and biological annotation of human chromosome 1 • Humphray SJ, et al. (2004) DNA sequence and analysis of human chromosome 9 • Lander ES, et al. (2001) Initial sequencing and analysis of the human genome • Mungall AJ, et al. (2003) The DNA sequence and analysis of human chromosome 6 • Ross MT, et al. (2005) The DNA sequence of the human X chromosome • Waterston R, Sulston JE. (1998) The Human Genome Project: Reaching the finish line • Waterston RH, et al. (2002) On the sequencing of the human genome • Wellcome Trust (2010) History of the Sanger Institute • Zwart H (2008) Understanding the Human Genome Project: A biographical approach
Connections	• Biological Research/Methods Development • Bourke, Frederic • C. elegans (nematode) • Laboratory of Molecular Biology, Cambridge (LMB) • Medical Research Council (MRC) • Public vs Private: Human Genome Project 1998-2000 • Sanger Centre/Wellcome Trust Sanger Institute/Archives • Scientific/Technological • Sulston, John • The Common Thread: A Story of Science, Politics, Ethics, and the Human Genome - John Sulston's inside account • The Early Years 1990-1997 • The Wellcome Trust
External Links	http://www.nobelprize.org/nobel_prizes/medicine/laureates/2002/sulston-bio.html http://www.manchester.ac.uk/research/john.sulston/ http://www.sanger.ac.uk/about/people/biographies/jsulston.html http://archives.wellcomelibrary.org/DServe/dserve.exe?dsqIni=Dserve.ini&dsqApp=Archive&dsqCmd=Show.tcl&dsqDb=

10.5.84 Sutton, Granger

Professor of Informatics at the J. Craig Venter Institute. Prior to this position he was director of the Informatics Research Department at Celera Genomics, which competed with the international public consortium to sequence the human genome. He was an important figure in the development of whole shotgun assembly.

Gender	Male
Selected Publications	• Adams MD, et al. (2000) The genome sequence of Drosophila melanogaster • Bult CJ, et al. (1996) Complete genome sequence of the methanogenic archaeon, methanococcus jannaschii • Casjens S, et al. (2000) A bacterial genome in flux: The twelve linear and nine circular extrachromosomal DNAs in an infectious isolate of the Lyme disease spirochete Borrelia burgdorferi • Fleischmann RD, et al. (1995) Whole-genome random sequencing and assembly of Haemophilus influenzae rd

	• Fraser CM, et al. (1995) The minimal gene complement of Mycoplasma genitalium • Fraser CM, et al. (1997) Genomic sequence of a Lyme disease spirochaete, Borrelia burgdorferi • Fraser CM, et al. (1998) Complete genome sequence of treponema pallidum, the syphilis spirochete • Klenk HP, et al. (1997) The complete genome sequence of the hyperthermophilic, sulphate-reducing archaeon archaeoglobus fulgidus • Myers EW, et al. (2000) A whole-genome assembly of Drosophila • Tomb JF, et al. (1997) The complete genome sequence of the gastric pathogen Helicobacter pylori • Venter JC, et al. (1998) Shotgun sequencing of the human genome
Connections	• Sutton, Granger
External Links	http://www.jcvi.org/cms/about/bios/gsutton https://www.cs.umd.edu/community/alumni/halloffame/13204

10.5.85 Syvanen, Michael

Michael Syvanen is a professor in the Department of Medical Microbiology and Immunology at the University of California, Davis. In the late 1980s and early 1990s, Syvanen was a staunch critic of the idea of sequencing the genome. He told the *New York Times* in June 1990 that "everybody I talk to thinks this is an incredibly bad idea." A leader among the genome project's critics, Syvanen believed that the huge sequencing initiative would divert scientific funding from important but smaller research.

Birth Date	
Gender	Male
External Links	http://www.ucdmc.ucdavis.edu/medmicro/Faculty_MR/Syvanen/syvanen_index_mr.html http://www.yvm.net/vme/hgt/ http://www.nytimes.com/1990/06/05/science/great-15-year-project-to-decipher-genes-stirs-opposition.html?pagewanted=all https://books.google.com/books?id=rBHyBwAAQBAJ&pg=PA233&lpg=PA233&dq=michael+syvanen+%22human+genome Qtn&sig=E0Q_TdMwg8KYcn-P1XmwrvrCjaA&hl=en&sa=X&ved=0ahUKEwjv8snFnvDJAhUG8z4KHc-ND5YQ6AEIKjAE#v=onepage&q=michael%20syvanen%20%22human%20genome%22&f=false

10.5.86 Tilghman, Shirley

Shirley Tilghman is Professor of Molecular Biology of Princeton University and was the institution's president from 2001 to 2013.

Tilghman played an important role in the Human Genome Project. She sat on the National Research Council committee that planned the United States's role in the project. In addition, she was a founding member of the National Advisory Council of the Human Genome Project. She is an expert on epigenetics and genetic imprinting.

Birth Date	1946
Gender	Female
Selected Publications	**Content by label** There is no content with the specified labels
Connections	• National Institutes of Health (NIH)/Archives • Princeton University • Princeton University/Archives • Tilghman, Shirley
External Links	http://molbio.princeton.edu/faculty/molbio-faculty/137-tilghman https://www.princeton.edu/pub/presidents/tilghman/ http://www.makers.com/shirley-tilghman

10.5.87 Tinoco, Ignacio

Ignacio Tinoco is Professor of Chemistry at the University of California at Berkeley. Tinoco chaired the Subcommittee on Human Genome of the Health and Environmental Research Advisory Committee. In 1987, the subcommittee produced a report ("Report on the Human Genome Initiative") that was an early study of the proposal to sequence human DNA. The report recommended that the Department of Energy begin a large project to sequence the genome.

Birth Date	1930
Gender	Male
Selected Publications	**Content by label** There is no content with the specified labels
Connections	• Lawrence Berkeley National Laboratory/Archives • Tinoco, Ignacio • University of California, Berkeley/Archives
External Links	http://www.cchem.berkeley.edu/intgrp/tinoco.html http://vcresearch.berkeley.edu/faculty/ignacio-tinoco-jr http://uhoo.lbl.gov/scientists/ignacio-tinoco/ http://www.osti.gov/accomplishments/documents/fullText/ACC0486.pdf

10.5.88 Varmus, Harold

Nobel laureate. Harold Varmus is Lewis Thomas University Professor at the Weill Cornell Medical College.

Varmus was director of the National Institutes of Health from 1993 to 1999, during much of the Human Genome Project. He went on to become President and CEO of Memorial Sloan Kettering Cancer Center in New York and then director of the National Cancer Institute.

Varmus is a co-winner of the 1989 Nobel Prize in Physiology or Medicine for his work on the cellular origin of retroviral oncogenes.

Birth Date	1939
Gender	Male
Selected Publications	• Stehelin D, et al. (1976) DNA related to the transforming gene(s) of avian sarcoma viruses is present in normal avian DNA
Connections	• National Institutes of Health (NIH)/Archives • Public vs Private: Human Genome Project 1998-2000 • University of California San Francisco (UCSF)/Archives • Varmus, Harold
External Links	http://www.nobelprize.org/nobel_prizes/medicine/laureates/1989/varmus-bio.html http://profiles.nlm.nih.gov/ps/retrieve/Narrative/MV/p-nid/184 http://weill.cornell.edu/news/pr/2015/03/nobel-laureate-harold-varmus-joins-weill-cornell-medical-college-to-advance-cancer-research.html

10.5.89 Venter, J. Craig

Founder, chairman, and CEO of J. Craig Venter Institute (JCVI). Previously the founder and CEO of Celera Genomics, the company that galvanized the race to sequence the human genome from 1998-2001. Also founding president of The Institute of Genomics Research (TIGR) in 1993.

Venter and colleagues have made numerous contributions to the Human Genome Project and the field of genomics over 25 years. In 1991, his group at NIH developed the expressed sequence tag method. He became immersed in controversy over the patenting of these human gene fragments by NIH. He later founded The Institute of Genomic Research, where his group was the first to publish a bacterial genome sequence in 1995. In 1998, Venter announced the formation of Celera Genomics, which applied shotgun sequencing and massive computational horsepower to assemble the genome from five anonymous donors. Venter joined Francis Collins in marking the completion of the first draft on June 26, 2000. Venter resigned from Celera after the publication of the first draft in 2001.

Building on his Celera work, Venter was the first individual to report the complete sequence of his personal genome. And building on work performed at TIGR, Venter's team was the first to transfect a cell with a synthetic microbial genome.

Venter is the founder of two other companies, Synthetic Genomics and Human Longevity Inc. He is also the author of two books on his research: *A Life Decoded* and *Life at the Speed of Light: From the Double Helix to the Dawn of Digital Life*.

Birth Date	1946
Gender	Male
Selected Publications	• Adams MD, et al. (1991) Complementary DNA sequencing: Expressed sequence tags and human genome project • Adams MD, et al. (2000) The genome sequence of Drosophila melanogaster • Bult CJ, et al. (1996) Complete genome sequence of the methanogenic archaeon, methanococcus jannaschii • Collins FS, et al. (1998) New goals for the U.S. Human Genome Project: 1998-2003 • Fleischmann RD, et al. (1995) Whole-genome random sequencing and assembly of Haemophilus influenzae rd • Fraser CM, et al. (1995) The minimal gene complement of Mycoplasma genitalium

	• Fraser CM, et al. (1997) Genomic sequence of a Lyme disease spirochaete, Borrelia burgdorferi • Fraser CM, et al. (1998) Complete genome sequence of treponema pallidum, the syphilis spirochete • Heidelberg JF, et al. (2000) DNA sequence of both chromosomes of the cholera pathogen vibrio cholerae • Hutchison CA, et al. (1999) Global transposon mutagenesis and a minimal mycoplasma genome • Kaul S, et al. (2000) Analysis of the genome sequence of the flowering plant arabidopsis thaliana • Klenk HP, et al. (1997) The complete genome sequence of the hyperthermophilic, sulphate-reducing archaeon archaeoglobus fulgidus • Martin-Gallardo A, et al. (1992) Automated DNA sequencing and analysis of 106 kilobases from human chromosome 19q13.3 • McCombie WR, et al. (1992) Expressed genes, Alu repeats and polymorphisms in cosmids sequenced from chromosome 4p16.3 • Myers EW, et al. (2000) A whole-genome assembly of Drosophila 30 related results
Connections	• AAAS Meeting (2001) • ABI 370 (373) DNA sequencing instruments • ABI Prism 3700 DNA Analyzer • Adams, Mark • Adler, Reid • Arnold & Porter • cDNA • D.C. Science Writers Association (DCSWA) • Decoding Our DNA: Craig Venter vs the Human Genome Project • EST (expressed sequence tag) strategy • ESTs (Expressed Sequence Tags) • European Patent Office • Illig, Jeannine Gocayne • J. Craig Venter Institute • J. Craig Venter Institute (JCVI)/Archives 41 related results
External Links	http://www.jcvi.org/cms/about/bios/jcventer/0 http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3068906/ https://www.dnalc.org/view/16830-Biography-39-John-Craig-Venter-1946-.html

10.5.90 Wada, Akiyoshi

Akiyosha Wada is emeritus professor at Tokyo University. He has also been director of the RIKEN Genome Sciences Center in Japan. In 1981, Wada pushed for the development of the first automated DNA sequencer in Japan. In 1986, he came to the United States in an attempt to set up an international project to sequence human DNA. At that time, the idea of sequencing the human genome was very new in United States. Wada's proposal was an important precursor to what came to be known as the Human Genome Project.

Birth Date	1929
Gender	Male

Selected Publications	**Content by label** There is no content with the specified labels
Connections	• Science and Technology Agency (STA) • Wada, Akiyoshi
External Links	http://www.gsc.riken.go.jp/eng/ayumi/01.html http://library.cshl.edu/special-collections/human-genome-project-japan/akiyoshi-wada-finding-aid http://www.nature.com/nature/journal/v399/n6732/full/399096a0.html http://www.nature.com/milestones/miledna/advisors/index.html

10.5.91 Waterman, Michael

Michael Waterman is Professor of Biological Sciences at the University of Southern California. Waterman is a highly influential figure in the fields of bioinformatics and sequence analysis. He is the 2015 winner of the Dan David Prize. The Dan David Foundation has said that “he developed the fundamental algorithms used for the mapping of sequence information in the Human Genome Project” and was a key figure in analyzing much of the resulting data.

Birth Date	1942
Gender	Male
Selected Publications	**Content by label** There is no content with the specified labels
Connections	• Page:Biological Research/Methods Development • Page:BLAST
External Links	http://dornsife.usc.edu/labs/msw/ http://www.iscb.org/iscb-awards/1129 http://www.dandavidprize.org/laureates/2015/191-future-bioinformatics/756-prof-michael-waterman

10.5.92 Waterston, Robert

Robert Waterston is Professor and Chair of Genome Sciences at the University of Washington. Waterston is a renowned molecular biologist who played a key role in sequencing the genome of C. elegans, a small worm.

Birth Date	1943
Gender	Male
Selected Publications	• C. elegans Sequencing Consortium (1998) Genome sequence of the nematode C. elegans: A platform for investigating biology • Cliften P, et al. (2003) Finding functional features in saccharomyces genomes by phylogenetic footprinting • Collins FS, et al. (2004) Finishing the euchromatic sequence of the human genome • Dunham I, et al (1999) The DNA sequence of human chromosome 22 • Heilig R, et al. (2003) The DNA sequence and analysis of human chromosome 14

	• Hillier LW, et al (2003) The DNA sequence of human chromosome 7 • Hillier LW, et al. (2005) Generation and annotation of the DNA sequences of human chromosomes 2 and 4 • Lander ES, et al. (2001) Initial sequencing and analysis of the human genome • Ross MT, et al. (2005) The DNA sequence of the human X chromosome • Sachidanandam R, et al. (2001) A map of human genome sequence variation containing 1.42 million single nucleotide polymorphisms • Skaletsky H, et al. (2003) The male-specific region of the human Y chromosome is a mosaic of discrete sequence classes • Waterston R, Sulston JE. (1998) The Human Genome Project: Reaching the finish line • Waterston RH, et al. (2002) Initial sequencing and comparative analysis of the mouse genome • Waterston RH, et al. (2002) On the sequencing of the human genome
Connections	• C. elegans (nematode) • Genome Mapping and Sequencing (1988-1997) • Mouse, genome sequence • Public vs Private: Human Genome Project 1998-2000 • Scientific/Technological • The Early Years 1990-1997 • University of Washington • Waterston, Robert
	http://www.gs.washington.edu/faculty/waterston.htm http://library.cshl.edu/oralhistory/speaker/robert-waterston/ http://www.yourgenome.org/stories/giants-in-genomics-robert-waterston

10.5.93 Watson, James D.

James Watson co-discovered the chemical structure of DNA in 1953 with Francis Crick, and for that revolutionary discovery they shared the 1962 Nobel Prize in Physiology or Medicine. Throughout his career, Watson was a professor of biology at Harvard University and also led Cold Spring Harbor Laboratory as its director from 1968 to 1994.

Watson was involved in the Human Genome Project from its earliest years. He took on a key administrative role in 1988, when he was named head of the Office of Human Genome Research, the headquarters of the National Institutes of Health's component of the genome project. The office was renamed the National Center for Human Genome Research in 1989. Watson resigned as head of the NCHGR in April 1992.

Birth Date	1928
Gender	Male
Selected Publications	• Green ED, et al. (2015) Human Genome Project: Twenty-five years of big biology • Watson JD, Cook-Deegan RM (1991) Origins of the Human Genome Project • Watson JD, Cook-Deegan RM. (1990) The human genome project and international health. JAMA • Watson JD, Cook-Deegan RM. (1991) Origins of the human genome project. FASEB journal • Watson JD, Crick FH (1953) Molecular structure of nucleic acids; a structure for deoxyribose nucleic acid

	• Watson JD, Jordan E. (1989) The human genome program at the National Institutes of Health. Genomics • Watson JD. (1990) The human genome project: Past, present, and future. Science
Connections	• 2nd Annual Watson Lecture and Awards, Genome Action Coalition (1997) • Ad Hoc Program Advisory Committee on Complex Genomes (1988) • Adler, Reid • Astrue, Michael • Baylor College of Medicine/Archives • Biological Research/Methods Development • BRCA - Brief For Amicus Curiae James D. Watson In Support Of Neither Party • Cold Spring Harbor Laboratory • Cold Spring Harbor Laboratory (CSHL)/Archives • Crick, Francis • Double helix, structure of DNA • Drawing the Map of Life: Inside the Human Genome Project • Genome Sequencer GS20, 454 Life Sciences next-generation sequencer unveiled • Harvard University/Archives • Healy, Bernadine 34 related results
External Links	http://www.nobelprize.org/nobel_prizes/medicine/laureates/1962/watson-bio.html https://www.cshl.edu/gradschool/james-d-watson.html http://library.cshl.edu/personal-collections/james-d-watson http://www.genome.gov/12011239 http://www.genome.gov/10001763

10.5.94 Weinberg, Robert A.

Professor of Biology at the Massachusetts Institute of Technology and one of the founders of the Whitehead Institute. Distinguished cancer researcher, from his early groundbreaking studies on the characterization of oncogenes to his influential review articles (with Doug Hanahan) laying out the essential “hallmarks of cancer.”

During the early years of the Human Genome Project, Weinberg was skeptical that scientists would be able to process and interpret the overwhelming amount of data that large-scale sequencing would produce. Years later, in 2010, Weinberg lauded the project’s accomplishments, but remained skeptical that genomic studies of cancer would yield the results many people had anticipated.

Birth Date	1942
Gender	Male
Selected Publications	• Shih C, Weinberg RA (1982) Isolation of a transforming sequence from a human bladder carcinoma cell line
Connections	• MIT (Massachusetts Institute of Technology)/Archives • Weinberg, Robert A. • Whitehead Institute, MIT/Archives
External Links	http://weinberglab.wi.mit.edu/

	http://wi.mit.edu/people/faculty/weinberg https://biology.mit.edu/people/robert_weinberg http://www.nature.com/nature/journal/v464/n7289/full/464678a.html

10.5.95 Weinstock, George

Professor, Evnin Family Chair and Director of Microbial Genetics at The Jackson Laboratory. From 1999 to 2008, Weinstock held an appointment at Baylor College of Medicine, where he was a leading figure in the Human Genome Project, serving as co-director of the institution's Human Genome Sequencing Center.

Birth Date	1949
Gender	Male
Selected Publications	• Adams MD, et al. (2000) The genome sequence of Drosophila melanogaster • Altshuler D, et al. (2010) A map of human genome variation from population-scale sequencing • Fraser CM, et al. (1998) Complete genome sequence of treponema pallidum, the syphilis spirochete • Murray BE, et al. (1990) Comparison of genomic DNAs of different enterococcal isolates using restriction endonucleases with infrequent recognition sites • Murray BE, et al. (1993) Generation of restriction map of Enterococcus faecalis OG1 and investigation of growth requirements and regions encoding biosynthetic function • Muzny DM, et al. (2006) The DNA sequence, annotation and analysis of human chromosome 3 • Ross MT, et al. (2005) The DNA sequence of the human X chromosome • Scherer SE, et al. (2006) The finished DNA sequence of human chromosome 12
Connections	• Jackson Laboratory/Archives • The Biology of Genomes (2004-2012) • Washington University in St. Louis/Archives • Washington University School of Medicine/Archives • Weinstock, George
External Links	https://www.jax.org/research-and-faculty/research-labs/the-weinstock-lab http://facultydirectory.uchc.edu/profile?profileId=Weinstock-George

10.5.96 Weissenbach, Jean

Jean Weissenbach is a geneticist and the Director of Genoscope, or the French National Sequencing Center. Weissenbach played an important role in the early history of the Human Genome Project in 1992, when his team produced a detailed linkage map of the human genome.

Birth Date	1946
Gender	Male

Selected Publications	• Adams MD, et al. (2000) The genome sequence of Drosophila melanogaster • Bouffard GG, et al. (1997) A physical map of human chromosome 7: An integrated YAC contig map with average STS spacing of 79 kb • Deloukas P, et al. (1998) A physical map of 30,000 human genes • Gemmill RM, et al. (1995) An integrated YAC contig map for human-chromosome-3 • Gyapay G, et al. (1994) The 1993-94 Genethon human genetic linkage map • Heilig R, et al. (2003) The DNA sequence and analysis of human chromosome 14 • Hudson TJ, et al. (1995) An STS-based map of the human genome • Kaul S, et al. (2000) Analysis of the genome sequence of the flowering plant arabidopsis thaliana • Lander ES, et al. (2001) Initial sequencing and analysis of the human genome • Weissenbach J et al. (1992) A second-generation linkage map of the human genome
Connections	• Centre d'Etude du Polymorphisme Humaine (CEPH) • The Early Years 1990-1997 • Weissenbach, Jean
External Links	http://www2.cnrs.fr/en/1331.htm http://www.genoscope.cns.fr/spip/ http://www.nature.com/nature/journal/v359/n6398/abs/359794a0.html

10.5.97 Wexler, Nancy Sabin

Nancy Sabin Wexler is a neurobiologist and the Higgins Professor of Neuropsychology at Columbia University. She is notable for leading the consortium that discovered the location of the gene responsible for Huntington's Disease. She has also served as chair of the Human Genome Organization (HUGO).

Birth Date	1945
Gender	Female
Selected Publications	• Gusella JF, et al. (1983) A polymorphic DNA marker genetically linked to Huntington's disease • MacDonald ME, et al. (1993) A novel gene containing a trinucleotide repeat that is expanded and unstable on Huntingtons-disease chromosomes
Connections	• Biological Research/Methods Development • Mapping the genome: The vision, the science, the implementation; What is the genome project? [A round-table discussion] (1992) • Wexler, Nancy Sabin • Women in Sequencing
External Links	http://asp.cumc.columbia.edu/facdb/profile_list.asp?uni=nsw1&DepAffil=Psychiatry http://www.cumc.columbia.edu/psjournal/archive/winter-2003/hd.html http://www.nap.edu/read/11548/chapter/1

10.5.98 White, Tony L.

Tony White is a businessman with several decades of executive experience in the biotechnology sector. From 1995 to 2008, he was the Chairman and CEO of Applied Biosystems, Inc., and was also the company's president for most of that period. He was Craig Venter's boss during the creation of Celera in the late 1990s. The *New York Times* described White as the "architect of Celera" and a major promoter of genomics in the private sector.

Birth Date	ca 1947
Gender	Male
Selected Publications	**Content by label** There is no content with the specified labels
Connections	• Public vs Private: Human Genome Project 1998-2000 • White, Tony L.
External Links	http://investors.cvshealth.com/corporate-governance/committee-composition/tony-white.aspx http://www.transmedics.com/wt/page/bod_twhite http://www.bloomberg.com/research/stocks/private/person.asp?personId=541969&privcapId=254131 https://partners.nytimes.com/library/national/science/062700sci-genome-sketches.html

10.5.99 Wilson, Richard

Professor of Genetics and Molecular Microbiology at the Siteman Cancer Center of the Washington University in St. Louis and co-director (with Elaine Mardis) of the McDonnell Genome Institute. He is a leading researcher on genomics and DNA sequence analysis. Wilson was part of the team that sequenced *C. elegans*, the first animal to have its genome sequenced completely. He was a major contributor to the Human Genome Project.

Birth Date	1959
Gender	Male
Selected Publications	• Altshuler D, et al. (2010) A map of human genome variation from population-scale sequencing • Dunham I, et al (1999) The DNA sequence of human chromosome 22 • Heilig R, et al. (2003) The DNA sequence and analysis of human chromosome 14 • Hillier LW, et al (2003) The DNA sequence of human chromosome 7 • Hillier LW, et al. (2005) Generation and annotation of the DNA sequences of human chromosomes 2 and 4 • Kidd JM, et al. (2008) Mapping and sequencing of structural variation from eight human genomes • Lander ES, et al. (2001) Initial sequencing and analysis of the human genome • Ley TJ, et al. (2008) DNA sequencing of a cytogenetically normal acute myeloid leukaemia genome • Ross MT, et al. (2005) The DNA sequence of the human X chromosome • Skaletsky H, et al. (2003) The male-specific region of the human Y chromosome is a mosaic of discrete sequence classes • Waterston RH, et al. (2002) Initial sequencing and comparative analysis of the mouse genome

Connections	• The Biology of Genomes (2004-2012) • Washington University in St. Louis/Archives • Wilson, Richard
External Links	http://genome.wustl.edu/people/individual/richard-wilson/ http://www.pediatriccancergenomeproject.org/site/research-contacts http://archive.sciencewatch.com/inter/aut/2011/11-jul/11julWils/

10.5.100 Wold, Barbara

Barbara Wold is the Bren Professor of Molecular Biology at Caltech. A specialist in genetics, genomics, and developmental biology, Wold has done considerable research on high-throughput sequencing technologies.

Gender	Female
Keywords	developmental genetics, high-throughput sequencing
Links	https://www.bbe.caltech.edu/content/barbara-j-wold

10.5.101 Zinder, Norton D.

Described by the National Academy of Sciences as a "founding member of the Human Genome Project," Norton Zinder was a renowned molecular biologist known for discovering genetic transduction. Zinder was also influential in shaping scientific policy, serving on many influential boards and committees throughout his career. This included chairing the National Institutes of Health's advisory board for the Genome Project.

Birth Date	1928
Death Date	2012
Gender	Male
Selected Publications	**Content by label** There is no content with the specified labels
Connections	• Biological Research/Methods Development • Mapping the genome: The vision, the science, the implementation; What is the genome project? [A round-table discussion] (1992) • Rockefeller University • Rockefeller University/Archives • Zinder, Norton D.
External Links	http://www.nytimes.com/2012/02/08/science/norton-d-zinder-researcher-in-molecular-biology-dies-at-83.html http://benchmarks.rockefeller.edu/2012/03/16/norton-zinder-pioneering-molecular-geneticist-dies-at-83/ http://www.nasonline.org/member-directory/deceased-members/48807.html http://library.cshl.edu/personal-collections/norton-zinder

10.6 Other Individuals

10.6.1 Bourke, Frederic

American venture capitalist who attempted to set up a company in Seattle and do genome research on a massive scale with high technology. Made an unsuccessful offer to John Sulston to lure the British geneticist away from academia.

Gender	Male
External Links	http://blog.wellcome.ac.uk/2011/05/05/75th-stories-sir-john-sulston-and-the-human-genome-project/

10.6.2 Bryer, Bruce

Boy who suffered from chronic granulomatous disease, Duchenne muscular dystrophy, and retinitis pigmentosa; died in 1983, and his chromosomes were used for research, tying specific genes to these diseases.

Birth	11/26/1966 - 12/26/1983
Gender	Male
External Links	https://news.google.com/newspapers?nid=1345&dat=19831228&id=_VZOAAAAIBAJ&sjid=fPkDAAAAIBAJ&pg=5503,2189

10.6.3 Castro, Jose

Suspect whose watch bore a blood stain that was found by company Lifecodes to match the DNA profile of a 1987 murder victim. This result was challenged by Mr. Castro's lawyers, and opened up a public debate about the interpretation of DNA profiles. Eric Lander wrote an article in *Nature* about this case, entitled “DNA fingerprinting on trial.”

Gender	Male
External Links	http://www.economist.com/node/2477036

10.6.4 DeSilva, Ashanthi

Ashanthi DaSilva was the first person to be treated with a government-sanctioned gene therapy; in 1990, she was given a normal copy of the ADA gene, which her own cells lacked. Dr. W. French Anderson of the National Heart, Lung and Blood Institute and Drs. Michael Blaese and Kenneth Culver, of the National Cancer Institute, were the doctors who treated Ashanthi DaSilva.

Gender	Female
External Links	http://www.cnn.com/TRANSCRIPTS/0007/01/yh.00.html http://www.pbs.org/saf/1202/features/genetherapy.htm

10.6.5 Kiley, Thomas D.

Legal Counsel and Vice President, Genentech, 1976-1988.

Author of "Patents on random complementary DNA fragments?" Science, 257, 915-918, 1992.

Gender	Male
External Links	Genentech

10.6.6 Mantyranta, Eero

Was a Finnish 7-time Olympic medalist, who was shown through a research study to have a genetic mutation that caused him to over-produce hemoglobin. Mantyranta was the subject of the last chapter of *The Sports Gene*, a book by David Epstein.

Gender	Male
External Links	http://sportsscientists.com/2013/12/eero-mantyranta-finlands-champion-1937-2013-obituary/

10.6.7 Metheny, Bradie

Coordinator of the Delegation for Basic Biomedical Research, which was founded in the early 1970s by Mahlon Hoagland. On behalf of the Delegation, Metheny organized a series of meetings in 1987 with the Senate and House appropriations committees.

Gender	Male
External Links	https://youtu.be/fsjcYln_msY https://www.linkedin.com/pub/bradie-metheny/41/461/b82

10.6.8 Steinberg, Wallace

Was chairman of the Healthcare Investment Corporation, once the largest venture capital fund devoted to health care. He was an early proponent of gene therapy and the use of animal organs for human transplantation.

Steinberg provided funding to establish The Institute for Genomic Research (TIGR), led by J. Craig Venter.

Gender	Male
External Links	http://www.nytimes.com/1995/07/29/obituaries/wallace-steinberg-dies-at-61-backed-health-care-ventures.html http://www.nytimes.com/1992/11/01/business/profile-wallace-steinberg-laying-pipe-for-the-fountain-of-youth.html?pagewanted=all

10.6.9 Witunski, Michael

Michael Witunski was president of the James S. McDonnell Foundation. In 1987, the James S. McDonnell Foundation was considering funding a private genome institute, an endeavor for which Witunski had approached Walter Gilbert.

Gender	Male
External Links	www.bloomberg.com-Story

11 MEETINGS & EVENTS

11.1 AAAS (meeting)

11.1.1 AAAS Annual Meeting - The Lawrence Livermore National Laboratory Human Genome Project (1989)

Topic	Meetings & Events
Historic Period	1989
Connections	American Association for the Advancement of Science (AAAS)
External Link	http://libgallery.cshl.edu/items/show/53628

11.1.2 AAAS Meeting (2001)

Public presentations by Francis Collins and Craig Venter the same week as the publication of the first drafts of the human genome.

Topic	Meetings & Events
Place	San Francisco
Historic Period	2001
Connections	American Association for the Advancement of Science (AAAS)

11.2 ASHG (meeting)

11.2.1 "The Human Genome Project" (1989)

Topic	Meetings & Events
Historic Period	1989
Connections	American Society of Human Genetics
External List	http://libgallery.cshl.edu/items/show/53290

11.3 Congress Centre Stazione Marittima

11.3.1 Final European Conference on the Yeast Genome Sequencing Network (1996)

Topic	Meetings & Events
Place	Trieste, Italy
Historic Period	1996

11.4 Cornell University (meeting)

11.4.1 Remembering Ef: A Symposium Celebrating the Life of Ef Racker - "The RNA Tie Club" and "The Human Genome Project" (1992)

Topic	Meetings & Events
Place	Cornell University
Historic Period	1992
Keywords	RNA
Connections	http://libgallery.cshl.edu/items/show/53350

11.5 Council of Scientific Society Presidents

11.5.1 Council of Scientific Society Presidents - "Mapping the Human Genome" (1990)

Topic	Meetings & Events
Historic Period	1990

11.6 CSHL/Wellcome Trust (meeting)

11.6.1 CSHL/Wellcome Trust Conference: Genome Informatics (2001-2009, 2011)

Topic	Meetings & Events
Historic Period	2001-2009, 2011
Keywords	bioinformatics
Connections	Cold Spring Harbor Laboratory The Wellcome Trust http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2447224/pdf/CFG-02-376.pdf

11.7 CSHL (meeting)

11.7.1 Arabidopsis Genomics (2000)

Topic	Meetings & Events
Date	2000
Links	Arabidopsis thaliana X

11.7.2 Cold Spring Harbor Symposia on Quantitative Biology: Human Genetics, Vol. XXIX (1964)

Topic	Meetings & Events
Synonyms	CSH Symposia
Place	Cold Spring Harbor, NY, USA
Historic Period	1964
Link	http://symposium.cshlp.org/site/misc/topic29.xhtml
Connections	McKusick, Victor

11.7.3 Cold Spring Harbor Symposia on Quantitative Biology LI: Molecular Biology of Homo Sapiens (1986)

During a discussion session, scientists hotly debate the merits of a possible human genome project at the annual Cold Spring Harbor Symposium on Quantitative Biology, held at Cold Spring Harbor Laboratory .

Topic	Meetings & Events
Place	Cold Spring Harbor Laboratory, Cold Spring Harbor, NY
Historic Period	1986

11.7.4 Commercial Implications of Genomics Research (1996)

Topic	Meetings & Events
Historic Period	1996

11.7.5 Computational Biology: Integrating Genome Sequence, Sequence Variation, and Gene Expression (2001)

Second CSHL Workshop on Computational Biology: Integrating Genome Sequence, Sequence Variation, and Gene Expression

Topic	Meetings & Events
Place	Cold Spring Harbor Laboratory
Historic Period	2001

11.7.6 Double Helix Awards - "First Lessons from My Personal Genome" (2008)

Topic	Meetings & Events
Historic Period	2008

11.7.7 First annual CSHL meeting on human genome mapping and sequencing (1988)

The idea for the Human Genome Organization (HUGO) was hatched at the first of CSHL's annual meetings on human genome mapping and sequencing.

Topic	Meetings & Events
Place	Cold Spring Harbor Laboratory
Historic Period	1988
Keywords	genome mapping; genome sequencing
Connections	http://www.hugo-hgm.org/about-hugo/

11.7.8 1998 Meeting (11th Annual)

Organized by: Boguski, Mark (Natl Center for Biotechnology Info; Brown, Stephen (MRC Mouse Genome Center); and Gibbs, Richard (Baylor College of Medicine).

Predecessor conference: Genome Mapping and Sequencing (1988-1997)

Successor conferences: Genome Sequencing and Biology (1999-2002) & The Biology of Genomes (2004-2012)

Topic	Meetings & Events
Place	Cold Spring Harbor Laboratory

Historic Period	1998
Connections	https://hum-molgen.org/meetings/meetings/0656.html

11.7.9 Genome Mapping and Sequencing (1988-1997)

The first of the Genome Mapping & Sequencing meetings was held at CSHL in 1988, organized by Charles Cantor, Maynard Olson, and Richard Roberts. These meetings rapidly became the annual focus for genome scientists. The first meeting had 96 abstracts; the 2010 meeting had 351. Now called The Biology of Genomes (2004-2012), it remains the preeminent meeting in the genomics world.

11.7.9.1 1988

Organized by: Cantor, Charles R. (Columbia University), Olson, Maynard (Washington University in St. Louis) and Roberts, Richard (Cold Spring Harbor Laboratory).

11.7.9.2 1989

Organized by: Cantor, Charles R. (Columbia University), Olson, Maynard (Washington University in St. Louis) and Roberts, Richard (Cold Spring Harbor Laboratory).

11.7.9.3 1990

Organized by: Cantor, Charles R. (Lawrence Berkeley National Laboratory), Olson, Maynard (Washington University in St. Louis) and Roberts, Richard (Cold Spring Harbor Laboratory).

11.7.9.4 1991

Organized by: Cantor, Charles R. (Lawrence Berkeley National Laboratory), Olson, Maynard (Washington University in St. Louis) and Roberts, Richard (Cold Spring Harbor Laboratory).

11.7.9.5 1992

Organized by: Myers, Rick (UCSF); Porteous, David (MRC) and Roberts, Richard (Cold Spring Harbor Laboratory).

11.7.9.6 1993

Organized by: Myers, Rick (Stanford University); Porteous, David (MRC) and Waterston, Robert (Washington University in St. Louis).

11.7.9.7 1994

Organized by: Myers, Rick (Stanford University); Porteous, David (MRC) and Waterston, Robert (Washington University in St. Louis).

11.7.9.8 1995

Organized by: Bentley, David (Sanger Centre); Green, Eric (National Institutes of Health (NIH)) and Waterston, Robert (Washington University in St. Louis).

11.7.9.9 1996

Organized by: Bentley, David (Sanger Centre); Green, Eric (National Institutes of Health (NIH)) and Hieter, Philip (John Hopkins Medical School).

11.7.9.10 1997

Organized by: Bentley, David (Sanger Centre); Green, Eric (National Institutes of Health (NIH)) and Hieter, Philip (John Hopkins Medical School).

Successor conferences: Genome Mapping, Sequencing, and Biology (1998) & Genome Sequencing and Biology (1999-2002) & The Biology of Genomes (2004-2012)

Topic	Meetings & Events
Place	Cold Spring Harbor Laboratory
Historic Period	1988-1997

11.7.10 Genome Sequencing and Biology (1999-2002)

11.7.10.1 1999

Organized by: Boguski, Mark (Natl Center for Biotechnology Info); Brown, Stephen (MRC Mouse Genome Center); and Gibbs, Richard (Baylor College of Medicine).

11.7.10.2 2000

Organized by: Boguski, Mark (Natl Center for Biotechnology Info); Brown, Stephen (MRC Mouse Genome Center); and Kwok, Pui-Yan (Washington University in St. Louis).

11.7.10.3 2001

Organized by: Kwok, Pui-Yan (Washington University in St. Louis); Rogers, Jane (Sanger Centre); and Rubin, Edward (Lawrence Berkeley National Laboratory).

11.7.10.4 2002 (15th Annual)

Organized by: Kwok, Pui-Yan (Washington University in St. Louis); Rogers, Jane (Sanger Centre); and Rubin, Edward (Lawrence Berkeley National Laboratory).

Predecessor conferences: Genome Mapping and Sequencing (1988-1997) & Genome Mapping, Sequencing, and Biology (1998)

Successor conference: The Biology of Genomes (2004-2012)

Topic	Meetings & Events
Place	Cold Spring Harbor Laboratory
Historic Period	1999-2002

11.7.11 Human Genome Planning Retreat (1989)

Place	CSHL (Banbury Center)
Historic Period	August 1989
Connections	http://libgallery.cshl.edu/items/show/53637

11.7.12 Meeting to plan the future of the U.S. genome project (1989)

Meeting held at Banbury to plan the future of the U.S. genome project.

Topics	Meetings
Place	Banbury Center, Cold Spring Harbor Laboratory (CSHL)
Historic Period	1989

11.7.13 Predecessor Conferences:

Personal Genomes conference launched at CSHL (2008, 2009, 2011)

Topic	Meetings & Events
Place	Cold Spring Harbor Laboratory
Historic Period	2012

11.7.14 Subsequent Conference

2012-Personal Genomes & Medical Genomics

Topic	Meetings & Events
Place	Cold Spring Harbor Laboratory
Historic Period	2008, 2009, 2011

11.7.15 Systems Biology: Genomic Approaches to Transcriptional Regulation (2003)

Topic	Meetings & Events
Place	CSHL
Historic Period	2003
Keywords	systems biology
Connections	http://www.ncbi.nlm.nih.gov/pmc/articles/PMC193626/

11.7.16 The Arabidopsis Genome: A Model for Crop Plants (1998)

Topic	Meetings & Events
Place	CSHL

Historic Period	1998
Keywords	plant genetics
Connections	https://groups.google.com/forum/#!topic/bionet.genome.arabidopsis/83WGiEjKS4o

11.7.17 The Arabidopsis Genome: From Sequence to Function (1997)

Topic	Meetings & Events
Place	CSHL
Historic Period	1997
Keywords	plant genetics
Connections	https://groups.google.com/forum/#!msg/bionet.genome.arabidopsis/jxuo9e9RTw8/ps_C9ZWHzjwJ

11.7.18 The Biology of Genomes (2004-2012)

11.7.18.1 2004

Organized by: Hudson, Thomas (McGill University); Paabo, Svante (Max Planck Institute for Molecular Genetics); Rogers, Jane (Sanger Centre); and Rubin, Edward (Lawrence Berkeley National Laboratory).

11.7.18.2 2005

Organized by: Frazer, Kelly (Perlegen); Hudson, Thomas (McGill University); Paabo, Svante (Max Planck Institute for Molecular Genetics); and Wilson, Richard (Washington University in St. Louis).

11.7.18.3 2006

Organized by: Frazer, Kelly (Perlegen); Hudson, Thomas (McGill University); Paabo, Svante (Max Planck Institute for Molecular Genetics); and Wilson, Richard (Washington University in St. Louis).

11.7.18.4 2007

Organized by: Ashburner, Michael (University of Cambridge); Frazer, Kelly (Perlegen); Lindblad-Toh, Kerstin (Broad Institute); and Wilson, Richard (Washington University in St. Louis).

11.7.18.5 2008

Organized by: Ashburner, Michael (University of Cambridge); Clark, Andrew (Cornell Univerisity); Lindblad-Toh, Kerstin (Broad Institute); and Weinstock, George (Washington University in St. Louis).

11.7.18.6 2009

Organized by: Ashburner, Michael (University of Cambridge); Clark, Andrew (Cornell Univerisity); Lindblad-Toh, Kerstin (Broad Institute); and Weinstock, George (Washington University in St. Louis).

11.7.18.7 2012

Organized by: Bustamante, Carlos; Celniker, Susan; Hirschhorn, Joel; and Ponting, Christopher.

Predecessor conferences: Genome Mapping and Sequencing (1988-1997) & Genome Mapping, Sequencing, and Biology (1998) & Genome Sequencing and Biology (1999-2002)

Topic	Meetings & Events
Place	Cold Spring Harbor Laboratory
Historic Period	2004-2012

11.7.19 The Bovine Genome (2009)

Topic	Meetings & Events
Place	CSHL
Historic Period	2009

11.7.20 The Evolution of Sequencing Technology (2015)

This meeting sought to document the evolving science of DNA sequencing by bringing together sequencing pioneers to talk about the history of their field. The history of the Human Genome Project figured prominently in the meeting.

Place	Cold Spring Harbor Laboratory, Cold Spring Harbor, NY
Historic Period	July 2015
Connections	http://library.cshl.edu/Meetings/sequencing/

11.7.21 The Genome of Homo Sapiens, CSHL Symposium Vol. LXVIII

Topic	Meetings & Events
Place	CSHL
Historic Period	2002-2003
Connections	http://www.cshlpress.com/default.tpl?action=full&--eqskudatarq=459

11.8 CUNY

11.8.1 "The Human Genome Project" (CUNY) (1989)

Topic	Meetings & Events
Place	Academy for the Humanities and Sciences, CUNY
Historic Period	1989
Keywords	Watson, James D.

External Link	http://libgallery.cshl.edu/items/show/53282

11.9 D. Collen Research Foundation

11.9.1 Genome Sequencing Meeting - "Human Genome Initiative" (1990)

Topic	Meetings & Events
Historic Period	1990
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/53306

11.10 DOE (meeting)

11.10.1 Alta Summit (1984)

According to author Robert Cook-Deegan: "The purpose was to ask those working on the front lines of DNA analytical methods to address a specific technical question: could new methods permit direct detection of mutations, and more specifically could any increase in the mutation rate among survivors of the Hiroshima and Nagasaki bombings be detected (in them or in their children)."

The meeting ended up influencing the idea of sequencing the human genome, however. "Many historical threads in the fabric that later became the Human Genome Project wind through that meeting, although it was not a meeting on mapping or sequencing the human genome," Cook-Deegan has written. "Through happenstance and historical accident, Alta links human genome projects to research on the effects of the atomic bombs dropped on Hiroshima and Nagasaki 40 years earlier. If genome projects prove important to biology, then historians will note the Alta meeting."

Topic	Meetings & Events
Historic Period	1984
Connections	U.S. DOE International Commission for Protection Against Environmental Mutagens and Carcinogens http://arep.med.harvard.edu/gmc/HGP.html http://www.histrecmed.fr/images/pdf/1984%201200%20Alta%20summit.pdf

11.10.2 DOE Human Genetics and Genome Analysis Meeting (1992)

Topic	Meetings & Events
Historic Period	February 1991
Place	CSHL (Banbury Center)
Links	http://libgallery.cshl.edu/items/show/53698

11.10.3 DOE Human Genome Program Contractor-Grantee Workshop I (1989)

Topic	Meetings & Events
Historic Period	1989

11.10.4 DOE Human Genome Program Contractor-Grantee Workshop II (1991)

Topic	Meetings & Events
Place	Santa Fe, NM
Historic Period	1991

11.10.5 DOE Human Genome Program Contractor-Grantee Workshop III (1993)

Topic	Meetings & Events
Place	Santa Fe, NM
Historic Period	1993

11.10.6 DOE Human Genome Program Contractor-Grantee Workshop IV (1994)

Topic	Meetings & Events
Place	Santa Fe, NM
Historic Period	1994

11.10.7 DOE Human Genome Program Contractor-Grantee Workshop IX (2002)

Topic	Meetings & Events
Place	Oakland, CA
Historic Period	2002

11.10.8 DOE Human Genome Program Contractor-Grantee Workshop V (1996)

Topic	Meetings & Events
Place	Santa Fe, NM
Historic Period	1996

11.10.9 DOE Human Genome Program Contractor-Grantee Workshop VI (1997)

Topic	Meetings & Events
Place	Santa Fe, NM
Historic Period	1997

11.10.10 DOE Human Genome Program Contractor-Grantee Workshop VII (1999)

Topic	Meetings & Events
Place	Oakland, CA
Historic Period	1999

11.10.11 DOE Human Genome Program Contractor-Grantee Workshop VIII (2000)

Topic	Meetings & Events
Place	Santa Fe, NM
Historic Period	2000

11.10.12 First DOE Human Genome Program Contractor-Grantee Workshop (1989)

Topic	Meetings & Events
Place	Santa Fe, NM
Historic Period	1989

11.10.13 Human Genome Project and the Private Sector: A Working Partnership (2001)

Topic	Meetings & Events
Historic Period	2001
Links	http://web.ornl.gov/sci/techresources/Human_Genome/project/privatesector.shtml

11.10.14 Largest-ever ELSI meeting attended by over 800 from diverse disciplines (1998)

Largest-ever ELSI meeting attended by over 800 from diverse disciplines. Sponsored by DOE; the Whitehead Institute; and the American Society of Law, Medicine, and Ethics.

Discipline	Meetings & Events
Synonyms	ELSI

Historic Period	1998
Connections	Whitehead Institute

11.10.15 Santa Fe Meeting (1986)

Charles DeLisi organizes the first DEO meeting on the HGP. DOE hosts meeting in Santa Fe to discuss plans to sequence the human genome.

Topic	Meetings & Events
Historic Period	1986
Connections	DOE
Links	http://www.nature.com/nature/journal/v455/n7215/full/455876a.html

11.11 EMBO (meeting)

11.12 ENCODE Project Consortium

11.12.1 Identification of Functional Elements in Mammalian Genomes (2004)

Topic	Meetings & Events
Historic Period	2004
Place	CSHL
Connections	ENCODE Project Consortium
Links	https://genomebiology.biomedcentral.com/articles/10.1186/gb-2005-6-3-312

11.13 Genome Action Coalition

11.13.1 2nd Annual Watson Lecture and Awards, Genome Action Coalition (1997)

Topic	Meetings & Events
Historic Period	1997
Keywords	Watson, James D.
Connections	http://libgallery.cshl.edu/items/show/51571

11.13.2 Genome Action Coalition Meeting (1998)

Topic	Meetings & Events
Historic Period	1998
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/54108

11.13.3 James Watson Lecture: The Genome Action Coalition (1995)

Topic	Meetings & Events
Historic Period	1995
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/54098

11.14 Green College

11.14.1 Green College Lecture - "From the Double Helix to the Human Genome Project" (1999)

Topic	Meetings & Events
Place	University of Oxford
Historic Period	1999
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/53421

11.15 Harvard (meeting)

11.15.1 John Harvard Lecture - "The Human Genome" (1992)

Topic	Meetings & Events
Place	Harvard Club of London
Historic Period	1992
Keywords	Watson, James D.
Connections	http://libgallery.cshl.edu/items/show/53351

11.16 Harvard Club of London

11.16.1 John Harvard Lecture, Harvard Club of London - "The Human Genome" (8 December 1992)

Topic	Meetings & Events
Historic Period	1992
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/53351

11.17 HGSE

11.17.1 HGSE Meeting (1989)

Topic	Meetings & Events
Place	Bethesda, Maryland
Historic Period	1989
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/53635

11.18 HHMI (meeting)

11.18.1 HHMI Meeting on Human Genome Sequencing (1986)

Topic	Meetings & Events
Place	Howard Hughes Medical Institute (HHMI)
Historic Period	1986
Keywords	Watson, James D.
Connections	http://libgallery.cshl.edu/items/show/53918

11.19 HUGO (meeting)

11.19.1 Genetic Mapping Workshop (1989)

Topic	Meetings & Events
Place	New Haven, CT

Historic Period	1989
Keywords	Watson, James D.
Connections	http://libgallery.cshl.edu/items/show/53636

11.19.2 Human Gene Mapping Workshop (HGM 9.5) (1988)

Topic	Meetings & Events
Synonym	HGM 9.5
Place	New Haven, CT
Historic Period	August 1988
Keywords	Watson, James D.
Connections	http://libgallery.cshl.edu/items/show/53621

11.19.3 Human Gene Mapping Workshop (HGM-10) (1989)

Topic	Meetings & Events
Synonym	HGM-10
Place	New Haven, CT
Historic Period	1989
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/53636

11.20 Hypothesis (Milan)

11.20.1 Ten Nobels for the Future Talk - "Ethical Implications of the Human Genome Project" (1994)

Topic	Meetings & Events
Place	Milan, Italy
Historic Period	1994
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/53386 http://libgallery.cshl.edu/items/show/53712

11.21 Illinois Institute of Technology

11.21.1 Henry Townley Heald Award - "From the Double Helix to the Human Genome Project" (1999)

Topic	Meetings & Events
Synonyms	Chicago, Illinois
Place	Illinois Institute of Technology, Chicago
Historic Period	1999
Keywords	Watson, James D.
Connections	http://libgallery.cshl.edu/items/show/53425

11.22 IMAGE Consortium (event)

11.22.1 International IMAGE Consortium established (1993)

This meeting established the International IMAGE consortium to coordinate efficient mapping and sequencing of gene-representing cDNAs.

Topic	Meetings & Events
Historic Period	1993
Links	http://www.imageconsortium.org/?p=19

11.23 Immunex Corporation (meeting)

11.23.1 Breaking New Ground Event, Immunex Corporation - "Genome Implications" (2001)

Topic	Meetings & Events
Place	Seattle, Washington
Historic Period	2001
Keywords	Watson, James D.
Connections	http://libgallery.cshl.edu/items/show/53440

11.24 Indiana University (meeting)

11.24.1 Breneman Lecture - "The Human Genome Project" (1992)

Topic	Meetings & Events
Place	Indiana University
Historic Period	1992
External Link	http://libgallery.cshl.edu/items/show/53333

11.25 Institute of Medicine

11.25.1 Decade of the Brain Symposium - "The Brain Frontier Beyond the Human Genome" (1990)

Topic	Meetings & Events
Place	Institute of Medicine
Historic Period	1990
Keywords	Watson, James D.
Connections	http://libgallery.cshl.edu/items/show/53305

11.26 International Congress of Genetics

11.26.1 17th International Congress of Genetics - "Genetics and Understanding of Life" (1993)

Topic	Meetings & Events
Historic Period	1993
Keywords	Watson, James D.
Connections	http://libgallery.cshl.edu/items/show/53776

11.27 International Rice Genome Sequencing Project (IRGSP)

11.27.1 Meeting to form the International Rice Genome Sequencing Project (1998)

Representatives of Japan, the U.S., the E.U., China, and South Korea meet in Tsukuba, Japan, to establish guidelines for an international collaboration to sequence the rice genome.

Topic	Meetings & Events
Place	Tsukuba, Japan
Historic Period	1998
Connections	International Rice Genome Sequencing Project (IRGSP)
Links	http://webcache.googleusercontent.com/search?q=cache:gtJPLUg3GlcJ:bic.searca.org/feature/bic-ricegenome.html+&cd=3&hl=en&ct=clnk&gl=us

11.28 Kaiser Wilhelm Institutes

11.28.1 Symposium entitled "Biomedical Sciences and Human Experimentation at Kaiser Wilhelm Institutes - The Auschwitz Connection" (2001)

Topic	Meetings & Events
Place	Max-Planck-Gessellschaft
Historic Period	2001
Keywords	Watson, James D. Markl, Hubert
Connections	Symposium_2001.pdf
External Link	http://libgallery.cshl.edu/items/show/43857 http://libgallery.cshl.edu/items/show/43860

11.29 Los Alamos National Laboratory (meeting)

11.29.1 Mapping the genome: The vision, the science, the implementation; What is the genome project? [A round-table discussion] (1992)

"Mapping the genome: The vision, the science, the implementation; What is the genome project?" [A round-table discussion at Los Alamos National Laboratory with David Baltimore, David Botstein, David R. Cox, David J. Galas, Leroy Hood, Robert K. Moyzis, Maynard V. Olson, Nancy S. Wexler, and Norton D. Zinder.] Los Alamos Science 20, 68–102. [1992]

Topic	Meetings & Events
Place	Los Alamos National Laboratory
Historic Period	1992

11.30 Max-Planck-Institut fur Entwicklungsbiologie

11.30.1 Watson speaks at the Max-Planck-Institut fur Entwicklungsbiologie (1990)

Topic	Meetings & Events
Place	Max-Planck-Institut fur Entwicklungsbiologie
Historic Period	1990
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/53657

11.31 MSKCC (meeting)

11.31.1 From the Double Helix to the Human Genome Meeting (1998)

Topic	Meetings & Events
Place	Memorial Sloan-Sloan Kettering Cancer Center
Historic Period	1998

Keywords	Watson, James D.
Connections	http://libgallery.cshl.edu/items/show/53409

11.32 New York Academy of Medicine

11.32.1 Sylvia and Herbert Berger Lecture - "The Ethical Consequences of the Human Genome Project" (1994)

Topic	Meetings & Events
Place	New York Academy of Medicine
Historic Period	1994
Keywords	Watson, James D.
Connections	http://libgallery.cshl.edu/items/show/53382

11.33 New York Hall of Science

11.33.1 Reflections on Science Past and Future by Nobel Laureate Recipients, New York Hall of Science - "The Human Genome Project" (March 1992)

Topic	Meetings & Events
Place	New York Hall of Science
Historic Period	1992
External Link	http://libgallery.cshl.edu/items/show/53336

11.34 NIH (meeting)

11.34.1 Ad Hoc Program Advisory Committee on Complex Genomes (1988)

James Wyngaarden, then director of the National Institutes of Health, called this meeting in order to organize a genome program. Wyngaarden then announced he would form the Office of Human Genome Research, and many scientists recommended James Watson become the head of it.

Topic	Meetings & Events
Historic Period	February - March 1988

Place	Reston, VA
Link	http://wellcomelibrary.org/item/b19988357#?c=0&m=0&s=0&cv=0 https://books.google.com/books?id=5B0k-LUDjVEC&pg=PA355&lpg=PA355&dq=Ad+Hoc+Program+Advisory+Committee+on+Complex+Genomes&source=bl&ots=SI E60&hl=en&sa=X&ved=0ahUKEwitm6vg283NAhXNQD4KHWg8DBM4ChDoAQgmMAI#v=onepage&q=Ad%20Hoc%20Prog

11.34.2 Board on Basic Biology Meeting on Mapping and Sequencing the Human Genome (1986)

Topic	Meetings & Events
Historic Period	1986
Connections	Burris, John
Links	http://libgallery.cshl.edu/items/show/53919

11.34.3 First Annual Center Director's Meeting (1991)

Topic	Meetings & Events
Historic Period	1991
Links	http://wellcomelibrary.org/item/b1984539x#?c=0&m=0&s=0&cv=0

11.34.4 From Double Helix to the Human Sequence and Beyond (2003)

This two-day event was organized by the National Institutes of Health, the National Human Genome Research Institute, and the Department of Energy to discuss the 50th anniversary of the discovery of the DNA double helix and the recently sequenced human genome.

Topic	Meetings & Events
Historic Period	April 2003
Place	Bethesda, MD
Connections	NHGRI
Links	https://www.genome.gov/27539610/from-double-helix-to-human-sequence--and-beyond/

11.34.5 From the Double Helix to the Human Genome Project, First Stetten Museum-NHGRI Lecture in the History of Modern Genetics (1998)

Topic	Meetings & Events
Historic Period	1998
Keywords	Watson, James D., Collins, Francis S.
Connections	http://libgallery.cshl.edu/items/show/51527

11.34.6 Genomics: The Next Step (1997)

Topic	Meetings & Events
Historic Period	1997

11.34.7 HGP Center Grants Meeting (1992)

Topic	Meetings & Events
Historic Period	1992
Connections	http://libgallery.cshl.edu/items/show/53704

11.34.8 Human Genome Conference (1989)

Topic	Meetings & Events
Place	Bethesda, Maryland
Historic Period	1989
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/53643

11.34.9 NCHGR Workshop (1991)

Topic	Meetings & Events
Historic Period	1991
Keywords	National Center for Human Genome Research (NCHGR)
External Link	http://libgallery.cshl.edu/items/show/53690

11.34.10 NHGRI Principal Investigator Meeting (1998)

Topic	Meetings & Events
Synonyms	Principal investigator (PI)
Historic Period	1998
Keywords	National Human Genome Research Institute (NHGRI)
External Link	http://libgallery.cshl.edu/items/show/53721

11.34.11 NIH Conference on International Aspects of Ethical and Social Issues in Human Genome Research (1991)

Topic	Meetings & Events
Historic Period	1991
Keywords	National Institutes of Health (NIH) Ethical, legal, and social implications (ELSI)
External Link	http://libgallery.cshl.edu/items/show/53686

11.34.12 The Genomics Landscape a Decade After the Human Genome Project (2013)

This symposium was held to celebrate the tenth anniversary of the completion of the Human Genome Project, as well as to discuss the scientific and medical advances made since sequencing the genome.

Place	Bethesda, MD
Historic Period	2013
Links	https://www.genome.gov/27552238/hgp10-the-genomics-landscape-a-decade-after-the-human-genome-project/ https://www.genome.gov/27552257/hgp10-symposium-agenda/

11.34.13 Workshop for Scientists Involved in Mapping Human Chromosome 11 (1989)

Topic	Meetings & Events
Place	Lister Hill Center
Historic Period	1989
External Link	http://libgallery.cshl.edu/items/show/53631

11.34.14 Workshop on Functional Properties of Tumors of T and B Lymphocytes (1976)

Topic	Meetings & Events
Historic Period	1976
External Link	http://libgallery.cshl.edu/items/show/40781

11.35 NSF (meeting)

11.35.1 International Workshop on the Applications of Genetic Engineering to Basic Biology (1984)

Topic	Meetings & Events
Place	Lahore, Pakistan
Historic Period	1984
Keywords	NSF; Government of Pakistan
External Link	http://libgallery.cshl.edu/items/show/53258

11.36 Phillips Academy

11.36.1 DNA and the Human Genome Project (1999)

Topic	Meetings & Events
Place	Phillips Academy, Andover, MA
Historic Period	1999
Keywords	Watson, James D.
Connections	http://libgallery.cshl.edu/items/show/53427

11.37 Presbyterian Health Foundation (meeting)

11.37.1 Historical Considerations and Sequencing the Entire Human Genome (The Human Genome Initiative) (1995)

Topic	Meetings & Events
Historic Period	1995
Keywords	Presbyterian Health Foundation
Connections	http://libgallery.cshl.edu/items/show/53390

11.38 President of the French Republic

11.38.1 From Gene to Genome: Hereditary and Society - "Genetic Variation in Human" (2005)

Topic	Meetings & Events
Historic Period	2005
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/53472

11.39 Princeton University (meeting)

11.39.1 Implementing the Human Genome Project Meeting (1990)

Topic	Meetings & Events
Place	Princeton University
Historic Period	1990
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/53297

11.40 Royal College of Physicians, London (meeting)

11.40.1 UK Human Genome Program Users Meetings (1991)

Topic	Meetings & Events
Place	Royal College of Physicians, London
Historic Period	1991
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/53682

11.41 Smithsonian Institution

11.41.1 Smithsonian Institution Lecture, "Mapping the Human Genome" (1989)

Topic	Meetings & Events (by sponsor)
Historic Period	1989
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/53284

11.41.2 Smithsonian opens human genome exhibit: Unlocking Life's Code (2013)

Topic	Meetings & Events
Historic Period	2013

Connections	http://www.nih.gov/news-events/news-releases/new-exhibition-makes-genome-accessible-public https://unlockinglifescode.org/about http://www.genome.gov/Smithsonian/

11.42 St. Jude Children's Research Hospital

11.42.1 Lecture: "From the Double Helix to the Human Genome" (1998)

Topic	Meetings & Events
Place	St. Jude Children's Research Hospital
Historic Period	1998
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/53417

11.43 Stanford University (meeting)

11.43.1 Louis S.B. Leakey Symposium: Genetics and Human Evolution - "An Historical Perspective and Outlook for the Future" (1995)

Topic	Meetings & Events
Place	Stanford University
Historic Period	1995
Keywords	Watson, James D.
Connections	http://libgallery.cshl.edu/items/show/53400

11.44 Stellenbosch University

11.44.1 "The Human Genome Project" and "My Life as a Scientist" (1993)

Topic	Meetings & Events
Place	Stellenbosch University
Historic Period	1993
Keywords	Watson, James D.
Connections	http://libgallery.cshl.edu/items/show/53353

11.44.2 Human Genome Project Lecture (1993)

Topic	Meetings & Events
Historic Period	1993
Keywords	Stellenbosch University; Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/53706

11.45 STEPP - The Association for Science, Engineering, Technology, and Public Policy

11.45.1 STEPP - Sequencing the Human Genome: Biology Meets Big Science (1989)

Topic	Meetings & Events
Historic Period	1989
Keywords	STEPP - The Association for Science, Engineering, Technology, and Public Policy
External Link	http://libgallery.cshl.edu/items/show/53630

11.46 Stony Brook University (meeting)

11.46.1 Human Diseases Colloquium: Molecular Basis of Viral and Oncogenic Diseases (1996)

Topic	Meetings & Events
Place	Stony Brook University
Historic Period	1996
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/53955

11.47 Ten Nobels for the Future (meeting)

11.47.1 10 Nobels for the Future Talk, Milan - Ethical Implications of the HPG (7 December 1994)

Topic	Meetings & Events
Historic Period	1994
Place	Milan, Italy
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/53712 http://libgallery.cshl.edu/items/show/53386

11.48 The Institute for Genomic Research - TIGR (event)

11.48.1 J. Craig Venter leaves NIH to set up The Institute for Genomic Research (TIGR) (1992)

J. Craig Venter leaves NIH to set up The Institute for Genomic Research (TIGR), a nonprofit in Rockville, Maryland. William Haseltine heads its sister company, Human Genome Sciences, to commercialize TIGR products.

Topic	Meetings & Events
Place	Rockville, Maryland
Historic Period	1992
Keywords	The Institute for Genomic Research (TIGR) Venter, J. Craig Human Genome Sciences Haseltine, William

11.49 Trinity College, Dublin

11.49.1 DNA and the Human Future (2001)

Topic	Meetings & Events
Place	Trinity College, Dublin
Historic Period	2001
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/53442

11.50 U.S. Congress (meeting)

11.50.1 Forum on Genetic Testing and its Use and Misuse in the Workplace (1998)

Topic	Meetings & Events
Historic Period	1998
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/53745

11.51 U.S. Department of Health and Human Services - HHS (event)

11.51.1 Genome Sequencing Conference III (1991)

Topic	Meetings & Events
Place	Hilton Head, SC
Historic Period	1991
Keywords	U.S. HHS
External Link	http://libgallery.cshl.edu/items/show/53691

11.51.2 HHS Secretary Shalala Lauds First Complete Sequencing of a Human Chromosome (1999)

HHS Secretary Shalala Lauds First Complete Sequencing of a Human Chromosome, on the Human Genome Project's sequencing of human chromosome 22.

Topic	Meetings & Events
Historic Period	1999
Connections	Shalala, Donna

11.51.3 Second Genome Sequencing Conference (1990)

Topic	Meetings & Events
Historic Period	1990
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/53662

11.52 U.S. President

11.52.1 HGP leaders and President Clinton announce the completion of a "working draft" (2000)

HGP leaders and President Bill Clinton announce the completion of a "working draft" DNA sequence of the human genome.

Topic	Meetings & Events
Historic Period	2000
Keywords	Clinton, William J.

11.52.2 Informatics Meets Genomics at the White House event (1999)

Informatics Meets Genomics at the White House event exploring the explosion of information technology and genetic research.

Topic	Meetings & Events
Historic Period	1999
Links	https://www.genome.gov/10002107/1999-release-informatics-meets-genomics-at-the-white-house/

11.53 UCLA (meeting)

11.53.1 Engineering and the Human Germline Symposium, UCLA - "The Road Ahead: Human Germline and Society" (Panel Discussion) (1998)

Topic	Meetings & Events
Place	UCLA
Historic Period	1998
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/53408

11.54 UNESCO (meeting)

11.54.1 Symposium on Human Genome Research, UNESCO (1990)

Topic	Meetings & Events
Synonyms	UNESCO
Historic Period	1990
Keywords	United Nations Educational, Scientific, and Cultural Organization (UNESCO)
External Link	http://libgallery.cshl.edu/items/show/53931

11.55 University College Galway

11.55.1 The Ethical Implications of the Human Genome Project (1995)

Topic	Meetings & Events
Place	University College Galway
Historic Period	1995
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/53777

11.56 University of Alabama School of Medicine, UAB

11.56.1 25th Annual Medical Student Research Day, University of Alabama School of Medicine - "Human Genome Project"

Topic	Meetings & Events
Place	University of Alabama School of Medicine
Historic Period	1998
Keywords	Human genome
External Link	http://libgallery.cshl.edu/items/show/53279

11.57 University of California

11.57.1 The Human Genome Projects: Issues, Goals, and California's Participation (1988)

Topic	Meetings & Events
Historic Period	1988
Keywords	University of California; Lawrence Berkeley Laboratory; California Department of Commerce
External Link	http://libgallery.cshl.edu/items/show/53622

11.58 University of California, Berkeley (meeting)

11.58.1 Biotechnology at 25 Symposium - From the Double Helix to the Human (1999)

Topic	Meetings & Events
Place	Bancroft Library, University of California, Berkeley
Historic Period	1999
External Link	http://libgallery.cshl.edu/items/show/53422

11.59 University of California, Santa Cruz (meeting)

11.59.1 Meeting on human genome sequencing (1986)

Topic	Meetings & Events
Title	National Research Council (NRC). Planning meeting for NRC Genome report
Place	Woods Hole
Historic Period	1986
Keywords	John Burris
External Link	http://libgallery.cshl.edu/items/show/53919

11.59.2 Santa Cruz 1985 Meeting (1985)

The 1985 meeting in Santa Cruz was one of the first discussions about possibly sequencing the human genome.

Topic	Meetings & Events
Historic Period	1985
Keywords	Watson, James D.
Connections	http://libgallery.cshl.edu/items/show/74470 http://genomesymposium.ucsc.edu/fs-1985SCW.html

11.60 University of Chicago (meeting)

11.60.1 From the Double Helix to the Human Genome (1993)

Topic	Meetings & Events
Place	University of Chicago
Historic Period	1993
External Link	http://libgallery.cshl.edu/items/show/53363

11.61 University of Iowa

11.61.1 Iowa Humanities Symposium - "The Next 10 Years in Human Genetics" (1992)

Topic	Meetings & Events
Place	University of Iowa
Historic Period	1992
External Link	http://libgallery.cshl.edu/items/show/53337

11.62 University of Leicester

11.62.1 Genetics and Society Silver Jubilee Symposium - "The Human Genome Initiative" (1990)

Topic	Meetings & Events
Place	University of Leicester
Historic Period	1990
External Link	http://libgallery.cshl.edu/items/show/53296

11.63 University of Michigan (meeting)

11.63.1 Our Genes Our Health: Implications of the Human Genome Project for the Future of Medicine (1991)

Topic	Meetings & Events
Place	University of Michigan
Historic Period	1991
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/53327

11.64 University of Oklahoma (meeting)

11.64.1 The Human Frontier: DNA, Genes and Molecular Biology (1995)

Topic	Meetings & Events
Place	University of Oklahoma
Historic Period	1995
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/53390

11.65 University of Toronto

11.65.1 Lecture - The Human Genome Project (1994)

Topic	Meetings & Events
Place	University of Toronto
Historic Period	1994
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/53711

11.65.2 Polanyi Chair Inaugural Talk - "The Human Genome Project" (1994)

Topic	Meetings & Events
Place	University of Toronto
Historic Period	1994
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/53384 http://libgallery.cshl.edu/items/show/51567 http://libgallery.cshl.edu/items/show/53711

11.66 UT Southwestern (meeting)

11.66.1 Lecture - "From the Double Helix to the Human Genome Project" (1998)

Topic	Meetings & Events
Place	University of Texas Southwestern Medical Center at Dallas

Historic Period	1998
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/53418

11.66.2 Roundtable: The Human Genome Project (1993)

Topic	Meetings & Events
Place	University of Texas Southwestern Medical Center
Historic Period	1993
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/53707

11.67 Wellcome Trust (meeting)

11.67.1 Bermuda Genome Meeting (1997)

This meeting reaffirmed the principles of "rapid data release and public access to the primary genomic sequence."

Topic	Meetings & Events
Historic Period	1997
External Link	http://dukespace.lib.duke.edu/dspace/handle/10161/7733 https://www.genome.gov/edkit/pdfs/1997a.pdf

11.67.2 International conference on status of HGP (1989)

Topic	Meetings & Events
Historic Period	1989
Keywords	Wellcome Trust

11.67.3 International Strategy Meeting on Human Genome Sequencing (1996-1999)

Annual meeting organized by the Wellcome Trust. First one held in 1996 in Bermuda, where the Bermuda Accord was formulated.

Topic	Meetings & Events
Historic Period	1996-1999
Keywords	Wellcome Trust
Links	Cracking the Genome: Inside the Race to Unlock Human DNA By Kevin Davies

11.67.4 Ten companies and the Wellcome Trust launch the SNP consortium (1999)

Ten companies and the Wellcome Trust launch the SNP consortium, with plans to publicly release data quarterly.

Topic	Meetings & Events
Historic Period	1999
Keywords	The Wellcome Trust SNP Consortium

11.67.5 Third International Meeting on Human Genome Sequencing (1998)

Topic	Meetings & Events
Historic Period	1998
Keywords	Wellcome Trust U.S. NIH U.S. DOE 164th Genome Technology Committee, Japan Society for Promotion of Science UK Medical Research Council

11.67.6 Wellcome Trust Genome Campus Inaugural Symposium - "From the Double Helix to the Human Genome" (1998)

Topic	Meetings & Events
Place	Wellcome Trust Genome Campus
Historic Period	1998

11.68 Wolf Trap Conference Center

11.68.1 Wolf Trap Genome Sequencing Conference (1989)

Topic	Meetings & Events
Historic Period	1989
Keywords	Watson, James D.
External Link	http://libgallery.cshl.edu/items/show/53641 http://libgallery.cshl.edu/items/show/70958

12 POLICY/FUNDING (BY AGENCY)

12.1 International

12.1.1 DOE-MRC Fugu rubripes genome collaborative project (2000)

Organized by the U.S. Department of Energy's Joint Genome Institute, the Fugu genome project was an international consortium of researchers dedicated to sequencing the genome of Fugu. A draft sequence of the genome was released in 2001.

Topic	Policy/Funding (by agency)
Historic period	2000-2002
Keywords	genome, sequencing, pufferfish, fugu, DOE, MRC
Connections	http://fugu.nimr.mrc.ac.uk/News/MRC_Press_release.html DOE Medical Research Council (MRC) Fugu rubripes (pufferfish)

12.1.2 Guidelines for HGP data release and resource sharing announced (1992)

In a meeting held in December 1992, the DOE-NIH Joint Subcommittee on the Human Genome approved a set of guidelines on sharing data gathered in the Human Genome Project. Data was mandated to be publicly released within six months of discovery.

Topic	Policy/Funding (by agency)
Place	Washington, DC
Historic Period	1992
Keywords	data sharing, data release, DOE, NIH
Connections	http://www.genome.gov/25520334 https://www.genome.gov/edkit/pdfs/1992b.pdf

12.1.3 HUGO founded (1989)

HUGO was first conceived in April 1988, at a meeting on genome mapping and sequencing at Cold Spring Harbor Laboratory; it was formally established and incorporated in 1989.

HUGO founded by genome scientists to coordinate their research efforts internationally.

Topic	Policy/Funding (by agency)
Synonyms	Human Genome Organisation
Place	Geneva, Switzerland
Historic Period	1989
Keywords	CSHL
Connections	http://www.hugo-international.org/abt_history.php http://www.hugo-international.org/HUGO-History Human Genome Organization (HUGO)

12.1.4 Human genome variation from population-scale sequencing (2010)

In October 2010, a paper appeared in *Nature* describing "a map of human genome variation from population-scale sequencing." This was the result of the 1000 Genomes Project, an effort to study genetic variation as a way to clarify genotype and phenotype.

Topic	Policy/Funding (by agency)
Synonyms	1000 Genomes Project
Historic period	2010
Keywords	genetic variation
Connections	http://www.ncbi.nlm.nih.gov/pubmed/20981092

12.1.5 International HapMap Project begins (2002)

The goal of the International HapMap Project was to find common sequence variations in the human genome as a way to study disease and possible diagnostics.

Topic	Policy/Funding (by agency)
Historic period	2002
Keywords	genetic variation
Connections	http://hapmap.ncbi.nlm.nih.gov/abouthapmap.html http://www.nature.com/nature/journal/v426/n6968/full/nature02168.html HapMap

12.1.6 International Strategy Meeting on Human Genome Sequencing (policy) (1996)

Meeting in Bermuda funded by the Wellcome Trust, where international HGP partners agree to release sequence data into public databases within 24 hours.

Topic	Policy/Funding (by agency)
Synonyms	International Strategy Meeting on Human Genome Sequencing
Place	Princess Hotel, Southampton, Bermuda
Historic Period	February 25-28, 1996
Keywords	data sharing

Connections	http://dukespace.lib.duke.edu/dspace/handle/10161/7715

12.1.7 Mouse genome projects (1999)

The Mouse Genome Project was an international effort to sequence the mouse genome. The project was completed by the international Mouse Genome Sequencing Consortium, which comprised scientists from research centers in the United States, the United Kingdom and Europe. These included the Whitehead Institute, the Wellcome Trust Sanger Institute and the European Bioinformatics Institute.

Topic	Policy/Funding (by agency)
Historic period	1999-2002
Connections	https://www.genome.gov/10002108 https://www.genome.gov/10005831/2002-release-the-mouse-genome-and-the-measure-of-man/

12.1.8 National Geographic-IBM Genographic Project is launched (2005)

The Genographic Project studies human migration through the analysis of DNA. It is a privately funded joint effort of National Geographic and IBM.

Topic	Policy/Funding (by agency)
Synonyms	Genographic Project
Historic period	2005-present
Keywords	migration patterns
Connections	https://genographic.nationalgeographic.com/genographic-launch/

12.1.9 Sydney Brenner urges the EU to undertake a concerted program to map and sequence the human genome (1986)

In February 1986, Sydney Brenner, then affiliated with the MRC, wrote the European Commission urging them to organize a program to sequence the human genome. He also urged that they get involved with mapping and sequencing the genomes of various other organisms.

Topic	Policy/Funding (by agency)
Place	Medical Research Council (MRC)
Historic Period	1986
Keywords	European Commission, sequencing, Sydney Brenner
Connections	http://www.ncbi.nlm.nih.gov/pubmed/3726552 https://dnapatents.georgetown.edu/genomearchive/TheGeneWarsByRobertCookDeeganP353toBackCover.pdf Brenner, Sydney

12.1.10 Universal Declaration on the Human Genome and Human Rights (1997)

In November 1997, UNESCO adopted the Universal Declaration on the Human Genome and Human Rights. In the face of advancing research in human genetics, the declaration asserted principles of human equality and dignity, especially in light of the Human Genome Project. Among other things, the declaration makes clear that though genetic research holds great promise to treating disease, no one should be discriminated against for his or her genetic makeup.

Topic	Policy/Funding (by agency)
Place	Paris, France
Historic Period	1997
Keywords	human rights, equality
Connections	http://portal.unesco.org/en/ev.php-URL_ID=13177&URL_DO=DO_TOPIC&URL_SECTION=201.html http://www.unesco.org/new/en/social-and-human-sciences/themes/bioethics/human-genome-and-human-rights/ http://unesdoc.unesco.org/images/0011/001102/110220e.pdf

12.2 Japanese Government

12.2.1 Japanese government funding of sequencing groups (1995)

In 1995 the Japanese government began funding sequencing research by groups at the universities of Tokyo, Keio, and Tokai.

Topic	Policy/Funding (by agency)
Historic period	1995
Keywords	Japan, sequencing, Tokyo, Keio, Tokai
Connections	http://www.ncbi.nlm.nih.gov/pubmed/1991587 http://web.stanford.edu/dept/HPS/RethinkingSciCiv/etexts/Fujimura/Transnational%20Genomics.html

12.2.2 Rice genome sequencing effort, Japan (1991)

Japan began a rice genome sequencing project in 1991.

Topic	Policy/Funding (by agency)
Synonyms	Rice Genome Research Program
Historic period	1991
Keywords	rice genome, Japan
Connections	http://www.ncbi.nlm.nih.gov/pubmed/9482829 http://www.pnas.org/content/95/5/2027.full.pdf

12.3 U.S. Congress

12.3.1 Advances in Genetics Research and Technologies: Challenges for Public Policy, to the Senate Committee on Labor and Human Resources (1996)

In July 1996, Francis Collins, then director of the National Center for Human Genome Research, appeared before the Senate Committee on Labor and Human Resources. He discussed, among other things, the NCHGR's increasing investment in new DNA sequencing technologies.

Topic	Policy/Funding (by agency)
Place	Washington, DC
Historic Period	1996
Keywords	sequencing technology
Connections	https://www.genome.gov/10002351 https://www.genome.gov/10002351/1996-senate-hearing-on-genetics-research/ U.S. Senate

12.3.2 Congressional Task Force on Health Records and Genetic Privacy Preventing Genetic Discrimination in Health Insurance (1997)

In July 1997, the Congressional Task Force on Health Records and Genetic Privacy Preventing Genetic Discrimination in Health Insurance heard testimony from Francis Collins, then director of the National Human Genome Research Institute. He stressed that advanced genetic testing and increased knowledge of disease genes made discrimination an imminent issue his organization and the government had to face.

Topic	Policy/Funding (by agency)
Place	Washington, DC
Historic Period	1997
Keywords	discrimination
Connections	https://www.genome.gov/10002352

12.3.3 Hearing on Possible Uses and Misuses of Genetic Information Before the House Government Operations Subcommittee on Government Information, Justice, and Agriculture (1991)

In October 1991, Bernadine Healy, then director of the National Institutes of Health, testified before the U.S. House of Representatives on the possible abuse of genetics research. She urged that, as a matter of civil rights, individuals not be discriminated against based on their genetic profiles.

Topic	Policy/Funding (by agency)
Place	Washington, DC
Historic Period	1991

Keywords	discrimination, Bernadine Healy
Connections	http://www.ncbi.nlm.nih.gov/pubmed/1562640 http://kdfletcherlaw.net/wp-content/uploads/2015/09/FRYE15-A1Proc2.pdf U.S. House of Representatives

12.4 U.S. DOE

12.4.1 Advisory panel suggests DOE spend $200 million per year on mapping and sequencing the human genome (1987)

In April 1987, a report from the U.S. Department of Energy's Health and Environmental Research Advisory Committee recommended spending $200 million per year on a fifteen-year project to sequence the human genome.

Topic	Policy/Funding (by agency)
Place	Washington, DC
Historic Period	1987
Keywords	DOE, funding
Connections	http://web.ornl.gov/sci/techresources/Human_Genome/publicat/OTAreport.pdf https://dnapatents.georgetown.edu/genomearchive/TheGeneWarsByRobertCookDeeganP353toBackCover.pdf

12.4.2 Department of Energy (DOE) genome studies begin (1986)

In 1986, the Department of Energy's Office of Health and Environmental Research (OHER) began to assess whether a human genome program would be feasible.

Topic	Policy/Funding (by agency)
Historic period	1986
Connections	https://www.osti.gov/accomplishments/genomehistory.html

12.4.3 DOE funding of pilot projects to sequence ends of BAC clones (1996)

in September 1996, the Department of Energy devoted $5 million to funding six pilot projects aimed at sequencing the ends of BAC clones.

Topic	Policy/Funding (by agency)
Historic period	1996
Keywords	BAC clones, DOE
Connections	http://web.ornl.gov/sci/techresources/Human_Genome/publicat/hgn/v8n1/08bacend.shtml http://www.biosino.org/hgp/Science-Robertsetal_%20291%285507%291195.htm Bacterial artificial chromosome (BAC)

12.4.4 DOE funding of production BAC end sequencing (1998)

Topic	Policy/Funding (by agency)
Historic period	1998
Connections	http://web.ornl.gov/sci/techresources/Human_Genome/publicat/hgn/v10n1/04bacend.shtml BAC clones, ends, sequences of

12.4.5 DOE Joint Genome Institute performance sequencing facility opens (1999)

Topic	Policy/Funding (by agency)
Historic period	1999
Connections	https://www.genomeweb.com/informatics/us-does-jgi-merges-best-its-bioinformatics-tools https://www.genomeweb.com/informatics/joint-genome-institute-installs-megabace-sequencers-after-4-week-performance-tes https://www.genome.gov/10001364 JGI

12.4.6 DOE Microbial Genome Project launched (1994)

The U.S. Department of Energy starting sequencing bacterial genomes in late 1994. They specifically chose microbes that are integral to the environment and industry.

Topic	Policy/Funding (by agency)
Historic period	1994
Keywords	microbial genetics, bacterial genetics
Connections	http://www.genome.gov/25520338 https://www.genome.gov/25520338/online-education-kit-1994-microbial-genome-project/

12.4.7 Health and Environmental Research Advisory Committee (HERAC) recommends 15-year undertaking to map and sequence the human genome (1987)

In April 1987, the Health and Environmental Research Advisory Committee of the U.S. Department of Energy released a report recommending a large project to map and sequence the human genome.

Topic	Policy/Funding (by agency)
Place	Washington, DC
Historic Period	1987
Keywords	government reports
Connections	http://www.osti.gov/accomplishments/documents/fullText/ACC0496.pdf https://www.osti.gov/accomplishments/genomehistory.html HERAC

12.5 U.S. Federal Law

12.5.1 Executive order regarding use of genetic information (2000)

In February 2000, then-U.S. President Bill Clinton signed an executive order that prevented the federal government from making any hiring or promoting decisions based on a person's genetic information.

Topic	Policy/Funding (by agency)
Place	Washington, DC
Historic Period	2000
Keywords	discrimination, Bill Clinton
Connections	http://www.genome.gov/12513980 https://www.genome.gov/12513980/president-clintons-executive-order-prohibiting-the-use-of-genetic-information-in-hiring-or-promoting/

12.5.2 Genetic Information Nondiscrimination Act (GINA) becomes law (2008)

In May 2008, President George W. Bush signed the Genetic Information Nondiscrimination Act (GINA) into law. GINA prohibits the use of genetic information by employers and insurance companies to make business decisions such as hiring, firing, and underwriting.

Topic	Policy/Funding (by agency)
Synonyms	GINA
Place	Washington, DC
Historic Period	2008
Keywords	discrimination, genetic discrimination, George W. Bush
Connections	http://www.genome.gov/24519851 Genetic Nondiscrimination Act of 2008 (GINA) - from HHS Genetic Nondiscrimination Act of 2008 (GINA) - from EEOC

12.5.3 Genetic Privacy Act (1994)

Passed in 1994, the Genetic Privacy Act was the first piece of federal legislation to address privacy issues based on the genome.

Topic	Policy/Funding (by agency)
Place	Washington, DC
Historic Period	1994
Keywords	privacy, discrimination
Connections	http://web.ornl.gov/sci/techresources/Human_Genome/resource/privacyact.pdf http://aquila.usm.edu/cgi/viewcontent.cgi?article=1000&context=ojhe

12.6 U.S. National Research Council

12.6.1 NRC endorses the Human Genome Project (HGP) (1988)

In a pivotal report in 1988, the National Research Council endorsed the Human Genome Project (HGP), calling for a phased approach and a rapid scale-up to $200 million a year of funding.

Historic Period	1988
Keywords	National Research Council, NRC, funding
Connections	https://repository.library.georgetown.edu/handle/10822/729230

12.7 U.S. NIH-DOE (joint)

12.7.1 DOE-NIH ELSI Working Group's Task Force on Genetic and Insurance Information release recommendations (1994)

The ELSI Working Group was established in 1989 by the Program Advisory Committee on the Human Genome. The Working Group's Task Force on Genetic Information and Insurance published its final report in 1994.

Topic	Policy/Funding (by agency)
Synonyms	Ethical, legal, and social implications (ELSI)
Place	Washington, DC
Historic Period	1994
Keywords	ELSI, ethics, insurance
Connections	http://www.genome.gov/10001787 https://www.genome.gov/10001787/elsi-working-group/

12.7.2 DOE-NIH joint 5-year U.S. HGP plan (1990)

In 1990, the U.S. Department of Energy and the National Institutes of Health submitted to the U.S. Congress a five-year plan for genetic mapping.

Topic	Policy/Funding (by agency)
Synonyms	Five-year plan
Historic period	1990
Keywords	genetic mapping, five-year plan, DOE, NIH
Connections	http://www.genome.gov/10001477

12.7.3 DOE-NIH joint committee on ethical, legal, and social implications of HGP is formed: Joint ELSI Working Group (1989)

The ELSI Working Group was formed in 1989 by the Program Advisory Committee on the Human Genome.

Topic	Policy/Funding (by agency)
Synonyms	ELSI Working Group
Place	Washington, DC
Historic Period	1989
Keywords	ELSI, ethics
Connections	http://www.genome.gov/10001787 https://www.genome.gov/10001787/elsi-working-group/ ELSI

12.7.4 Draft NIH-DOE 5-year plan (1998)

In 1998 the U.S. Department of Energy and the National Institutes of Health submitted a new five-year plan to the U.S. Congress, proposing to finish the human genome by 2003.

Topic	Policy/Funding (by agency)
Historic period	1998
Keywords	genetic mapping
Connections	http://www.genome.gov/10001475 DOE National Institutes of Health (NIH) https://books.google.com/books?id=KzjR8_JSDxgC&pg=PA13&lpg=PA13&dq=1998+DOE+NIH+five+year+plan+revise AQ6AEILjAD#v=onepage&q=1998%20DOE%20NIH%20five%20year%20plan%20revised&f=false

12.7.5 GenBank database officially moves from Los Alamos to NCBI (1993)

Originally based at the Los Alamos National Laboratory, the GenBank database began transitioning to the new National Center for Biotechnology Information during the period from 1989 to 1992. By 1993 the transition was complete and NCBI began to accept submissions to the database.

Topic	Policy/Funding (by agency)
Historic Period	1993
Keywords	GenBank, Los Alamos, NCBI, database
Connections	http://www.nih.gov/news-events/news-releases/genbank-celebrates-25-years-service-two-day-conference-leading-scien april-7-8-meeting https://books.google.com/books?id=Guj1AgAAQBAJ&pg=PA80&lpg=PA80&dq=1993+genbank++los+alamos&source=l TyKpQ3J5-f9m-- 8J2rg&hl=en&sa=X&ved=0ahUKEwjKubK1rqzMAhUMNT4KHVmDBH4Q6AEILDAC#v=onepage&q=1993%20genbank GenBank database

12.7.6 Genetic-mapping 5-year goal achieved (1994)

In 1990, the U.S. Department of Energy and the National Institutes of Health presented to the U.S. Congress a five-year plan for genetic mapping. They completed this five-year goals a full year ahead of schedule in 1994.

Topic	Policy/Funding (by agency)
Synonyms	Five-year plan
Historic period	1994
Keywords	DOE, NIH, five-year plan, genetic mapping
Connections	http://www.genome.gov/10001763 https://books.google.com/books?id=pc7UCgAAQBAJ&pg=PA15&lpg=PA15&dq=1994+genetic+mapping+5-year+goal&source=bl&ots=r6RrTp9MA5&sig=gs5Ybw7SlQGoMFN0G_Lt4_cWuyY&hl=en&sa=X&ved=0ahUKEwjVp5yj year%20goal&f=false

12.7.7 NIH and DOE announce new goal of creating a “working draft” of the human genome by 2001, move completion date for finished draft from 2005 to 2003 (1998)

In 1998, the National Institutes of Health and the Department of Energy announced a five-year plan in which they planned to have a "working draft" of the human genome completed by the end of 2001.

Topic	Policy/Funding (by agency)
Synonyms	Five-year plan
Place	Washington, DC
Historic Period	1998
Keywords	working draft
Connections	http://www.genome.gov/10001475 https://www.genome.gov/10001475/1998-five-year-plan-new-goals/ DOE National Institutes of Health (NIH)

12.7.8 NIH and DOE restart clock, declaring official beginning of HGP (1990)

The Department of Energy and the National Institutes of Health declared that October 1, 1990, was the official start of the Human Genome Project.

Topic	Policy/Funding (by agency)
Place	Washington, DC
Historic Period	1990
Keywords	NIH, DOE, start date
Connections	http://www.genome.gov/25520329

12.7.9 NIH becomes major player in HGP, seizing lead from DOE (1988)

In March 1988, James Wyngaarden, then director of the National Institutes of Health, decided that the NIH should take on a larger role in the Human Genome Project. The effect of this was to have the NIH move ahead of the Department of Energy as the leader of the HGP.

Topic	Policy/Funding (by agency)
Historic Period	1988
Keywords	NIH, DOE, James Wyngaarden
Connections	http://www.ncbi.nlm.nih.gov/books/NBK234203/

12.7.10 NIH-DOE revised U.S. HGP plan (1993)

IN 1993, the Department of Energy and National Institutes of Health revised their five-year plan for the Human Genome Project. Considering technological advances since they first put the plan forward in 1990, as well as the completion of certain tasks ahead of schedule, the two departments expanded their goals beyond what they had anticipated.

Topic	Policy/Funding (by agency)
Historic period	1993
Keywords	DOE, NIH
Connections	http://www.genome.gov/10001476

12.7.11 NIH-DOE sign MOU and agree to collaborate on the HGP and genome research (1988)

In 1988, the U.S. Department of Energy and the National Institutes of Health signed a memorandum of understanding that laid out their plans to work together on genome research.

Topic	Policy/Funding (by agency)
Synonyms	Memorandum of understanding
Place	Washington, DC
Historic Period	1988
Keywords	DOE, NIH
Connections	https://www.nih.gov/about-nih/what-we-do/nih-almanac/national-human-genome-research-institute-nhgri http://www.ncbi.nlm.nih.gov/books/NBK19861/

12.8 U.S. NIH NCHGR/NHGRI

12.8.1 ELSI Research Planning and Evaluation Group (ERPEG) releases its final report (2000)

ELSI Research Planning and Evaluation Group (ERPEG), a joint group of the NHGRI's National Advisory Council for Human Genome Research (NACHGR) and DOE's Biological and Environmental Research Advisory Committee (BERAC), released its final report in 2000.

Historic period	2000
Keywords	ELSI
Connections	http://www.genome.gov/10001754 National Human Genome Research Institute

12.8.2 James D. Watson resigns as head of NCHGR (1992)

In April 1992, James Watson stepped down as the first head of the National Center for Human Genome Research. His resignation arose out of conflicts with Bernadine Healy, who was then the director of the National Institutes of Health.

Topic	Policy/Funding (by agency)
Historic Period	1992
Keywords	James Watson, Bernadine Healy, NIH, NCHGR
Connections	http://www.genome.gov/10001763 Watson, James D. National Center for Human Genome Research (NCHGR)

12.9 U.S. Supreme Court Briefs/Rulings

12.9.1 Myriad gene patent is upheld (2011)

In August 2011, a federal appeals court affirmed the validity of two patents Myriad Genetics held on BRCA1 and BRCA2, the two human genes associated with breast and ovarian cancer.

Topic	Policy/Funding (by agency)
Historic Period	2011
Keywords	gene patenting, Myriad Genetics, breast cancer
Connections	http://www.nytimes.com/2011/08/25/business/despite-gene-patent-victory-myriad-genetics-faces-challenges.html http://blogs.nature.com/news/2011/07/us_court_upholds_myriad_patent.html Myriad Genetics

12.9.2 U.S. Supreme Court ruling regarding gene patenting (2013)

In June 2013, the U.S. Supreme Court ruled that human genes could not be patented. This decision negated controversial patents held by Myriad Genetics on the human genes associated with breast and ovarian cancers.

Topic	Policy/Funding (by agency)
Place	Washington, DC
Historic Period	2013
Keywords	gene patenting, U.S. Supreme Court, Myriad Genetics
Connections	http://www.nytimes.com/2013/06/14/us/supreme-court-rules-human-genes-may-not-be-patented.html http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3777541/ U.S. Supreme Court

12.9.3 U.S. Supreme Court ruling regarding warrantless collection of DNA (2013)

In June 2013, the U.S. Supreme Court ruled in Maryland v. King that police officers may take DNA from those arrested for serious crimes.

Topic	Policy/Funding (by agency)
Place	Washington, DC
Historic Period	2013
Keywords	privacy, genetic privacy, U.S. Supreme Court
Connections	http://www.supremecourt.gov/opinions/12pdf/12-207_d18e.pdf http://www.nytimes.com/2013/06/04/us/supreme-court-says-police-can-take-dna-samples.html U.S. Supreme Court

12.10 Wellcome Trust-MRC

12.10.1 Sydney Brenner starts a small genome initiative at MRC (1986)

In February 1986, after urging the European Community to get involved in genome sequencing, Sydney Brenner, then at the Medical Research Council, began a small-scale genome project at the MRC.

Topic	Policy/Funding (by agency)
Place	Medical Research Council (MRC)
Historic Period	1986
Keywords	Sydney Brenner, MRC, European Community
Connections	http://www.ncbi.nlm.nih.gov/pubmed/1991595 http://science.sciencemag.org/content/291/5507/news-summaries Brenner, Sydney

12.10.2 Wellcome Trust-MRC Sanger Centre (1993)

The Wellcome Trust established the Sanger Centre (now known as the Sanger Institute) in 1993. It is named for Frederick Sanger, the father of DNA sequencing.

Topic	Policy/Funding (by agency)
Synonyms	Sanger Institute
Historic period	1993
Keywords	Wellcome Trust, MRC, Sanger Centre, Sanger Institute
Connections	http://www.wellcome.ac.uk/Funding/Biomedical-science/Funded-projects/Major-initiatives/Wellcome-Trust-Sanger-Institute/History/index.htm Medical Research Council (MRC) The Wellcome Trust

13 GENOME MAPS & SEQUENCES (BY ORGANISM)

13.1 Arabidopsis

Arabidopsis thalania (mustard weed) is a small flowering plant, one of the leading plant model organisms and the first plant genome to be fully sequenced.

13.1.1 Arabidopsis thaliana genome sequence

In December 2000, the completion of the first plant genome sequence (Arabidopsis thaliana, 125 Mb) was announced by the Arabidopsis Genome Initiative (AGI), an international consortium of scientists.

Topic	Genome Maps & Sequences (by organism)
Historic period	2000
Selected Publications	Kaul S, et al. (2000) Analysis of the genome sequence of the flowering plant arabidopsis thaliana
Connections	Arabidopsis Genome Initiative PlantGDB Plant Genome Research Outreach Portal First-Ever Complete Plant Genome Sequence Is Announced Fact Sheet Arabidopsis Genome Initiative Arabidopsis Genome Initiative - Chromosome Assignments GNN Quick Guide to Sequenced Genomes Genome NCBI

13.2 C. elegans (nematode)

The nematode worm, Caenorhabditis elegans, is a critical animal model for the study of developmental biology, neuroscience, apoptosis and other fields. Proposed by Sydney Brenner, the nematode's cellular development was painstakingly documented by Brenner's MRC colleague, John Sulston. In the 1990s, Sulston and Bob Waterston conducted the physical mapping and DNA sequencing of the nematode genome, an important prelude to the Human Genome Project.

13.2.1 Caenorhabditis elegans, DNA sequence of

Nematode *Caenorhabditis elegans* genome sequence was determined in 1998.

Topic	Genome Maps & Sequences (by organism)

Synonyms	Caenorhabditis elegans (C. elegans)
Historic period	1998
Selected Publications	C. elegans Sequencing Consortium (1998) Genome sequence of the nematode C. elegans: A platform for investigating biology

13.3 Drosophila melanogaster (fruit fly)

Drosophila melanogaster – the fruit fly – was the model organism that Thomas Hunt Morgan and colleagues made famous with their pioneering studies in genetic mapping in the Columbia University "fly room" in the early 1900s. The fruit fly remains hugely important for genetics, developmental biology, neuroscience and many other fields; it has led, for example, to the discovery of the homebox genes. The Drosophila genome was sequenced in 2000 by a public-private partnership between academic researchers, led by Gerry Rubin, and Celera Genomics.

13.3.1 Drosophila melanogaster genome sequence

Fruit fly Drosophila melanogaster genome sequence in 2000.

Topic	Genome Maps & Sequences (by organism)
Historic period	2000
Selected Publications	Adams MD, et al. (2000) The genome sequence of Drosophila melanogaster
Connections	Drosophila melanogaster (fruit fly)

13.4 E. coli

The *Escherichia coli* bacterium is the workhorse of genetic engineering, used as the vehicle to identify and isolate genes. The E. coli genome was fully sequenced by Fred Blattner and colleagues in 1997. The organism is still under intense scrutiny because of its impact on human health due to serious outbreaks of food poisoning.

13.4.1 Escherichia coli, DNA sequence of

Topic	Genome Maps & Sequences (by organism)
Synonyms	E. coli
Historic period	1997
Selected Publications	Blattner FR, et al. (1997) The complete genome sequence of escherichia coli k-12

13.5 Epstein-Barr (virus)

Discovered in 1964, the Epstein-Barr virus (EBV) is one of eight herpes virus family members, and a commonly found virus in the human body. The genome of the first EBV strain to be sequenced was reported by Bart Barrell and colleagues in 1984.

13.5.1 Epstein-Barr virus, DNA sequence of

Topic	Genome Maps & Sequences (by organism)
Historic period	1984
Selected Publications	Baer R, et al. (1984) DNA sequence and expression of the b95-8 Epstein-Barr virus genome

13.6 Fugu

The pufferfish (Fugu rubripes) genome project was proposed by Sydney Brenner in 1989 due to Fugu's extremely compact genome – only about 1/8 the size of the human genome. The complete Fugu genome was reported by Brenner and colleagues in 2002.

13.6.1 Fugu rubripes genome sequence

Topic
Selected Publications

13.7 Haemophilus influenzae

Haemophilus influenzae was the first bacterial genome to be fully decoded by J. Craig Venter, Claire Fraser, Hamilton Smith and coworkers at The Institute for Genomic Research in 1995. The feat utilized shotgun sequencing, giving rise to a fierce debate about the adaptability of that approach for more complex genome assemblies, including human.

13.7.1 Haemophilus influenzae, DNA sequence of

Complete sequence of free-living organism. Bacterium *Haemophilus influenzae*.

Topic	Genome Maps & Sequences (by organism)
Historic period	1995
Selected Publications	Fleischmann RD, et al. (1995) Whole-genome random sequencing and assembly of Haemophilus influenzae rd

13.8 Human (Homo sapiens)

13.8.1 BAC clones, ends, sequences of

In 1996, DOE initiated six pilot projects, funded at $5 million total, to sequence the ends of BAC clones.

Topic	Genome Maps & Sequences (by organism)
Historic period	1999
Selected Publications	Kelley JM et al. (1999) High throughput direct end sequencing of BAC clones
Connections	U.S. Department of Energy (DOE)

13.8.2 Chromosome 1, sequence

Topic
Selected Publications

13.8.3 Chromosome 2, sequence

Topic	Genome Maps & Sequences (by organism)
Historic period	2005
Selected Publications	Hillier LW, et al. (2005) Generation and annotation of the DNA sequences of human chromosomes 2 and 4

13.8.4 Chromosome 3, moderate-resolution map

Topic	Genome Maps & Sequences (by organism)
Historic period	1995

13.8.5 Chromosome 3, sequence

Topic	Genome Maps & Sequences (by organism)
Historic period	2006
Selected Publications	Muzny DM, et al. (2006) The DNA sequence, annotation and analysis of human chromosome 3

13.8.6 Chromosome 4, sequence

Topic	Genome Maps & Sequences (by organism)
Historic period	2005
Selected Publications	Hillier LW, et al. (2005) Generation and annotation of the DNA sequences of human chromosomes 2 and 4

13.8.7 Chromosome 5, draft sequence

Topic	Genome Maps & Sequences (by organism)
Historic period	2000

13.8.8 Chromosome 5, sequence

Topic	Genome Maps & Sequences (by organism)
Historic period	2004
Selected Publications	Schmutz J, et al. (2004) The DNA sequence and comparative analysis of human chromosome 5

13.8.9 Chromosome 6, sequence

Topic	Genome Maps & Sequences (by organism)
Historic period	2003
Selected Publications	Mungall AJ, et al. (2003) The DNA sequence and analysis of human chromosome 6

13.8.10 Chromosome 7, high-resolution physical map

Topic	Genome Maps & Sequences (by organism)
Historic period	1997
Selected Publications	Bouffard GG, et al. (1997) A physical map of human chromosome 7: An integrated YAC contig map with average STS spacing of 79 kb

13.8.11 Chromosome 7, sequence

Topic	Genome Maps & Sequences (by organism)
Historic period	2003
Selected Publications	Hillier LW, et al (2003) The DNA sequence of human chromosome 7

13.8.12 Chromosome 8, sequence

Topic	Genome Maps & Sequences (by organism)
Historic period	2006
Selected Publications	Nusbaum C, et al. (2006) DNA sequence and analysis of human chromosome 8

13.8.13 Chromosome 9, sequence

Topic	Genome Maps & Sequences (by organism)
Historic period	2004

Selected Publications	Humphray SJ, et al. (2004) DNA sequence and analysis of human chromosome 9

13.8.14 Chromosome 10, sequence

Topic	Genome Maps & Sequences (by organism)
Historic period	2004
Selected Publications	Deloukas P, et al. (2004) The DNA sequence and comparative analysis of human chromosome 10

13.8.15 Chromosome 11, moderate-resolution map

Topic	Genome Maps & Sequences (by organism)
Historic period	1995
Selected Publications	Quackenbush J, et al. (1995) An STS content map of human chromosome 11: Localization of 910 YAC clones and 109 islands

13.8.16 Chromosome 11, sequence

Topic	Genome Maps & Sequences (by organism)
Historic period	2006
Selected Publications	Taylor TD, et al. (2006) Human chromosome 11 DNA sequence and analysis including novel gene identification

13.8.17 Chromosome 12, moderate-resolution map

Topic	Genome Maps & Sequences (by organism)
Historic period	1995
Selected Publications	Krauter K, et al. (1995) A second-generation YAC contig map of human chromosome 12

13.8.18 Chromosome 12, sequence

Topic	Genome Maps & Sequences (by organism)
Historic period	2006
Selected Publications	Scherer SE, et al. (2006) The finished DNA sequence of human chromosome 12

13.8.19 Chromosome 13, sequence

Topic	Genome Maps & Sequences (by organism)
Historic period	2004
Selected Publications	Dunham A, et al (2004) The DNA sequence and analysis of human chromosome 13

13.8.20 Chromosome 14, sequence

Topic	Genome Maps & Sequences (by organism)
Historic period	2003
Selected Publications	Heilig R, et al. (2003) The DNA sequence and analysis of human chromosome 14

13.8.21 Chromosome 15, sequence

Topic	Genome Maps & Sequences (by organism)
Historic period	2006
Selected Publications	Zody MC, et al. (2006) Analysis of the DNA sequence and duplication history of human chromosome 15

13.8.22 Chromosome 16, high-resolution physical map

Topic	Genome Maps & Sequences (by organism)
Historic period	1995
Selected Publications	Doggett NA, et al. (1995) An integrated physical map of human chromosome 16

13.8.23 Chromosome 16, sequence

Topic	Genome Maps & Sequences (by organism)
Historic period	2004
Selected Publications	Martin J, et al. (2004) The sequence and analysis of duplication-rich human chromosome 16

13.8.24 Chromosome 17, sequence

Topic	Genome Maps & Sequences (by organism)
Historic period	2006
Selected Publications	Zody MC, et al. (2006) DNA sequence of human chromosome 17 and analysis of rearrangement in the human lineage

13.8.25 Chromosome 18, sequence

Topic	Genome Maps & Sequences (by organism)
Historic period	2004
Selected Publications	Nusbaum C, et al. (2005) DNA sequence and analysis of human chromosome 18

13.8.26 Chromosome 19, high-resolution physical map

Topic	Genome Maps & Sequences (by organism)

Historic period	1995
Selected Publications	Ashworth LK, et al. (1995) An integrated metric physical map of human chromosome 19

13.8.27 Chromosome 19, sequence

Topic	Genome Maps & Sequences (by organism)
Historic period	2004
Selected Publications	Grimwood J, et al. (2004) The DNA sequence and biology of human chromosome 19

13.8.28 Chromosome 20, sequence

Topic	Genome Maps & Sequences (by organism)
Historic period	2001
Keywords	sequence, chromosome, chromosome 20
Selected Publications	http://www.nature.com/nature/journal/v414/n6866/full/414865a.html

13.8.29 Chromosome 21, physical map of

Topic	Genome Maps & Sequences (by organism)
Historic period	1992

13.8.30 Chromosome 21, sequence

Chromosome 21 complete sequence in 2000.

Topic	Genome Maps & Sequences (by organism)
Historic period	2000
Selected Publications	Hattori M, et al. (2000) The DNA sequence of human chromosome 21
Notes	Down syndrome (DS or DNS), also known as trisomy 21, is a genetic disorder caused by the presence of all, or part of a third copy of chromosome 21.

13.8.31 Chromosome 22, complete sequence

Topic	Genome Maps & Sequences (by organism)
Historic period	1999
Selected Publications	Dunham I, et al (1999) The DNA sequence of human chromosome 22

13.8.32 Chromosome 22, moderate-resolution map

Topic	Genome Maps & Sequences (by organism)
Historic period	1995
Selected Publications	Bell CJ, et al. (1995) Integration of physical, breakpoint and genetic maps of chromosome 22. Localization of 587 yeast artificial chromosomes with 238 mapped markers

13.8.33 Chromosome X, high-resolution physical map

Topic	Genome Maps & Sequences (by organism)
Historic period	1997
Selected Publications	Nagaraja R, et al. (1997) X chromosome map at 75-Kb STS resolution, revealing extremes of recombination and GC content

13.8.34 Chromosome X, sequence

Topic	Genome Maps & Sequences (by organism)
Historic period	2005
Selected Publications	Ross MT, et al. (2005) The DNA sequence of the human X chromosome

13.8.35 Chromosome Y, physical map of

Topic	Genome Maps & Sequences (by organism)
Historic period	1992
Selected Publications	Vollrath D, et al. (1992) The human Y chromosome: A 43-interval map based on naturally occurring deletions

13.8.36 Chromosome Y, sequence

Topic	Genome Maps & Sequences (by organism)
Historic period	2003
Selected Publications	Skaletsky H, et al. (2003) The male-specific region of the human Y chromosome is a mosaic of discrete sequence classes

13.8.37 ENCODE project published in Nature and other journals

Topic	Genome Maps & Sequences (by organism)
Historic period	2012

13.8.38 GeneMap'98

Topic	Genome Maps & Sequences (by organism)
Historic period	1998

13.8.39 Human genome, complete sequence draft and preliminary analysis

Topic	Genome Maps & Sequences (by organism)
Historic period	2001
Selected Publications	Lander ES, et al. (2001) Initial sequencing and analysis of the human genome

13.8.40 Human genome, genetic linkage map, average marker spacing 0.7 cM

Topic	Genome Maps & Sequences (by organism)
Historic period	1994
Selected Publications	Botstein D, et al. (1980) Construction of a genetic-linkage map in man using restriction fragment length polymorphisms

13.8.41 Human genome, genetic linkage map, average marker spacing 5 cM

Topic	Genome Maps & Sequences (by organism)
Historic period	1992
Selected Publications	Donis-Keller H, et al. (1987) A genetic linkage map of the human genome

13.8.42 Human Microbiome Project published

Topic	Genome Maps & Sequences (by organism)
Historic period	2009
Selected Publications	Peterson J, et al. (2009) The NIH human microbiome project

13.8.43 Human T-cell receptor region sequence

Topic	Genome Maps & Sequences (by organism)
Historic period	1996
Selected Publications	Rowen L, et al. (1996) The complete 685-kilobase DNA sequence of the human beta t cell receptor locus

13.8.44 Structural variation from eight human genomes

Topic	Genome Maps & Sequences (by organism)
Historic period	2008
Selected Publications	Kidd JM, et al. (2008) Mapping and sequencing of structural variation from eight human genomes

13.8.45 Telomere (chromosome end), DNA sequence of

Topic	Genome Maps & Sequences (by organism)
Historic period	1988
Selected Publications	Moyzis RK, et al. (1988) A highly conserved repetitive DNA-sequence, (TTAGGG)n, present at the telomeres of human-chromosomes

13.9 Methanococcus jannaschii (Archaeon)

The 1.66-megabase genome of the Archaeon Methanococcus jannaschii was reported in 1996 by J. Craig Venter, Carl Woese and co-workers. The results showed that many genes closed resembled bacterial genes, but others bore closer resemblance to eukaryotic sequences.

13.9.1 Methanococcus jannaschii, DNA sequence of

Topic	Genome Maps & Sequences (by organism)
Historic period	1996
Selected Publications	Bult CJ, et al. (1996) Complete genome sequence of the methanogenic archaeon, methanococcus jannaschii

13.10 Mouse (Mus musculus)

13.10.1 Mouse, genetic map of

Topic	Genome Maps & Sequences (by organism)
Historic period	1992
Selected Publications	Dietrich W, et al. (1992) A genetic map of the mouse suitable for typing intraspecific crosses

13.10.2 Mouse, genome sequence

The Mouse Genome Sequencing Consortium announced the publication of the mouse genome draft sequence in December 2002.

Topic	Policy/Funding (by agency)
Historic period	2002
Keywords	genome sequence, mouse
Selected Publications	Waterston RH, et al. (2002) Initial sequencing and comparative analysis of the mouse genome

Connections	https://www.genome.gov/10002983 https://www.genome.gov/10005831/2002-release-the-mouse-genome-and-the-measure-of-man/

13.11 Mycobacterium tuberculosis (bacteria)

The 4.4-megabase genome of the tuberculosis bacillus was decoded in 1998 by an Anglo-French collaboration led by Bart Barrell at the MRC Laboratory of Molecular Biology in Cambridge and S.T. Cole at the Pasteur Institute in Paris. The genome revealed a trove of genetic information that shed light on the bacterial life cycle and mechanisms of pathogenesis.

13.11.1 Mycobacterium tuberculosis, DNA sequence of

Topic	Genome Maps & Sequences (by organism)
Historic period	1998
Selected Publications	Cole ST, et al. (1998) Deciphering the biology of mycobacterium tuberculosis from the complete genome sequence

13.12 Mycoplasma capricolum (bacteria)

The Mycoplasma capricolum genome project originated in Walter Gilbert's group at Harvard University. Several sub-species have been fully sequenced. M. capricolum also served as the "shell" en route to the development of a synthetic minimal genome by Venter and colleagues.

13.12.1 Mycoplasma capricolum, DNA sequence of

Topic	Genome Maps & Sequences (by organism)
Historic period	2011
Selected Publications	Bork P, et al. (1995) Exploring the mycoplasma capricolum genome: A minimal cell reveals its physiology

13.13 Mycoplasma genitalium (bacteria)

Weighing in at just 525 genes, the genome of Mycoplasma genitalium was the model for the minimal genome project. Following lengthy ethical review, J. Craig Venter and colleagues synthesized a stripped down M. genitalium genome in an effort to identify the smallest number of genes to sustain life.

13.13.1 Mycoplasma genitalium, DNA sequence of

Bacterium Mycoplasma genitalium sequenced in 1995.

Topic	Genome Maps & Sequences (by organism)
Historic period	1995
Selected Publications	Fraser CM, et al. (1995) The minimal gene complement of Mycoplasma genitalium

13.14 Pig (Sus scrofa)

The Swine Genome Sequencing Consortium reported a draft genome sequence of the domesticated pig (Sus scrofa), which shared a common ancestor with humans less than 100 million years ago, as well as comparisons with wild and domestic species from Asia and Europe, in 2012.

13.14.1 Pig, genome sequence

Topic	Genome Maps & Sequences (by organism)
Historic period	2009
Selected Publications	Archibald AL, et al. (2010) Pig genome sequence--analysis and publication strategy

13.15 Rice

The International Rice Genome Sequencing Project (IRGSP) launched in September 1997 to undertake the sequencing of the most important food crop in the world. After the release of many draft efforts, including some privately funded biotech projects, a finished sequence was published by IRGSP in 2005. A 3,000-rice genome project is currently resequencing strains to identify genes variants that can aid in crop production and nutrition.

13.15.1 Rice genome sequence

Topic	Genome Maps & Sequences (by organism)
Historic period	1998
Selected Publications	Sasaki T, Burr B (2000) International rice genome sequencing project: The effort to completely sequence the rice genome Yu J, et al. (2002) A draft sequence of the rice genome (oryza sativa l. Ssp. Indica) Goff SA (2005) A draft sequence of the rice genome (oryza sativa l. Ssp. Japonica)

13.16 Yeast

Yeast is a very important model organism for the study of eukaryotes. The genome of Saccharomyces cerevisiae was the first eukaryotic genome to be reported, paving the way for systematic analysis of every gene product and the yeast two-hybrid mapping procedure to catalog protein-protein interactions.

13.16.1 Saccharomyces cerevisiae, DNA sequence of

Yeast Saccharomyces cerevisiae complete genome sequence in 1996.

Topic	Genome Maps & Sequences (by organism)
Historic period	1996
Selected Publications	Goffeau A, et al. (1996) Life with 6000 genes

13.17 φX174 (Phi X 174)

The first DNA-based genome to be fully sequenced by Fred Sanger and colleagues in Cambridge in 1977/78. It was also the first genome sequenced by Solexa scientists using a sequencing-by-synthesis approach in 2002.

13.17.1 Bacteriophage φX174 DNA (virus)

Topic	Genome Maps & Sequences (by organism)
Historic period	1977
Selected Publications	Sanger F, et al. (1977) Nucleotide sequence of bacteriophage φX174 DNA

14 TOPICS (BY SUBJECT AREA)

14.1 Cloning/Recombinant DNA Methods

The recombinant DNA era gave birth to the era of molecular genetics and the biotechnology industry. Gene (or molecular) cloning refers to the isolation, transfer and propagation of a specific gene or DNA fragment using a cloning vehicle such as a bacterial plasmid. The circular plasmid containing the foreign DNA insert is grown in the host bacteria. The creation of DNA libraries using various vectors led to the identification of genes and the production of crucial biotechnology products such as insulin. Gene cloning was used to isolate and characterize genomic stretches of DNA as well as complementary DNA (cDNA), derived from the messenger RNA transcripts of genes.

14.1.1 BACs (Bacterial Artificial Chromosomes)

A vector that enabled the cloning and propagation of relatively large DNA fragments (about 150-350 kilobases). BACs succeeded yeast artificial chromosomes, which had a larger fragment capacity but were prone to artifact rearrangements. The system was developed by Mel Simon and colleagues at Caltech and proved to be an important component in building physical maps of human chromosomes (Shizuya, H. *e t al. Proc. Natl. Acad. Sci. USA* 1992). The construction of BAC libraries from anonymous donors by Pieter de Jong and coworkers at the Roswell Park Cancer Institute was a key step in the sequencing of the reference genome (Osoegawa, K. *et al. Genome Res.* 2001).

Topic	Cloning/Recombinant DNA Methods
Historic period	1992

14.1.2 cDNA

Complementary DNA (cDNA) synthesized by reverse transcriptase from a messenger RNA transcript. cDNA libraries provide a resource for analyzing the actively transcribed genes in any tissue or organism. cDNA sequencing was a key step in the characterization and sequencing of coding genes because cDNA correspond to the expressed gene segments without the intervening sequences (introns). The analysis of cDNAs was also popularized as ESTs (expressed sequence tags) by Venter and colleagues.

Topic	Cloning/Recombinant DNA Methods
Historic period	1972

14.1.3 Cloning

See **Genetic engineeering**.

Topic	Cloning/Recombinant DNA Methods
Historic period	1972

14.1.4 Cosmid cloning vector

A hybrid cloning vehicle that is a bacterial plasmid that also contains lambda phage cos sequence (hence the name). Cosmid libraries contained inserts of up to 50 kilobases.

Topic	Cloning/Recombinant DNA Methods
Historic period	1983

14.1.5 Genetic engineering

The process of isolating and combining DNA from one organism into another. Genetic engineering has occurred for thousands of years by virtue of selective breeding of plants and animals, but the term is usually associated with the use of recombinant DNA technologies, which were discovered in the 1970s.

Genetic engineering is used in a range of commercial and clinical applications, from genetically modified food to transgenic animals. More recently, genetic engineering has been referred to as synthetic biology, used to create an artificial bacterial genome and gene editing using tools such as CRISPR/Cas9.

Topic	Cloning/Recombinant DNA Methods
Historic period	1973

14.1.6 Human insulin production

Topic	Cloning/Recombinant DNA Methods
Historic period	1978

14.1.7 Positional cloning method described by Collins and Weissman

A very important method that spurred the isolation of disease genes previously localized by genetic linkage mapping studies. The task involved navigating along a chromosome from the position of a linked DNA marker to the disease gene (or candidate gene). The term “positional cloning” contrasts with “functional cloning,” the traditional method by which disease genes were characterized and identified on the basis of a biochemical study of the disease (Collins, F.S. *Nat. Genet.* 1992). Accelerating the positional cloning strategy was a method that enabled larger steps to be taken from marker to disease gene. Rather than building a tiling path of overlapping DNA clones (“chromosome walking”), Francis Collins and Sherman Weissman devised a “chromosome jumping” method in which DNA libraries with long inserts were constructed: the inserts were circularized, such that the junction consisted of DNA from disparate regions of the chromosome. This provided a means to “jump” several hundred kilobases towards the desired target in one step (Collins, F.S. & Weissman, S. *Proc. Natl. Acad. Sci. USA* 1984).

Topic	Cloning/Recombinant DNA Methods
Historic period	1984

14.1.8 Recombinant DNA technologies

See **Genetic engineering.**

Topic	Cloning/Recombinant DNA Methods

14.1.9 Vectors

DNA vehicles used to isolate and propagate (i.e. clone) DNA fragments. Commonly used vectors include bacterial plasmids, bacterial and yeast artificial chromosomes, and lambda phage.

Topic	Cloning/Recombinant DNA Methods
Historic period	1987

14.1.10 YACs (Yeast Artificial Chromosomes)

Yeast artificial chromosomes are a vehicle for cloning large fragments of DNA. Although they provided significant advantages over other cloning vectors, the inserts were prone to rearrangements, thus reducing their value as a physical mapping tool. YACs were replaced by BACs as the primary cloning tool for the Human Genome Project.

Topic	Cloning/Recombinant DNA Methods
Historic period	1987

14.2 DNA/Gene Structure/Genetic Code

The iconic double helix structure of DNA was deduced in the classic model of Francis Crick and James Watson in 1953. Seminal work by Crick, Sydney Brenner, Marshall Nirenberg and others helped crack the genetic code in the 1960s, revealing the triplet codon schema that corresponds to each of the 20 amino-acid building blocks of proteins. The development of DNA sequencing techniques in the late 1970s revealed the sequence of genes, as well as the dramatic revelation that eukaryotic genes are punctuated by non-coding introns. The portion of the human genome that encodes genes is surprisingly low, although a decade after the Human Genome Project, the ENCODE Project showed that as much as 80 percent of the genome has some biochemical or functional activity.

14.2.1 Double helix, structure of DNA

The iconic structure of DNA deduced in 1953 by Francis Crick and James D. Watson. The two scientists built a model of DNA based on unpublished X-ray crystallography data from Rosalind Franklin and Ray Gosling. The ratios of the four nucleotides, known as Chargaff's Rule, also helped Watson establish the complementary base-pairing structure. The model was published in a short letter to *Nature* in April 1953 (Watson, J.D. & Crick, F.H.C. *Nature* 1953), opening with the classic lines: "We wish to suggest a structure for the salt of deoxyribose nucleic acid (D.N.A.). This structure has novel features which are of considerable

biological interest." The Crick accompanied by a pair of experimental papers from the King's College London researchers, one from Maurice Wilkins and colleagues (Wilkins, M.H.F. *et al. Nature* 1953), the other from Franklin and Gosling (Franklin, R.E. & Gosling, R.G. *Nature* 1953)

Crick and Watson shared the Nobel Prize for Physiology or Medicine in 1962 with Wilkins (Franklin died in 1958). The completion of the Human Genome Project was announced in April 2003, the golden anniversary of the publication of the double helix.

Topic	DNA/Gene Structure/Genetic Code
Synonyms	DNA
Historic period	1953
Connections	Watson, James D. Crick, Francis

14.2.2 Functional genomics

Functional genomics is the study of the dynamic properties of the genome – the structure, interactions and functions of all gene transcripts and products (proteins). It uses the understanding of the genome sequence and various other "-omics" approaches – proteomics, transcriptomics, lipidomics, and so on.

Topic	DNA/Gene Structure/Genetic Code

14.2.3 Gene count, human - settling a science wager on the gene tally in the human genome

For many years, the total number of genes in the human genome was estimated to be in excess of 100,000. This figure was widely reproduced in genetics textbooks, reinforced by estimates of expressed cDNAs in the late 1990s and the eagerness of some biologists to have a more complex genetic architecture than organisms such as Drosophila or nematodes. On the eve of the announcement of the first draft, Ewan Birney (EMBL) organized Genesweep, a much publicized wager on the total number of genes at Cold Spring Harbor Laboratory for about 500 scientists. The winner was named in July 2003 as Lee Rowen (Institute for Systems Biology), for her estimate of 25,947.

In the decade since the completion of the Human Genome Project, the total gene count has been refined to around 21,000 genes, but estimates still vary from 19,000-22,000. The emergence of long non-coding RNAs (linc RNA) has confirmed that much more of the genome is transcribed than previously thought, even if the function of these low-level transcripts remains unclear.

Topic	DNA/Gene Structure/Genetic Code
Historic period	2003

14.2.4 SNPs (Single Nucleotide Polymorphisms)

Single nucleotide polymorphisms are specific nucleotide locations in the genome that vary in sequence from person to person. A SNP exists on average every 300 bases, for an estimated total of 10 million SNPs in the human genome. SNPs can occur in genes or in non-coding regions, and may be direct causes of genetic mutations or may serve as benign markers for linkage and association studies.

The cataloging of SNPs has played a major role in the explosion of genome-wide association studies (GWAS) over the past decade. These high-throughput experiments have enabled the systematic analysis of hundreds of thousands of SNPs with thousands of individuals with different complex disorders and traits. GWAS have identified several thousand SNPs that are associated with complex disorders including type 2 diabetes, Crohn's disease, and mental illness.

Topic	DNA/Gene Structure/Genetic Code
Historic period	1988

14.2.5 Structure of telomeres

The telomere is the structure at the tip of a chromosome, similar to the plastic aglet at the end of a shoelace. It was discovered when Elizabeth Blackburn found a tandemly repeating structure art the end of chromosomes in Tetrahymena. Blackburn went on to share the 2009 Nobel Prize in Physiology or Medicine for her work on telomere structure and function.

The telomere consists of a repetitive DNA motif, TTAGGG, tandemly repeated some 2,500 times in humans, that serves as the scaffold for a protein complex. Telomeres gradually get shorter as cells divide. This shortening is compensated by the enzyme telomerase, which is overexpressed in malignant cells. This has prompted much interest in targeting telomerase as a potential cancer therapeutic strategy.

Topic	DNA/Gene Structure/Genetic Code
Historic period	1978

14.3 Laboratory Methods

In addition to DNA sequencing and mapping methods, a broad spectrum of laboratory methods for manipulating DNA were crucial in the run-up to the sequencing of the human genome. The discovery of restriction enzymes allowed for the manipulation of genes and the ability to stitch genes of interest into cloning vectors. Restriction enzyme cleavage of patient DNA was the pre-requisite to performing linkage analysis; radioactively labeled DNA probes were hybridized to cleaved DNA separated on an agarose gel and transferred to a nitrocellulose membrane using the Southern blot, named after Ed Southern. (The corresponding method for RNA was dubbed the Northern blot). These methods also paved the way for the discovery of DNA fingerprinting, with the focus on inheritance of repetitive DNA fragments rather than single genes. Perhaps the most important lab method was the DNA amplification method called polymerase chain reaction (PCR), developed by Kary Mullis and colleagues in the mid- 1990s.

14.3.1 Capillary sequencing

Breakthrough method in DNA sequencing that considerably increased throughput of automated DNA sequencing instruments. Replacing polyacrylamide gels, the application of capillary electrophoresis was commercially introduced in 1998 with the ABI 3700 and the MegaBACE 1000. (see Karger, B.L. & Guttman, A. *Electrophoresis* 2009).

Topic	Laboratory Methods

Historic period	1990
Connections	Karger, Barry Smith, Lloyd M. Dovichi, Norman

Three groups develop capillary electrophoresis

14.3.2 DNA chips

See **Microarrays**.

Topic	Laboratory Methods
Synonyms	Microarrays
Historic period	1996
Connections	Affymetrix

14.3.3 Microarrays

Microarrays of cDNA clones on glass slides transformed the analysis of gene expression. Pioneered by Patrick Brown (Stanford University) and coworkers, DNA microarrays enabled researchers to measure the expression of thousands of genes simultaneously, from any organism and any tissue, with particular success in the study of cancer (Schena, M. *et al. Science* 1995). The method was amenable to low-cost DIY approaches, although commercial offerings from companies such as Affymetrix and Illumina proved popular. (See Gitchier, J. *PLOS Genet.* 2009).

Topic	Laboratory Methods
Synonyms	Gene chips, DNA chips
Historic period	1995
Keywords	DNA microarrays
Connections	Brown, Patrick O. Stanford University Affymetrix Illumina

14.3.4 Polymerase, thermostable

A DNA polymerase originally isolated from the thermophilic bacterium *Thermus aquaticus,* which inhabits hot springs, in 1976. Also known as Taq polymerase, the enzyme's temperature profile made it the automatic choice for automated PCR. It was named *Science* magazine's inaugural "Molecule of the Year" in 1989.

Topic	Laboratory Methods
Historic period	1995
Connections	Reeve, Michael Fuller, Carl Amersham Pharmacia Biotech

14.3.5 Polymerase chain reaction (PCR)

Revolutionary DNA amplification method devised by Kary Mullis in the mid 1980s. Mullis deduced that using pairs of oligonucleotides in combination with DNA polymerase, it was possible to amplify any specific stretch of DNA by repeated cycles of DNA synthesis. The development of a thermostable polymerase greatly improved the convenience of the method, which rapidly became a staple method in the arsenal of molecular biologists. Mullis shared the Nobel Prize for Chemistry in 1993.

Topic	Laboratory Methods
Synonyms	PCR
Historic period	1984

14.3.6 Proteins

14.3.6.1 Insulin sequence

Topic	Genome Maps & Sequences (by organism)
Selected Publications	Sanger F, Tuppy H (1951) The amino-acid sequence in the phenylalanyl chain of insulin. I. The identification of lower peptides from partial hydrolysates Sanger F, Tuppy H (1951) The amino-acid sequence in the phenylalanyl chain of insulin. 2. The investigation of peptides from enzymic hydrolysates

14.3.6.2 The X-ray structure of myoglobin

Topic	Genome Maps & Sequences (by organism)
Historic period	1958
Selected Publications	Kendrew JC, et al (1958) A Three-dimensional model of the myoglobin molecule obtained by x-ray analysis

14.3.7 Pulsed-field electrophoresis

A form of agarose gel electrophoresis developed by David Schwartz and Charles Cantor at Columbia University in the early 1980s to separate large DNA fragments using an alternating voltage (Schwartz, D.C. & Cantor, C.R. *Cell* 1984). The method enabled the separation and isolation of fragments up to 2 Mb in size, and improved long-range physical mapping of genomes.

Topic	Laboratory Methods
Historic period	1984
Connections	Cantor, Charles R. Schwartz, David Columbia University

14.3.8 Southern blot

A simple, ingenious method for transferring DNA fragments from agarose gels to nitrocellulose filters prior to DNA hybridization. The method was devised by Scottish molecular biologist Ed Southern and published in 1975 (Southern, E.M. *J. Mol. Biol.* 1975). After separating DNA using an agarose gel, the separated

fragments were lifted onto a filter membrane using stacks of absorbent paper towels. The filter could then be placed in a sealed bag with a radioactive DNA probe.

The Southern blot inspired similar experimental approaches for the study of RNA (Northern blot) and proteins (Western blot).

Topic	Laboratory Methods
Historic period	1975

14.4 Mapping Methods

In 1980, Ray White and colleagues published a landmark paper describing a strategy to produce a genetic map of the human genome utilizing evenly spaced DNA markers called restriction fragment length polymorphisms (RFLPs). These markers provided signposts along each chromosome that provided the critical framework upon which to map the locations of disease genes, Prominent examples included genes responsible for Huntington's disease (chromosome 4, 1983), cystic fibrosis (chromosome 7, 1985) and BRCA1 (chromosome 17, 1990). For mapping purposes RFLPs were superseded by polymorphic STR (short tandem repeat) microsatellite markers in the early 1990s. Concurrently, physical maps of the human genome were produced using artificial chromosomes, cloning vehicles for large DNA inserts, first yeast and then bacterial. The physical map provided the reference framework for the sequencing effort of the public consortium.

14.4.1 Banding technique for chromosomes

Banding techniques stained chromosome in a banding pattern characteristic of each chromosome. These techniques revolutionized cytogenetics. The most useful technique was giemsa staining, See **Giemsa banding**.

Topic	Mapping Methods
Historic period	1970
Keywords	Banding techniques, **Giemsa**, cytogenetics

14.4.2 Chromosome mapping

See **Physical mapping**.

Topic	Mapping Methods

14.4.3 Chromosome paints introduced for cytogenetics

Fluorescently tagged probes used to hybridize to chromosome preparations in a procedure called fluorescence in situ hybridization (FISH). Different fluorophores "paint" each chromosome a different color. The method was developed in the late 1980s, by investigators including Joe Gray (Lawrence Livermore Lab)

and David Ward (Yale University) (Pinkel, D. *et al. PNAS* 1988; Lichter, P. *et al. Hum.Genet.* 1988). It is used to detect chromosomal aberrations and rearrangements, and gene duplications and deletions (copy number variations). It can reveal the extent of DNA rearrangements in tumor cells. The tools are used in related methods including fiber-FISH and comparative genomic hybridization.

Topic	Mapping Methods
Historic period	1988

14.4.4 ESTs (Expressed Sequence Tags)

EST (expressed sequence tag) was a term coined by J. Craig Venter, Mark Adams and colleagues at the NIH in a landmark 1991 article in *Science* (Adams, M.D. *et al. Science* 1991). As originally defined, an EST was a cDNA fragment selected at random and partially sequenced, prior to searching for sequence homologies in GenBank. Venter's 1991 paper identified more than 300 ESTs expressed in human brain tissue with sequence similarity to known genes in human or other organisms. The large collection of ESTs, just one year after the launch of the HGP, sparked a patent controversy (as NIH applied for patents on the gene fragments) and led to Venter's leaving the NIH in 1992. Venter then established a non-profit institute, The Institute of Genome Research (TIGR), which continued to build an EST catalogue.

Topic	Mapping Methods
Connections	https://www.ncbi.nlm.nih.gov/pubmed/2047873 Adams MD, et al. (1991) Complementary DNA sequencing: Expressed sequence tags and human genome project

14.4.5 Fluorescence in situ hybridization (FISH)

See **Chromosome paints**.

Topic	Mapping Methods

14.4.6 Genetic mapping (topic)

In 1978, David Botstein and colleagues laid out a strategy for building a genetic map of linked DNA markers in humans. The strategy required identifying a few hundred polymorphic DNA markers evenly spread across the genome, based on insights from genetic studies in organisms such as yeast and bacteria.

Topic	Mapping Methods

14.4.7 Giemsa banding

A standard technique in cytogenetics used to stain and identify chromosomes. Metaphase chromosomes are treated with trypsin prior to staining with the Giemsa stain, revealing a trademark pattern of light and dark bands (based on the AT content of the chromosome regions) that allow chromosomes to be identified.

Topic	Mapping Methods

Keywords	Giemsa stain, technigue

14.4.8 Physical mapping

Physical mapping was a vital pre-requisite to the complete sequencing of the human genome. The strategy was outlined in the important NRC report in 1988 preceding the launch of the HGP. The map was viewed as a hybrid of a restriction map and a contig map, in which chromosomes would be demarcated into maps of overlapping cloned DNA fragments. The DNA fragments were initially mapped as cosmid clones, subsequently replaced by larger vectors – yeast artificial chromosomes (YACs) and bacterial artificial chromosomes (BACs).

Physical mapping provided the framework upon which full sequencing could be performed. A fierce controversy arose in the late 1990s as to whether it was absolutely necessary in order to sequence the human genome: Gene Myers and Jim Weber argued that shotgun sequencing could be performed without necessitating construction of a physical map.

Topic	Mapping Methods
Historic period	1988

14.4.9 RFLPs (Restriction Fragment Length Polymorphisms)

Restriction fragment length polymorphisms were the first DNA-based markers used to establish linkage to disease genes and build a genetic map of the human genome. DNA variations can create or destroy the palindromic sites recognized by bacterial restriction enzymes and used to cleave DNA. Using Southern blotting, researchers could use restriction enzymes to reveal polymorphic DNA fragments that served as reproducible markers. The first RFLP linkage applied to prenatal diagnosis was used by Y.W. Kan in 1978 to perform diagnosis in a family with beta thalassemia. In 1980, Botstein, Davis, Skolnick and White published a landmark paper in which they laid out the conceptual basis for building a framework genetic linkage map using RFLPs, extrapolating from the existence of such markers in bacteria and yeast. In 1983, Jim Gusella and colleagues mapped the gene for Huntington disease to the tip of chromosome 4 using a random RFLP marker.

Topic	Mapping Methods

14.4.10 Statistical methods in genetic linkage mapping

In the early days of creating genetic maps, gene markers and disease genes were linked using a statistical lod (logarithm of the odds) score. A lod score of +3.0 or greater was taken to mean that two genes or markers are linked at a statistically significant level (odds of 1000:1). Multipoint linkage mapping assumed a big role in gene mapping in the 1990s.

Topic	Mapping Methods
Historic period	1985

14.4.11 Structural variation of human genomes

Structural variations are large-scale variations of the human genome, including copy number variants and aneuploidies. The most common structural variations are trisomies (a third copy of a chromosome, instead to two copies) of chromosomes such as 21 (Down syndrome), 18 and 13. Duplications of internal regions of particular chromosomes were associated with genetic disease in 1991 in the case of Charco-Marie-Tooth disease (by the groups of James Lupski and Christine van Broekhoven). More recently, copy number variants (CNVs) have been shown to be much more prevalent in humans than previously suspected, contributing significantly to the total level of genetic variation between different individuals.

There is mounting evidence that CNVs are associated in some cases of psychiatric disorders such as autism and schizophrenia. Studies have also implicated CNVs in cognitive function.

Topic	Mapping Methods

14.4.12 STS (Sequence-Tagged Sites)

A unique site in the genome (typically 200-500 bases) that can be amplified and serve as a discrete and reproducible landmark for the construction of a physical map of the genome. The concept was first voiced in a commentary in *Science* co-authored by Maynard Olson, Lee Hood, Charles Cantor and David Botstein (Olson, M. *et al. Science* 1989). The major advantage outlined by the authors was that an STS could be "completely described as information in a database." That information could include not only raw sequence data but information on how to amplify said sequence using PCR. (See also: Green, E.D. and Green, P. *Genome Res.* 1991).

Topic	Mapping Methods
Historic period	1989

14.5 Medical Genetics

Medical genetics has been defined as the science of human biological variation applied to health and disease. Over the course of several decades, medical geneticists led by Victor McKusick compiled a comprehensive catalog of human traits and disease genes. Progress in diagnosing genetic disorders was advanced by the advent of recombinant DNA and gene cloning, linkage analysis, and DNA sequencing. In the 1980s, linkage mapping and positional cloning led to the successful identification of some major disease genes. In the 1990s, hundreds of genes underlying mostly rare Mendelian disorders were sequenced and identified. Since the completion of the Human Genome Project and the HapMap, genomewide association studies have identified hundreds of genes that govern relative risk of scores of common diseases including type 2 diabetes, asthma, and neurological disorders. It could be argued that medical genetics is being superseded by genomic medicine, which marshals the data-rich potential of genomics to the diagnosis, treatment and fundamental understanding of disease.

14.5.1 BRCA1 gene

The hereditary breast and ovarian cancer gene on chromosome 17.

The gene was mapped by Mary-Claire King (UC Berkeley) and colleagues in 1990 after an epic 15-year quest. King collected hundreds of families with multiple affected individuals and performed modeling and linkage analysis. The breakthrough came in 1990, when King's team performed linkage analysis with a marker on chromosome 17, stratifying the families by average age-of-onset. (The earlier age-of-onset correlated with BRCA1 carriers.) From 1990-94, multiple groups joined King to isolate BRCA1 by positional cloning. The gene was ultimately cloned by a group from Myriad Genetics, a biotech company in Salt Lake City.

Topic	Medical Genetics
Historic period	1990-1994

14.5.2 Designer babies

Advances in genetic diagnostics and gene therapy have raised fears in the media and certain scholarly circles about the advent of designer babies. These are fueled by works of literature and art, including books (*Brave New World*) and films (*GATTACA*). Recently developed diagnostic methods such as PGD raise real-life ethical issues about the selection of embryos. More modern gene editing techniques including CRISPR/Cas9 raise the spectre of human gene editing, possibly even applied to the germline. Most experts believe that tampering with the germline, even if the technology could be shown to be safe, is unethical. In December 2015, the National Academy of Sciences convened a workshop to address the ethical questions raised by CRISPR gene editing.

Topic	Medical Genetics
Historic period	2001
Keywords	gene editing, gene therapy, bioethics

14.5.3 Gene-based designer drugs

The poster child for drugs that tailor known genetic or genomic targets is Gleevec, a drug developed by Novartis and approved by the FDA in 2002. The Philadelphia Chromosome has been known for decades to be a hallmark of CML – chronic myelogenous leukemia. This rearranged chromosome fuses two genes – BCR and ABL – to form a hybrid oncoprotein. Gleevec is a small molecule that effectively targets BCR-ABL and resulted in excellent results during clinical trials and upon approval. Although some patients relapse, several companion drugs have subsequently been approved that either replace or are used in combination with Gleevec to provide more sustained and effective benefit to patients.

Another good example for gene-based drugs comes from the recent identification of PCSK9 as a key modulator of cholesterol levels. Drugs that target PCSK9 enable the LDL receptor to scavenge more LDL-cholesterol. Two such drugs were approved in 2015.

Topic	Medical Genetics
Historic period	2003

14.5.4 Gene therapy, first approved clinical trial

The first government-sanctioned gene therapy trial took place at the NIH in 1990 under the guidance of W. French Anderson and colleagues. Two young girls were treated for a rare inherited immune disorder called adenosine deaminase deficiency. The results were declared a success, even though limited doses of the

purified enzyme were also administered for ethical reasons. During the 1990s, a variety of viral-based gene therapy methods were investigated for a range of diseases including liver diseases and cystic fibrosis. But in 1999, a teenage volunteer named Jesse Gelsinger died after receiving a high dose of an engineered virus. Gelsinger's death was a major setback to the gene therapy field, but it has slowly regained momentum. French researchers reported successful treatment of patients with immune deficiency, although some developed cancer (as in these cases, there was no control over where the healthy gene inserted in the host genome). Researchers have also treated patients with eye disease. There is growing optimism that immunotherapies will provide clinical benefit for patients with various forms of cancer.

Topic	Medical Genetics
Historic period	1990

14.5.5 Genetic enhancement

See **Designer babies.**

Topic	Medical Genetics
Historic period	1989

14.5.6 Human leukocyte antigen (HLA) markers

The Human Leukocyte Antigen (HLA) is a cluster of genes (the multihistocompatability complex, MHC) on chromosome 6 that encode cell-surface antigens. The HLA complex plays a critical role in the immune response and in patient-donor matching for bone marrow transplants.

In 1979, Mark Skolnick and colleagues at the University of Utah reported linkage between the HLA region and hereditary hemochromatosis (Kravitz, K. *et al. AJHG* 1979). It was the desire of researchers to find more naturally occurring polymorphic markers like HLA that inspired the search for DNA markers (RFLPs) and the conception of the human genetic linkage map (Botstein, D. *et al. AJHG* 1980).

The HLA region was fully sequenced by a consortium in 1999 (The MHC sequencing consortium, *Nature* 1999).

Topic	Medical Genetics
Historic period	1958

14.5.7 In vitro fertilization, first live birth

The first live birth by IVF was Louise Brown, born in Manchester, UK, in 1978. The technique was devised by physicians Patrick Steptoe and Robert Edwards (the latter won the Nobel Prize in Physiology or Medicine in 2010). The first IVF boy, Alastair MacDonald, was born in Glasgow the following year. The technique was controversial at first, but over several decades, it has proven safe and popular. More than 5 million babies have been born since Louise Brown using IVF methods. The technique has been expanded in many areas including preimplantation genetic diagnosis (PGD) and cryopreservation.

Topic	Medical Genetics
Synonyms	IVF
Historic period	1978

14.5.8 MyGenome app

A smartphone app developed by Illumina to showcase personal genome data. It was unveiled in 2012 initially to present data from CEO Jay Flatley's genome. The app is used for individuals who have had their genome sequenced using Illumina's Individual Genome Sequencing (IGS) service.

Topic	Medical Genetics
Historic period	2012
Connections	Illumina Launches MyGenome App for iPad - Press Release

14.5.9 Newborn screening

Newborn screening was made possible in the 1960s by the development of the Guthrie heel stick test. A drop of the newborn baby's blood is placed on a filter paper, which can be screened for dozens of genetic disorders. The most famous of these disorders is phenylketonuria (PKU), a recessively inherited inborn error of metabolism that affects about 1 in 15,000 newborns in the United States. PKU patients lack the enzyme that metabolizes the amino acid phenylalanine; if undetected, the amino acid builds up to toxic levels. However, if diagnosed, the condition can be managed by dietary modification. Most states test for about 30-40 inherited disorders at birth, but the precise number and list varies from state to state.

Topic	Medical Genetics

14.5.10 Online Mendelian Inheritance in Man (OMIM)

The online version of Mendelian Inheritance in Man, the classic volume of medical genetics traits and gene mutations for researchers and physicians, written by the legendary Johns Hopkins University geneticist Victor McKusick. The original version was published in 12 editions, the first in 1966, the last print edition in 1998. The online database, which is curated and maintained by Johns Hopkins University, contains more than 23,000 entries as of 2015. http://www.omim.org

Topic	Medical Genetics
Synonyms	OMIM
Historic period	1985
Connections	Online Mendelian Inheritance in Man

14.5.11 Parkinson's disease gene

The first confirmed Parkinson's gene mutation was in alpha-synuclein, which cause a dominant form of the disease. Another notable gene mutation is in LRRK2 – a publicly disclosed mutation carrier is Sergey Brin, the co-founder of Google, who has a family history of the disease. Several genes have been associated with Parkinson's disease, although in sum they only account of a minority of cases.

Topic	Medical Genetics
Historic period	1997

14.5.12 Pharmacogenetics

Pharmacogenomics is the study of the effects of genes on drug metabolism and activity. The phenomenon was described 2500 years ago by Pythagoras, who noted an association between eating fava beans and hemolytic anemia in some individuals (a disorder now called favism). The term 'pharmacogenetics' was coined in the 1950s by Friedrich Vogel.

Many enzymes are involved in drug metabolism, most notably enzymes known as cytochrome P450, encoded by dozens of genes. Several cytochrome P450 enzymes are involved in the metabolism of the majority of known prescription drugs. The FDA approved selective cytochrome P450 (for CYP2D6) testing in December 2004. Another well-known example is VKORC1, which processes the blood thinner warfarin (Coumadin). Genetic variations in VKORC1 impact an individual's ability to process warfarin, requiring the necessity to carefully titrate dosage to minimize the risk of hemorrhage or an emobolism. In 2007, the FDA changed the drug label to note the potential benefit of genetic testing.

In recent years pharmacogenomics testing has become more mainstream with applications including testing for drugs combatting HIV and certain forms of breast and colon cancer. There is also strong evidence that genetic variations in drug metabolizing enzymes modulate the activity of anti-depressant drugs (serotonin re-uptake inhibitors).

Topic	Medical Genetics
Historic period	1962

14.5.13 Preimplantation genetic diagnosis

A revolutionary diagnostic application of IVF in which embryos are grown for a couple of days before genetic testing is performed on one isolated cell from the 8-cell blastomere. After PCR, the amplified DNA is tested for the disease mutation in question; this enables decision to be made about which embryos to implant in the mother and which are to be frozen. The method was first used by Alan Handyside and colleagues in London for sex determination in cases with X-linked diseases, then expanded to a larger and larger number of monogenic/Mendelian diseases. Ethical questions surrounded whether PGD should be used for diseases that are not fully penetrant and/or adult-onset. Another ethical question surrounded savior siblings – the use of PGD to identify embryos that not only are healthy but could provide a bone marrow match in cases such as Fanconi anemia.

Topic	Medical Genetics
Historic period	1989

14.5.14 Prenatal genetic testing using RFLP markers

Prenatal diagnosis was first performed in 1978 using RFLPs by Y.W. Kan in a family with sickle-cell anemia on an amniotic fluid sample. The fetal DNA sample is traditionally obtained using invasive methods such as amniocentesis (from 14-20 weeks) or chorionic villus sampling (8-12 weeks) of gestation. Both (especially the latter) carry a small percentage risk to the fetus. The technique was used cautiously in the 1980s and 1990s using DNA linkage in some cases, but has been expanded to thousands of genetic disorders. Ethical or religious objections to abortion have in part led to increased uptake of PGD, where affected embryos are never implanted back into the mother.

In recent years, non-invasive prenatal testing (NIPT) has exploded in use. Several companies now offer commercially this non-invasive screening procedure. In NIPT, the small percentage of fetal DNA can be detected non-invasively in the maternal blood using high-throughput DNA sequencing. The method is used to detect trisomies (of chromosomes 21, 18 and 13) by counting the relative amount of millions of DNA fragments from each human chromosome. (The increased dosage in the case of a trisomy is detected by the

corresponding increase in DNA sequences from that fetal chromosome.) The method is not 100% accurate, but it does not carry the finite health risks to the fetus associated with traditional methods of amniocentesis or chorionic villus sampling.

Topic	Medical Genetics
Historic period	1956

14.6 Sequencing Methods/Technology

The Human Genome Project relied on dideoxy sequencing, developed by Nobel laureate Fred Sanger, Alan Coulson and colleagues at the University of Cambridge in the late 1970s. Sanger sequencing ingeniously used trace amounts of dideoxy nucleotides to halt the synthesis of DNA strands at specific bases; by separating these radioactively labeled strands using polyacrylamide gel electrophoresis, the native sequencing could be determined by reading the position of the bands on an autoradiograph. Sanger's method outlasted a rival method developed by Allan Maxam and Walter Gilbert, who shared the Nobel Prize for chemistry in 1980 with Sanger. Key developments included the introduction of automated instruments using fluorescent dye labels and capillary electrophoresis. Commercial instruments were used in factory-like settings by genome centers and the sequencing firm Celera Genomics to produce the first draft of the human genome in 2000.

14.6.1 ABI 310, first capillary DNA sequencer

The first capillary DNA sequencing instrument, replacing slab gels, was introduced by Applied Biosystems in 1996.

Topic	Sequencing Methods/Technology
Historic period	1996
Keywords	sequencing, automated sequencers
Connections	http://home.appliedbiosystems.com/about/presskit/pdfs/celebrating_25_years_aln_article.pdf

14.6.2 ABI 370 (373) DNA sequencing instruments

The first commercial automated DNA sequencing instrument from Applied Biosystems, introduced in 1986. The system relied on Sanger's dideoxy sequencing method and fluorescent dyes. One of the earliest adopters was J. Craig Venter and Richard McCombie at the NIH, who used the machine for trial genome sequencing of human chromosomes 4 and 19, as well as EST sequencing.

Topic	Sequencing Methods/Technology
Historic period	1986

14.6.3 ABI 3730

Launched 2002, a 48-capillary instrument for medium- to high-throughput labs.

Topic	Sequencing Methods/Technology
Historic period	2000

14.6.4 ABI Prism 3100 Genetic Analyzer

Launched 2000, a 16-capillary electrophoresis instrument designed for medium-throughput labs, giving reads of 500-700 bases.

Topic	Sequencing Methods/Technology
Historic period	1998
Connections	PE Applied Biosystems Hitachi

14.6.5 ABI Prism 3700 DNA Analyzer

The first 96-capillary sequencing instrument, launched in 1998. In searching for a market for these new high-throughput machines, Applied Biosystems management decided to launch a spin-off company (later named Celera Genomics) and recruit J. Craig Venter to head it. The ABI 3700 was the workhorse of both the international genome sequencing consortium and Celera from 1998 to 2000 and beyond.

Topic	Sequencing Methods/Technology
Historic period	2000
Keywords	automated sequencing, sequencer

14.6.6 ALF DNA Analysis System, Pharmacia

The Pharmacia ALF DNA sequencer was one of several commercial competitors to the ABI franchise in the 1990s. During the early '90s, the ALF DNA sequencer relied on a single fluorescently labeled DNA primer in four parallel sequencing lanes.

Topic	Sequencing Methods/Technology
Historic period	1988

14.6.7 Chain-terminating dideoxynucleotides, fluorescent

See **Sequencing dyes.**

Topic	Sequencing Methods/Technology

14.6.8 Chain termination

See **Sanger sequencing.**

Topic	Sequencing Methods/Technology

14.6.9 DNA fingerprinting/DNA forensics

DNA fingerprinting was discovered by Alec Jeffreys at the University of Leicester in 1983. Although the initial finding was serendipitous, Jeffreys and colleagues instantly recognized the implications of inherited variations in DNA, from forensic analysis to genealogy to paternity testing. The method was quickly put into practical use, notably in a British murder investigation that was made into a best-selling book.

Current methods of DNA fingerprinting use PCR to amplify and detect small variations in microsatellite (short tandem) repeats (rather than minisatellite repeats). The FBI uses a defined set of 14 DNA markers spread across the genome, known as CODIS (Combined DNA Index System) for forensic identification. DNA fingerprinting has become a ubiquitous method for identifying victims of accidents and crime scenes. It has also led to the identification of major historical figures, including the family of Tsar Nicholas II, the criminal Josef Mengele, and the remains of King Richard III, uncovered beneath a car park in Leicester, UK (King, T.E. *et al. Nature Communications* 2014).

Topic	Sequencing Methods/Technology
Historic period	1984

14.6.10 DNA sequencing

The technology that reveals the sequence of nucleotides that make up the genetic code. The breakthrough method of DNA sequencing was developed by Fred Sanger in the late 1970s in Cambridge, UK. It was automated in the 1980s by Applied Biosystems (Smith, L.M. *et al. Nature* 1986) and was the mainstay method throughput the Human Genome Project (Hutchison, C.A. III, *Nucl. Acids Res.* 2007). Although Sanger sequencing has been relegated to niche applications in clinical and forensic uses, it is still considered the gold standard in those scenarios. Since 2005, newer high-throughput methods of DNA sequencing (see “high-throughput sequencing”) have superseded Sanger sequencing, with Illumina proving to be the dominant method for human genome sequencing. Several other technologies exist including long-range sequencing from Pacific Biosciences and nanopore sequencing from Oxford Nanopore and Genia.

Topic	Sequencing Methods/Technology
Connections	http://sidesandassociates.com/index.php/the-ipod-of-sequencing/

14.6.11 Genesis 2000, DuPont

In 1987, scientists at DuPont published details of a system for rapid DNA sequencing using fluorescent chain-terminating dideoxynucleotides (Prober, J.M. *et al. Science* 1987). Developed by George Trainor and colleagues, the instrument was named the Genesis 2000 DNA Analysis System and featured a 12-lane gel and an argon laser to read the fluorescently labeled DNA fragments. The major advance was to label the dideoxynucleotide terminators rather than the oligonucleotide primers. Because of this and the emission characteristics of the dye set, the instrument was able to combine the four labeled deoxynucleotides into a single lane.

DuPont briefly marketed the instrument but subsequently sold the license to Applied Biosystems.

Topic	Sequencing Methods/Technology

14.6.12 Genome Sequencer GS20, 454 Life Sciences next-generation sequencer unveiled

See **454 Life Sciences**.

The inaugural benchtop sequencer from 454 Life Sciences, which debuted in October 2005 (Margulies, M. *et al,. Nature* 2005). The first "next-generation" DNA sequencer, it used pyrosequencing and emulsion PCR, building hundreds of thousands of DNA sequence reads from the sequential cycling of four nucleotides and a luciferase-based assay. (The instrument name "GS20" stood for the 20 megabase output from a single run of the instrument.) The technology was successfully used for metagenomics and Neanderthal sequencing applications and amassed several high-profile publications. It also provided the basis for the first personal genome sequence of James D. Watson in 2007, published in *Nature* in 2008.

Topic	Sequencing Methods/Technology
Historic period	2005

14.6.13 High-throughput sequencing

Also known as "next-generation sequencing", high-throughput sequencing is the massive increase in throughput – and concomitant decrease in price – from the advent of new post-Sanger sequencing technologies initially from 454 Life Sciences and Solexa, subsequently Life Technologies, Helicos, Pacific Biosciences, and Complete Genomics.

Topic	Sequencing Methods/Technology
Historic period	2002

14.6.14 Introduction of ABI 377 sequencing machine

Applied Biosystems sequencer launched in 1995, with expanded capacity up to 96 sequencing lanes.

Topic	Sequencing Methods/Technology
Historic period	1995

14.6.15 Massively parallel sequencing

See **High-Throughput sequencing.**

The development of high-throughput sequencing platforms in which the sequence of hundreds of thousands or millions of DNA molecules are determined in parallel. The resulting sequence data are assembled computationally.

Topic	Sequencing Methods/Technology
Historic period	1994

14.6.16 Maxam-Gilbert DNA sequencing method

An ingenious DNA sequencing method developed in the late 1970s by Walter Gilbert and his student Allan Maxam. Gilbert shared the Nobel Prize in Chemistry in 1980 with Fred Sanger and Paul Berg. The chemical method used for chemicals to break apart DNA fragments at specific nucleotides prior to fragment separation on polyacrylamide gels and autoradiography. The method had its supporters but the toxic nature of some of the chemical reagents (notably hydrazine), as well as the relative ease of the rival Sanger sequencing, led to the consumer market swiftly adopting the Sanger method.

Topic	Sequencing Methods/Technology
Historic period	1977

14.6.17 MegaBACE sequencing machine, Molecular Dynamics

A capillary sequencing instrument launched by Molecular Dynamics (subsequently acquired by Amersham) in 1997 and briefly provided some serious competition for PerkinElmer's subsequent ABI 3700. The MegaBACE 1000 operated 96 capillaries and offered a 2-hour run time. In certain configurations it could sequence read lengths of up to 600 bases. The advent of the MegaBACE accelerated development of the ABI 3700.

Topic	Sequencing Methods/Technology
Historic period	1997
Connections	Molecular dynamics

14.6.18 Model 470A Protein Sequencer, first commercial instrument

In August 1982, Applied Biosystems introduced its first instrument – the Model 470A protein sequencer.

Topic	Sequencing Methods/Technology
Historic period	1982

14.6.19 Multiplex (Polony) sequencing

An alternative method for high-throughput DNA sequencing developed by George Church, Jay Shendure, Rob Mitra and colleagues (Shendure, J. *et al. Science* 2005). The method utilized sequencing by ligation, emulsion PCR to amplify DNA fragments attached to 1-micrometer beads, and the customization of an epifluorescence microscope. The system was commercially developed by Danaher as "The Polonator" with the first instrument shipped in 2008. It was amenable to microbial genome sequencing, re-sequencing and digital gene expression studies. Methods of ligation sequencing were licensed to Life Technologies as part of the development of the SOLiD sequencer.

Topic	Sequencing Methods/Technology
Historic period	1999

14.6.20 Nanopore sequencing

First proposed in 1996 by Daniel Branton, David Deamer and colleagues, nanopore sequencing is a technology based on threading a DNA strand through a pore (either a natural protein such as bacterial alpha-

hemolysin) or a synthetic channel, and inferring the base sequence based on fluctuations in current. Branton and Deamer predicted that if the speed of DNA translocation could be slowed, then the shape and size of the nucleotides passing through the center of the pore would change the electrical resistance and that information could be translated into sequence data (Kasianowicz, J.J. *et al. PNAS* 1996). Work from Hagan Bayley (Oxford), Mark Akeson (UCSC) and others have confirmed this prediction. The first nanopore sequencer – the minION – was made commercially available by Oxford Nanopore. The device plugs into a laptop using a USB connection, and uses an engineered helicase or gyrase to unwind the DNA template and ratchet the DNA through the pore. A Hidden Markov Model is used to convert the current to sequence data.

Topic	Sequencing Methods/Technology

14.6.21 Next-generation sequencing

See **High Throughput Sequencing.**

Topic	Sequencing Methods/Technology

14.6.22 Paleontology, use of DNA sequencing in

High-throughput sequencing has enabled major advances in the sequencing of ancient DNA – extracting DNA from fossils and other sources. Svante Paabo (Max Planck Institute) has pioneered methods of extracting and sequencing DNA from various paleontological samples, including Egyptian mummies and Neanderthal and Denisovan fossils. In 2012, Paabo and colleagues published the draft genome sequencing from Neanderthal bone fragments, providing strong evidence that modern humans and Neanderthals interbred some 40-70,000 years ago.

Topic	Sequencing Methods/Technology

14.6.23 PE Prism 3700 sequencer

See **ABI Prism 3700 DNA Analyzer.**

Topic	Sequencing Methods/Technology

14.6.24 Protein sequencing

In the late 1970s, Leroy Hood and Michael Hunkapiller at Caltech developed the first protein sequencer, automating the Edman degradation reaction. The technology was commercialized in 1982, when Applied Biosystems (a company co-founded by Hood) launched the first protein sequencer instrument, the Model 470A.

The first protein sequence – the two linked polypeptide chains of insulin – was determined using chromatographic fingerprinting methods by British biochemist Fred Sanger in 1951-52. Deducing the compete amino acid sequence was an important milestone in its own right but also showed that, contrary to popular opinion, proteins possessed a unique chemical structure. Sanger was subsequently awarded the Nobel Prize for Chemistry in 1958.

Topic	Sequencing Methods/Technology

14.6.25 Pyrosequencing

See also **Genome Sequencer 20.**

A method of DNA sequencing devised by Pal Nyren and Mostafa Ronaghi in Stockholm in the mid 1990s. A sequencing-by-synthesis method, it detects the release of pyrophosphate molecules upon the incorporation of a deoxynucleotide. Each nucleotide is cycled into the reaction sequentially. Once a nucleotide is incorporated, a two-stage reaction detects the release of pyrophosphate. First, pyrophosphate is converted to ATP by the enzyme ATP sulfurylase; next, ATP acts as a substrate for the production of oxyluciferin from luciferin, catalyzed by an enzyme called luciferase. The emittance of light in this reaction (proportional to the amount of ATP) is detected by a camera. After degrading the unincorporated nucleotides and ATP with apyrase, the cycle can be repeated with the next nucleotide.

The rights to pyrosequencing were commercialized by a Swedish company that became known as Biotage. The rights were licensed to 454 Life Sciences, leading to the launch of the GS20 in 2005. Roche acquired 454 in 2006, but the platform was shuttered in 2013.

Topic	Sequencing Methods/Technology

14.6.26 Sanger DNA sequencing method

Also known as the chain-termination or dideoxy method, Sanger sequencing revolutionized DNA sequencing and made the Human Genome Project possible. Sanger and colleagues developed dideoxy sequencing from an earlier method (plus/minus sequencing). The method ran four identical DNA synthesis reactions in parallel, the only difference being that in each pot was a limiting concentration of the dideoxy variant of one of the four nucleotides (A, C, T, G). When a dideoxy nucleotide is incorporated into the DNA strand, it halts any further elongation by virtue of the missing 3' hydroxyl group. The resulting mélange of DNA fragments are separated by gel electrophoresis and then detected by radiation or fluorescence. Sanger sequencing was automated by Applied Biosystems in the mid-1980s, and drove advances in bacterial, yeast, worm, fruit fly, mouse and ultimately human genome sequencing in 1999-2000. Even though Sanger sequencing has been displaced by high-throughput DNA sequencing methods, it is still widely used for clinical validation and forensic applications, among others.

Topic	Sequencing Methods/Technology
Historic period	1977
Connections	Sanger, Frederick

14.6.27 Sequencing by hybridization (SBH)

Sequencing by hybridization is a sequencing method that involves hybridizing a series of oligonucleotides to an unknown template and deducing the sequence from the binding pattern. An early champion of the method was Rade Drmanac (DeFrancesco, L. *Nat. Biotech.* 2008) , who adapted it to a ligation method that was commercially developed by Complete Genomics (now part of BGI).

Topic	Sequencing Methods/Technology
Historic period	1993

14.6.28 Sequencing dyes

The introduction of fluorescent dyes was a key breakthrough in the development of automated DNA sequencing. By using a distinct dye for each of the four dideoxy nucleotides, it was possible to consolidate four parallel sequencing reactions into a single tube and reading the DNA ladder on an electropherogram.

Topic	Sequencing Methods/Technology

14.6.29 Shotgun sequencing strategy described

See **Whole genome shotgun method**.

Topic	Sequencing Methods/Technology
Historic period	1979
Connections	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC327874/

14.6.30 Single-molecule sequencing

Single-molecule DNA sequencing has been a target of many groups and biotech companies, as it obviates the need for DNA amplification. Solexa initially began working on a single-molecule sequencing method in the early 2000s before switching to an amplification method. In 2003, Stanford University's Stephen Quake successfully sequenced five bases of a single molecule of DNA (Braslavsky, I. *et al. PNAS*, 2003); the technology was commercially developed by a company called Helicos. Meanwhile, Stephen Turner and colleagues at Cornell developed a single-molecule sequencing method using zero mode waveguides (Levene, M.J. *et al. Science* 2003) to eavesdrop on the real-time synthesis of DNA strands by isolated DNA polymerase molecules. The technology was developed by Pacific Biosciences; the technology offers very long read-lengths of 10-40,000 bases, which is advantageous for de novo genome assembly.

Topic	Sequencing Methods/Technology

14.6.31 Solexa (Illumina) next-generation sequencer introduced

Solexa was a UK biotech company founded in 1998 by two Cambridge University chemistry professors, Shankar Balasubramanian and David Klenerman. The company aimed to study the biophysics of DNA sequencing one nucleotide at a time, using reversible chain terminators. In February 2005, the group sequenced its first viral genome. A reverse merger with Lynx Therapeutics in 2006 gave Solexa a public listing on the NASDAQ stock exchange. The company's first instrument was commercially launched that year. In 2007, Illumina bought Solexa for $650 million. In November 2008, Solexa sequencing was the basis for three complete genome sequence reports, heralding a turning point in the race to establish the dominant next-generation sequencing platform.

Topic	Sequencing Methods/Technology

Historic period	2006

14.6.32 SOLiD sequencer (Life Technologies)

The high-throughput sequencing instrument launched by Life Technologies after the acquisition of Agencourt Life Sciences. The system relied on DNA ligase, rather than DNA polymerase, and an ingenious two-color coding system. From 2007-10, the SOLiD sequencing platform and Illumina competed head-to-head for market share and price per genome. Life Technologies' decision to purchase Ion Torrent Systems for $700 million signaled a shift in the firm's priorities for high-throughput sequencing.

Topic	Sequencing Methods/Technology
Historic period	2007

14.6.33 Transposon-mediated chromosome sequencing

Topic	Sequencing Methods/Technology

14.6.34 Whole-genome shotgun method

Shotgun sequencing was used by J. Craig Venter and colleagues in the sequencing of the first microbial genome in 1995. It was controversial at the time because most researchers favored building a physical framework map before embarking on detailed sequencing. Venter's group relied on computational assembly of overlapping DNA fragments. In 1996, Gene Myers and Jim Weber controversially proposed that shotgun sequencing could be used to assemble a draft human genome sequence. The idea was vigorously rebutted by computational biologist Phil Green. The controversy continued through the HGP: Celera utilized shotgun sequencing for its own sequence data, but also incorporated publicly available data in its first draft genome assembly.

Today, shotgun sequencing – also known as hierarchical shotgun sequencing -- has become the standard method for genome assembly projects.

Topic	Sequencing Methods/Technology
Synonyms	Shotgun sequencing
Historic period	1995-present

14.7 Software/Databases

Bioinformatics tools -- software and databases – were critical to the success of the Human Genome Project. Some of the critical programs, such as BLAST (sequence alignment) and GRAIL (gene detection), were developed at the beginning of the project. Tools and strategies for genetic mapping steadily improved while the Mendelian Inheritance in Man catalog of genetic traits was put online. In 2000, Jim Kent, a graduate student at University of California Santa Cruz with David Haussler, wrote a program called GigAssembler to assemble the first draft of the human genome – the so-called "Golden Path." This assembly was made available through the UCSC Genome Browser. Other key genome databases were launched by Ensembl in the UK and in Japan.

14.7.1 BLAST

The Basic Local Alignment Search Tool (BLAST) is the classic heuristic algorithm for the comparison of amino acid or nucleotide DNA sequences against a database of known sequences. It was developed by Stephen Altschul, Gene Myers, David Lipman, Webb Miller, and Warren Gish (Altschul, S.F. *et al. J. Mol. Biol*. 1990). BLAST quickly gained popularity in part because it was an order of magnitude faster than previous methods of sequence alignment, such as the Smith-Waterman Process. It remains today the most commonly used sequence similarity search tool.

Topic	Software/Databases
Synonyms	Basic Local Alignment Search Tool
Historic period	1990
Connections	Lipman, David Myers, Eugene National Center for Biotechnology Information (NCBI)

14.7.2 Ensembl (UK)

The Ensembl organization was established in 1999 to launch an online portal for the analysis and annotation of genome data, which debuted in July 2000. It has evolved into a major data repository, providing tools and data on some 70-80 different genomes (including human). Ensembl is a joint project between the European Bioinformatics Institute (EBI) – an outstation of the Molecular Biology Laboratory (EMBL) -- and the Wellcome Trust Sanger Centre, both located in Hinxton, just south of Cambridge, UK. This review summarizes Ensembl's resources as of 2015 (Cunningham, F. *et al. Nucl. Acids Res.* 2015).

The Ensembl browser has served as one of three major global portals to genome data, the others being the UCSC Golden Path browser and the NCBI.

Topic	Software/Databases

14.7.3 FBI Combined DNA Index System (CODIS) for DNA fingerprinting

CODIS is the term for the Federal Bureau of Investigation's support of criminal justice databases. The centerpiece of CODIS is the National DNA Index System (NDIS), a database containing records contributed by federal, state and local participating forensic laboratories. DNA records submitted to CODIS fit a set of standard criteria: 13 core (STR) loci -- CSF1PO, FGA, THO1, TPOX, VWA, D3S1358, D5S818, D7S820, D8S1179, D13S317, D16S539, D18S51, D21S11 – and a Y-chromosome marker. As of December 2015, CODIS contained more than 12 million offender DNA fingerprint profiles.

Topic	Software/Databases
Synonyms	CODIS
Historic period	1990

14.7.4 GenBank database

GenBank was established by the NIH in 1982 as a central repository for researchers to submit DNA and genome sequence data. The resource began with a five-year contract for the nucleic acid sequence database issued by NIH to Bolt, Beranek and Newman, with a subcontract to Los Alamos National Laboratory. The

following year, David Lipman and John Wilbur published an algorithm that greatly facilitated similarity searches against the sequences housed in the database. This was in turn succeeded by BLAST. Since the mid-1980s, GenBank has exchanged data daily with databases at EMBL and DNA Data Bank of Japan -- this is known as the International Nucleotide Sequence Database Collaboration (INSDC). From 1987-1992, GenBank was managed by Intelligenetics, after which it was permanently transferred to the National Center for Biotechnology Information (NCBI). NCBI currently hosts GenBank and many other biological and literature databases, including PubMed and PubMed Central.

In April 2002, GenBank began collecting whole genome sequence data. In April 2008, a symposium at NIH celebrated the 25-year anniversary of Genbank. As of October 2015, GenBank contained a total of more than 202 trillion bases of sequence data. The rate of sequence data submission has roughly doubled every 18 months.

Topic	Software/Databases
Historic period	1982
Keywords	database
Connections	http://www.ncbi.nlm.nih.gov/genbank/

14.7.5 Genome Database (GDB) launched

The GDB Human Genome Data Base was launched in 1990 under the directorship of Johns Hopkins University geneticist Peter Pearson. Initial funding was provided by the Howard Hughes Medical Institute. The database contained curated (peer reviewed) information on genes, clones, STSs and genetic maps. The GDB played an important role during the Human Genome Project (Letovsky, S.I. *et al. Nucl. Acids. Res.* 1998) but funding shifts led to the GDB being relocated to Canada. The GDB was shut down in 2008.

Topic	Software/Databases
Synonyms	Genome Data Base; Genome Databank
Historic period	1990
Keywords	database

14.7.6 Genome Directory (LocusLink)

LocusLink was an NCBI resource providing a single point-of-access to gene-specific information sources. The site was retired in 2005, replaced by Entrez Gene.

Topic	Software/Databases
Synonyms	LocusLink
Historic period	1999

14.7.7 GENSCAN program released

Genscan is one of a number of programs developed by Christopher Burge. Genscan is an algorithm for the ab initio prediction of complete gene structures in human, vertebrate, Drosophila and plant genome sequences.

Topic	Software/Databases
Historic period	1997
Connections	MIT New GENSCAN Web Server at MIT Burge, Chris Stanford University

14.7.8 GRAIL gene-finding program

GRAIL (Gene Relationships Across Implicated Loci) is a statistical method designed to evaluate the degree of relatedness among genes within disease regions. It was developed by Mark Daly and coworkers at the Broad Institute, working with the International Schizophrenia Consortium (Raychaudhuri, S. *et al. PLOS Genet.* 2009).

Topic	Software/Databases
Historic period	1991
Connections	Uberbacher, Edward Oak Ridge National Laboratory (ORNL)/Archives Comparative Genomics at ORNL

14.7.9 IMAGE (Integrated Molecular Analysis of Gene Expression)

The I.M.A.G.E. Consortium is the world's largest public cDNA collection. It was launched in 1993 by Greg Lennon, Charles Auffray, Mihael Polymeropoulos, and M. Bento Soares (Lennon, G.G. *et al. Genomics* 1996.) The primary aim was to create and distribute arrayed cDNA libraries as well as related bioinformatics tools, providing the research community with a resource to aid gene discovery without facing royalty or patent issues. The resource included libraries from mammals (including non-human primate species), zebrafish, pufferfish, and *Xenopus.* More than 5 million distinct cDNA clones (from more than 400 human cDNA libraries among others) were arrayed into 384-well microtiter plates, suitable for distribution to sequencing and other genome centers. Investigators who identify a clone of interest can freely request that clone from a distributor.

Topic	Software/Databases
Historic period	1993

14.7.10 Los Alamos sequence database

Launched in 1979 by Walter Goad (Los Alamos National Laboratory), merging with GenBank in 1982.

Topic	Software/Databases
Historic period	1979

14.7.11 PHRAP

An important software programs for DNA sequence assembly developed by University of Washington mathematician Phil Green (see also Phred). Phrap ("Phil's Revised Assembly Program") was originally

developed to help assemble large-scale contig maps for the Human Genome Project. Phrap works with Phred to determine accurate consensus sequences, and was instrumental in assembling bacterial genomes.

Topic	Software/Databases
Historic period	1996
Connections	Phred, Phrap, Consed Green, Philip

14.7.12 PHRED

An important software program developed by University of Washington mathematician Phil Green and Brent Ewing (see also Phrap). Phred ("Phil's Revised Editor") is a base calling scorer for automated sequence traces, published in 1998 (Ewing, B. *et al. Genome Res.* 1988). The program assigns quality scores to each base call. It was widely used by genome centers and commercial DNA sequencing laboratories. Phred was used in combination with Phrap for sequence assemblies.

Topic	Software/Databases
Historic period	1998
Connections	Phred, Phrap, ConsedGreen, Philip

14.7.13 UCSC Golden Path

The first human genome browser for the reference genome developed in 2000 by Jim Kent, then a graduate student in David Haussler's group at the University of California, Santa Cruz. The UCSC genome browser is affectionately known as "The Golden Path." Kent volunteered to write a genome assembly program just weeks before the announcement of the draft genome sequence in June 2000. The raw data for the first draft consisted of about 375,000 sequence contigs. Kent's program--GigAssembler--merged and ordered these contigs, using RNA, EST, BAC and other data--to provide the first working draft of the human genome (chromosomes 21 and 22 had already been more or less finished). The draft genome was first assembled on June 22, just four days before the White House announcement. The assembly took four weeks of compute time on a distributed network of 100 computers that Haussler had persuaded the UCSC chancellor to fund (Wade, N. *New York Times* 2001). The assembly contained 2.7 billion bases spanning nearly 90% of the human genome (Kent, W.J. & Haussler, D. *Genome Res.* 2001).

The first draft of the human genome was released to the public via the UCSC portal on July 7, 2000. The portal has evolved to contain genome data on a number of vertebrate species and the Neanderthal genome. In July 2015, the browser switched to using GENCODE v 22 as the default gene set on the latest genome assembly, replacing the default gene set created at UCSC using Jim Kent's code, thereby reducing the number of competing gene sets. (This is the same set of genes as Ensembl.) The new gene set has more than 195,000 total transcripts, and more than 49,500 canonical genes.

Topic	Software/Databases

15 PUBLICATIONS, MULTIMEDIA AND UNPUBLISHED MATERIALS

15.1 Abstracts (see Meetings & Events)

15.2 Articles

15.2.1 454 Life Sciences (2005) 454 Life Sciences and Roche Announce commercial launch of the GS20 System and reagents

Jonathan Rothberg's Curagen spin-out, 454 Life Sciences, unveils pyrosequencing technology, which became the first commercially available "next-generation" sequencing platform in 2006.

http://454.com/resources-support/news.asp?display=detail&id=36

Type of reference	Press Release

15.2.2 Adams MD, et al. (1991) Complementary DNA sequencing: Expressed sequence tags and human genome project

A paper in which NIH neuroscientist Craig Venter – an early adopter of automated DNA sequencing – identified more than 300 randomly selected genes, dubbed expressed sequence tags (ESTs).

Adams MD, et al. Complementary DNA sequencing: Expressed sequence tags and human genome project. Science. 1991;252(5013):1651-6. DOI: 10.1126/science.2047873. PMID: 2047873

Type of reference	Article
Authors	Adams MD, Kelley JM, Gocayne JD, Dubnick M, Polymeropoulos MH, Xiao H, Merril CR, Wu A, Olde B, Moreno RF, Kerlavage AR, McCombie WR, Venter JC

15.2.3 Adams MD, et al. (2000) The genome sequence of Drosophila melanogaster

First publication of the 180-Mb Drosophila genome, produced by a controversial academic-industry coalition led by Gerry Rubin (Berkeley) and Craig Venter's new company, Celera Genomics.

Adams MD, et al. The genome sequence of drosophila melanogaster. Science. 2000;287(5461):2185-95. Epub 2000/03/25. DOI: 10.1126/science.287.5461.2185. PMID: 10731132

The fly *Drosophila melanogaster* is one of the most intensively studied organisms in biology and serves as a model system for the investigation of many developmental and cellular processes common to higher eukaryotes, including humans. We have determined the nucleotide sequence of nearly all of the ~120 megabase euchromatic portion of the *Drosophila* genome using a whole-genome shotgun sequencing strategy supported by extensive clone-based sequence and a high-quality bacterial artificial chromosome physical map. Efforts are under way to close the remaining gaps; however, the sequence is of sufficient accuracy and contiguity to be declared substantially complete and to support an initial analysis of genome structure and preliminary gene annotation and interpretation. The genome encodes ~13,600 genes, somewhat fewer than the smaller *Caenorhabditis elegans* genome, but with comparable functional diversity.

Type of reference	Article
Authors	Mark D. Adams, Susan E. Celniker, Robert A. Holt, Cheryl A. Evans, Jeannine D. Gocayne, Peter G. Amanatides, Steven E. Scherer, Peter W. Li, Roger A. Hoskins, Richard F. Galle, Reed A. George, Suzanna E. Lewis, Stephen Richards, Michael Ashburner, Scott N. Henderson, Granger G. Sutton , Jennifer R. Wortman, Mark D. Yandell, Qing Zhang, Lin X. Chen, Rhonda C. Brandon, Yu-Hui C. Rogers, Robert G. Blazej, Mark Champe, Barret D. Pfeiffer, Kenneth H. Wan, Clare Doyle, Evan G. Baxter, Gregg Helt, Catherine R. Nelson, George L. Gabor, Miklos, Josep F. Abril, Anna Agbayani, Hui-Jin An, Cynthia Andrews-Pfannkoch, Danita Baldwin, Richard M. Ballew, Anand Basu, James Baxendale, Leyla Bayraktaroglu, Ellen M. Beasley, Karen Y. Beeson, P. V. Benos, Benjamin P. Berman, Deeali Bhandari, Slava Bolshakov, Dana Borkova, Michael R. Botchan, John Bouck, Peter Brokstein, Phillipe Brottier, Kenneth C. Burtis, Dana A. Busam, Heather Butler, Edouard Cadieu, Angela Center, Ishwar Chandra, J. Michael Cherry, Simon Cawley, Carl Dahlke, Lionel B. Davenport, Peter Davies, Beatriz de Pablos, Arthur Delcher, Zuoming Deng, Anne Deslattes Mays, Ian Dew, Suzanne M. Dietz, Kristina Dodson, Lisa E. Doup, Michael Downes, Shannon Dugan-Rocha, Boris C. Dunkov, Patrick Dunn, Kenneth J. Durbin, Carlos C. Evangelista, Concepcion Ferraz, Steven Ferriera, Wolfgang Fleischmann, Carl Fosler, Andrei E. Gabrielian, Neha S. Garg, William M. Gelbart, Ken Glasser, Anna Glodek, Fangcheng Gong, J. Harley Gorrell, Zhiping Gu, Ping Guan, Michael Harris, Nomi L. Harris, Damon Harvey, Thomas J. Heiman, Judith R. Hernandez, Jarrett Houck, Damon Hostin, Kathryn A. Houston, Timothy J. Howland, Ming-Hui Wei, Chinyere Ibegwam, Mena Jalali, Francis Kalush, Gary H. Karpen, Zhaoxi Ke, James A. Kennison, Karen A. Ketchum, Bruce E. Kimmel, Chinnappa D. Kodira, Cheryl Kraft, Saul Kravitz, David Kulp, Zhongwu Lai, Paul Lasko, Yiding Lei, Alexander A. Levitsky, Jiayin Li, Zhenya Li, Yong Liang, Xiaoying Lin, Xiangjun Liu, Bettina Mattei, Tina C. McIntosh, Michael P. McLeod, Duncan McPherson, Gennady Merkulov, Natalia V. Milshina, Clark Mobarry, Joe Morris, Ali Moshrefi, Stephen M. Mount, Mee Moy, Brian Murphy, Lee Murphy, Donna M. Muzny, David L. Nelson, David R. Nelson, Keith A. Nelson, Katherine Nixon, Deborah R. Nusskern, Joanne M. Pacleb, Michael Palazzolo, Gjange S. Pittman, Sue Pan, John Pollard, Vinita Puri, Martin G. Reese, Knut Reinert, Karin Remington, Robert D. C. Saunders, Frederick Scheeler, Hua Shen, Bixiang Christopher Shue, Inga Sidén-Kiamos, Michael Simpson, Marian P. Skupski, Tom Smith, Eugene Spier, Allan C. Spradling, Mark

	Stapleton, Renee Strong, Eric Sun, Robert Svirskas, Cyndee Tector, Russell Turner, Eli Venter, Aihui H. Wang, Xin Wang, Zhen-Yuan Wang, David A. Wassarman, George M. Weinstock, Jean Weissenbach, Sherita M. Williams, Trevor Woodage, Kim C. Worley, David Wu, Song Yang, Q. Alison Yao, Jane Ye, Ru-Fang Yeh, Jayshree S. Zaveri, Ming Zhan, Guangren Zhang, Qi Zhao, Liansheng Zheng, Xiangqun H. Zheng, Fei N. Zhong, Wenyan Zhong, Xiaojun Zhou, Shiaoping Zhu, Xiaohong Zhu, Hamilton O. Smith, Richard A. Gibbs, Eugene W. Myers , Gerald M. Rubin , J. Craig Venter

15.2.4 Adamson A, et al. (2009) Genome Management Information System: A Multifaceted Approach to DOE Systems Biology Research Communication and Facilitation

Adamson A, et al. Genome Management Information System: A Multifaceted Approach to DOE Systems Biology Research Communication and Facilitation

Type of reference	Article
Authors	Anne E. Adamson, Shirley H. Andrews, Jennifer L. Bownas, Sharon Burris, Kris Christen, Holly Haun, Sheryl A. Martin, Marissa D. Mills, Kim Nylander, Judy M. Wyrick, Anita J. Alton, and Betty K. Mansfield, GTL. Available at: http://genomicscience.energy.gov/pubs/2009abstracts/elsi.pdf

15.2.5 Akerley BJ, et al. (2002) A genome-scale analysis for identification of genes required for growth or survival of haemophilus influenzae

Study revealed potential roles for some 250 open reading frames of previously unknown function.

Akerley BJ, et al. A genome-scale analysis for identification of genes required for growth or survival of haemophilus influenzae. Proceedings of the National Academy of Sciences of the United States of America 2002.99(2):966-71. Epub 2002/01/24. doi: 10.1073/pnas.012602299. PubMed PMID: 11805338; PMCID: PMC117414

Type of reference	Article
Authors	Akerley BJ, Rubin EJ, Novick VL, Amaya K, Judson N, Mekalanos JJ

15.2.6 Albertsen HM, et al. (1990) Construction and characterization of a yeast artificial chromosome library containing seven haploid human genome equivalents

Early effort demonstrating the feasibility of constructing a yeast artificial chromosome library containing large DNA fragments for the human genome.

Albertsen HM, et al. Construction and characterization of a yeast artificial chromosome library containing seven haploid human genome equivalents. Proceedings of the National Academy of Sciences of the United States of America 1990.87(11):4256-60. Epub 1990/06/01. PubMed PMID: 2190217; PMCID: PMC54087

Type of reference	Article
Authors	Albertsen HM, Abderrahim H, Cann HM, Dausset J, Le Paslier D, Cohen D

15.2.7 Altschul SF, et al. (1990) Basic local alignment search tool

NIH researchers publish BLAST, the classic sequence homology search tool.

Altschul SF, et al. Basic local alignment search tool. J Mol Biol. 1990;215(3):403-10. doi: 10.1016/S0022-2836(05)80360-2. PMID: 2231712

Type of reference	Article
Authors	Altschul SF, Gish W, Miller W, Myers EW, Lipman DJ

15.2.8 Altshuler D, et al. (2010) A map of human genome variation from population-scale sequencing

The 1000 Genomes Project Consortium's comprehensive survey of human population genomic variation, studying 179 individuals from seven populations, cataloguing 15 million SNPs, 1 million indels, and 20,000 copy number variants. The study also revealed that, on average, each subject carries 250-300 loss-of-function variants.

Altshuler D, et al. A map of human genome variation from population-scale sequencing. Nature. 2010;467(7319):1061-73. DOI: 10.1038/nature09534. PMID: 20981092

Type of reference	Article
Authors	Altshuler D, Durbin RM, Abecasis GR, Bentley DR, Chakravarti A, Clark AG, Collins FS, De la Vega FM, Donnelly P, Egholm M, Flicek P, Gabriel SB, Gibbs RA, Knoppers BM, Lander ES, Lehrach H, Mardis ER, McVean GA, Nickerson D, Peltonen L, Schafer AJ, Sherry ST, Wang J, Wilson RK, Deiros D, Metzker M, Muzny D, Reid J, Wheeler D, Li JX, Jian M, Li G, Li RQ, Liang HQ, Tian G, Wang B, Wang W, Yang HM, Zhang XQ, Zheng HS, Altshuler DL, Ambrogio L, Bloom T, Cibulskis K, Fennell TJ, Jaffe DB, Shefler E, Sougnez CL, Gormley N, Humphray S, Kingsbury Z, Koko-Gonzales P, Stone J, McKernan KJ, Costa GL, Ichikawa JK, Lee CC, Sudbrak R, Borodina TA, Dahl A, Davydov AN, Marquardt P, Mertes F, Nietfeld W, Rosenstiel

	P, Schreiber S, Soldatov AV, Timmermann B, Tolzmann M, Affourtit J, Ashworth D, Attiya S, Bachorski M, Buglione E, Burke A, Caprio A, Celone C, Clark S, Conners D, Desany B, Gu L, Guccione L, Kao K, Kebbel A, Knowlton J, Labrecque M, McDade L, Mealmaker C, Minderman M, Nawrocki A, Niazi F, Pareja K, Ramenani R, Riches D, Song W, Turcotte C, Wang S, Dooling D, Fulton L, Fulton R, Weinstock G, Burton J, Carter DM, Churcher C, Coffey A, Cox A, Palotie A, Quail M, Skelly T, Stalker J, Swerdlow HP, Turner D, De Witte A, Giles S, Bainbridge M, Challis D, Sabo A, Yu F, Yu J, Fang XD, Guo XS, Li YR, Luo RB, Tai S, Wu HL, Zheng HC, Zheng XL, Zhou Y, Marth GT, Garrison EP, Huang W, Indap A, Kural D, Lee WP, Leong WF, Huang WC, Quinlan AR, Stewart C, Stromberg MP, Ward AN, Wu JT, Lee C, Mills RE, Shi XH, Daly MJ, DePristo MA, Ball AD, Banks E, Browning BL, Garimella KV, Grossman SR, Handsaker RE, Hanna M, Hartl C, Kernytsky AM, Korn JM, Li H, Maguire JR, McCarroll SA, McKenna A, Nemesh JC, Philippakis AA, Poplin RE, Price A, Rivas MA, Sabeti PC, Schaffner SF, Shlyakhter IA, Cooper DN, Ball EV, Mort M, Phillips AD, Stenson PD, Sebat J, Makarov V, Ye K, Yoon SC, Bustamante CD, Boyko A, Degenhardt J, Gravel S, Gutenkunst RN, Kaganovich M, Keinan A, Lacroute P, Ma X, Reynolds A, Clarke L, Cunningham F, Herrero J, Keenen S, Kulesha E, Leinonen R, McLaren W, Radhakrishnan R, Smith RE, Zalunin V, Zheng-Bradley XQ, Korbel JO, Stutz AM, Bauer M, Cheetham RK, Cox T, Eberle M, James T, Kahn S, Murray L, De La Vega FM, Fu YT, Hyland FCL, Manning JM, McLaughlin SF, Peckham HE, Sakarya O, Sun YA, Tsung EF, Batzer MA, Konkel MK, Walker JA, Albrecht MW, Amstislavskiy VS, Herwig R, Parkhomchuk DV, Agarwala R, Khouri H, Morgulis AO, Paschall JE, Phan LD, Rotmistrovsky KE, Sanders RD, Shumway MF, Xiao CL, Auton A, Iqbal Z, Lunter G, Marchini JL, Moutsianas L, Myers S, Tumian A, Knight J, Winer R, Craig DW, Beckstrom-Sternberg SM, Christoforides A, Kurdoglu AA, Pearson J, Sinari SA, Tembe WD, Haussler D, Hinrichs AS, Katzman SJ, Kern A, Kuhn RM, Przeworski M, Hernandez RD, Howie B, Kelley JL, Melton SC, Li Y, Anderson P, Blackwell T, Chen W, Cookson WO, Ding J, Kang HM, Lathrop M, Liang LM, Moffatt MF, Scheet P, Sidore C, Snyder M, Zhan XW, Zollner S, Awadalla P, Casals F, Idaghdour Y, Keebler J, Stone EA, Zilversmit M, Jorde L, Xing JC, Eichler EE, Aksay G, Alkan C, Hajirasouliha I, Hormozdiari F, Kidd JM, Sahinalp SC, Sudmant PH, Chen K, Chinwalla A, Ding L, Koboldt DC, McLellan MD, Wallis JW, Wendl MC, Zhang QY, Albers CA, Ayub Q, Balasubramaniam S, Barrett JC, Chen YA, Conrad DF, Danecek P, Dermitzakis ET, Hu M, Huang N, Hurles ME, Jin HJ, Jostins L, Keane TM, Le SQ, Lindsay S, Long QA, MacArthur DG, Montgomery SB, Parts L, Tyler-Smith C, Walter K, Zhang YJ, Gerstein MB, Abyzov A, Balasubramanian S, Bjornson R, Du JA, Grubert F, Habegger L, Haraksingh R, Jee J, Khurana E, Lam HYK, Leng J, Mu XJ, Urban AE, Zhang ZD, Coafra C, Dinh H, Kovar C, Lee S, Nazareth L, Yu FL, Wilkinson J, Khouri HM, Scott C, Gharani N, Kaye JS, Kent A, Li T, McGuire AL, Ossorio PN, Rotimi CN, Su YY, Toji LH, Brooks LD, Felsenfeld AL, McEwen JE, Abdallah A, Christopher R, Clemm NC, Duncanson A, Green ED, Guyer MS, Peterson JL, Genomes Project C

15.2.9 Amersham Pharmacia Biotech - Agreement to Acquire Molecular Dynamics

Applied Biosystems faces some competition in the automated DNA sequencing market in the form of Molecular Dynamics' MegaBACE.

http://www.prnewswire.com/news-releases/nycomed-amersham---agreement-to-acquire-molecular-dynamics-76126457.html

Type of reference	Press release

15.2.10 Anderson, WF (1992) Human Gene Therapy

Commentary on early clinical application of human gene therapy, including those performed by Anderson and colleagues at the NIH.

Anderson, WF, Human Gene Therapy, Science, 08 May 1992: Vol. 256, Issue 5058, pp. 808-813.

Type of reference	Article
Authors	Anderson, WF

15.2.11 Anderson S, et al. (1981) Sequence and organization of the human mitochondrial genome

Complete sequence and gene structure for the 16.6-kb mitochondrial genome.

Anderson S, et al. Sequence and organization of the human mitochondrial genome. Nature 1981.290(5806):457-65. Epub 1981/04/09. PubMed PMID: 7219534.http://www.ncbi.nlm.nih.gov/pubmed/7219534

Type of reference	Article
Authors	Anderson S, Bankier AT, Barrell BG, de Bruijn MH, Coulson AR, Drouin J, Eperon IC, Nierlich DP, Roe BA, Sanger F, Schreier PH, Smith AJ, Staden R, Young IG

15.2.12 Ankeny RA (2003) Sequencing the genome from nematode to human: Changing methods, changing science

Review on the evolution of DNA sequencing methods during the Human Genome Project.

Ankeny RA. Sequencing the genome from nematode to human: Changing methods, changing science. Endeavour. 2003;27(2):87-92. DOI: 10.1016/s0160-9327(03)00061-9. PMID: 12798815

Type of reference	Article
Authors	Ankeny RA

15.2.13 Aparicio S, et al. (2002) Whole-genome shotgun assembly and analysis of the genome of Fugu rubripes

The genome of Fugu rubripes by Sydney Brenner and colleagues, long proposed as a useful evolutionary model because of minimal "junk DNA." The project was a collaboration between the DOE and MRC.

Aparicio S, et al. Whole-genome shotgun assembly and analysis of the genome of Fugu rubripes. Science. 2002;297(5585):1301-10. DOI: 10.1126/science.1072104. PMID: 12142439

Type of reference	Article
Authors	Aparicio S, Chapman J, Stupka E, Putnam N, Chia J, Dehal P, Christoffels A, Rash S, Hoon S, Smit A, Gelpke MDS, Roach J, Oh T, Ho IY, Wong M, Detter C, Verhoef F, Predki P, Tay A, Lucas S, Richardson P, Smith SF, Clark MS, Edwards YJK, Doggett N, Zharkikh A, Tavtigian SV, Pruss D, Barnstead M, Evans C, Baden H, Powell J, Glusman G, Rowen L, Hood L, Tan YH, Elgar G, Hawkins T, Venkatesh B, Rokhsar D, Brenner S

15.2.14 Ashburner M, Bergman CM. (2005) Drosophila melanogaster: a case study of a model genomic sequence and its consequences

A personal review and look back at the history of Drosophila genome sequencing and analysis, including the public-private partnership and genome analysis “jamboree” held at Celera, and subsequent progress.

Ashburner M, Bergman CM. (2005) Drosophila melanogaster: a case study of a model genomic sequence and its consequences. Genome Res. 2005 Dec;15(12):1661-7.

Type of reference	Article
Authors	Ashburner M, Bergman CM

15.2.15 Ashburner M, et al. (2000) Gene ontology: Tool for the unification of biology. The gene ontology consortium

The Gene Ontology Consortium describes progress to building a controlled vocabulary applied to all eukaryotes, focusing on biological process, molecular function and cellular components.

Ashburner M, et al. Gene ontology: Tool for the unification of biology. The gene ontology consortium. Nature genetics 2000.25(1):25-9. Epub 2000/05/10. doi: 10.1038/75556. PubMed PMID: 10802651; PMCID: PMC3037419.

Type of reference	Article

Authors	Ashburner M, Ball CA, Blake JA, Botstein D, Butler H, Cherry JM, Davis AP, Dolinski K, Dwight SS, Eppig JT, Harris MA, Hill DP, Issel-Tarver L, Kasarskis A, Lewis S, Matese JC, Richardson JE, Ringwald M, Rubin GM, Sherlock G

15.2.16 Ashworth LK, et al. (1995) An integrated metric physical map of human chromosome 19

A detailed physical map of human chromosome 19, subject of close study because of location of genes for Alzheimer's disease and myotonic dystrophy.

Ashworth LK, et al. An integrated metric physical map of human chromosome 19. Nat Genet. 1995;11(4):422-7. DOI: 10.1038/ng1295-422. PMID: 7493023

Type of reference	Article
Authors	Ashworth LK, Batzer MA, Brandriff B, Branscomb E, Dejong P, Garcia E, Garnes JA, Gordon LA, Lamerdin JE, Lennon G, Mohrenweiser H, Olsen AS, Slezak T, Carrano AV

15.2.17 Baer R, et al. (1984) DNA sequence and expression of the b95-8 Epstein-Barr virus genome

Sequence of the 170-kb Epstein Barr virus genome.

Baer R, et al. DNA sequence and expression of the b95-8 Epstein-Barr virus genome. Nature. 1984;310(5974):207-11. DOI: 10.1038/310207a0. PMID: 6087149

Type of reference	Article
Authors	Baer R, Bankier AT, Biggin MD, Deininger PL, Farrell PJ, Gibson TJ, Hatfull G, Hudson GS, Satchwell SC, Seguin C, Tuffnell PS, Barrell BG

15.2.18 Barillot E, et al. (1991) Theoretical analysis of library screening using a n-dimensional pooling strategy

A fingerprint method to improve the efficiency of DNA library screening.

Barillot E, et al. Theoretical analysis of library screening using a n-dimensional pooling strategy. Nucleic acids research 1991.19(22):6241-7. Epub 1991/11/25. PubMed PMID: 1956784; PMCID: PMC329134.http://www.ncbi.nlm.nih.gov/pmc/articles/PMC329134

Type of reference	Article
Authors	Barillot E, Lacroix B, Cohen D

15.2.19 Bell CJ, et al. (1995) Integration of physical, breakpoint and genetic maps of chromosome 22. Localization of 587 yeast artificial chromosomes with 238 mapped markers

Early progress in integrating genetic and physical maps for the smallest human chromosome.

Bell CJ, et al. Integration of physical, breakpoint and genetic maps of chromosome 22. Localization of 587 yeast artificial chromosomes with 238 mapped markers. Hum Mol Genet. 1995;4(1):59-69. PMID: 7711735

Type of reference	Article
Authors	Bell CJ, Budarf ML, Nieuwenhuijsen BW, Barnoski BL, Buetow KH, Campbell K, Colbert AME, Collins J, Daly M, Desjardins PR, Dezwaan T, Eckman B, Foote S, Hart K, Hiester K, Hoog MJV, Hopper E, Kaufman A, McDermid HE, Overton GC, Reeve MP, Searls DB, Stein L, Valmiki VH, Watson E, Williams S, Winston R, Nussbaum RL, Lander ES, Fischbeck KH, Emanuel BS, Hudson TJ

15.2.20 Bentley DR, et al. (2008) Accurate whole human genome sequencing using reversible terminator chemistry

Landmark paper from the original Solexa scientists and colleagues who developed the Solexa sequence-by-synthesis technology.

Bentley DR, et al. Accurate whole human genome sequencing using reversible terminator chemistry. Nature. 2008;456(7218):53-9. DOI: 10.1038/nature07517. PMID: 18987734

Type of reference	Article
Authors	Bentley DR, Balasubramanian S, Swerdlow HP, Smith GP, Milton J, Brown CG, Hall KP, Evers DJ, Barnes CL, Bignell HR, Boutell JM, Bryant J, Carter RJ, Cheetham RK, Cox AJ, Ellis DJ, Flatbush MR, Gormley NA, Humphray SJ, Irving LJ, Karbelashvili MS, Kirk SM, Li H, Liu XH, Maisinger KS, Murray LJ, Obradovic B, Ost T, Parkinson ML, Pratt MR, Rasolonjatovo IMJ, Reed MT, Rigatti R, Rodighiero C, Ross MT, Sabot A, Sankar SV, Scally A, Schroth GP, Smith ME, Smith VP, Spiridou A, Torrance PE, Tzonev SS, Vermaas EH, Walter K, Wu XL, Zhang L, Alam MD, Anastasi C, Aniebo IC, Bailey DMD, Bancarz IR, Banerjee S, Barbour SG, Baybayan PA, Benoit VA, Benson KF, Bevis C, Black PJ, Boodhun A, Brennan JS, Bridgham JA, Brown RC, Brown AA, Buermann DH, Bundu AA, Burrows JC, Carter NP, Castillo N, Catenazzi MCE, Chang S, Cooley RN, Crake NR, Dada OO, Diakoumakos KD, Dominguez-Fernandez B, Earnshaw DJ, Egbujor UC, Elmore DW, Etchin SS, Ewan MR, Fedurco M,

	Fraser LJ, Fajardo KVF, Furey WS, George D, Gietzen KJ, Goddard CP, Golda GS, Granieri PA, Green DE, Gustafson DL, Hansen NF, Harnish K, Haudenschild CD, Heyer NI, Hims MM, Ho JT, Horgan AM, Hoschler K, Hurwitz S, Ivanov DV, Johnson MQ, James T, Jones TAH, Kang GD, Kerelska TH, Kersey AD, Khrebtukova I, Kindwall AP, Kingsbury Z, Kokko-Gonzales PI, Kumar A, Laurent MA, Lawley CT, Lee SE, Lee X, Liao AK, Loch JA, Lok M, Luo SJ, Mammen RM, Martin JW, McCauley PG, McNitt P, Mehta P, Moon KW, Mullens JW, Newington T, Ning ZM, Ng BL, Novo SM, O'Neill MJ, Osborne MA, Osnowski A, Ostadan O, Paraschos LL, Pickering L, Pike AC, Pinkard DC, Pliskin DP, Podhasky J, Quijano VJ, Raczy C, Rae VH, Rawlings SR, Rodriguez AC, Roe PM, Rogers J, Bacigalupo MCR, Romanov N, Romieu A, Roth RK, Rourke NJ, Ruediger ST, Rusman E, Sanches-Kuiper RM, Schenker MR, Seoane JM, Shaw RJ, Shiver MK, Short SW, Sizto NL, Sluis JP, Smith MA, Sohna JES, Spence EJ, Stevens K, Sutton N, Szajkowski L, Tregidgo CL, Turcatti G, vandeVondele S, Verhovsky Y, Virk SM, Wakelin S, Walcott GC, Wang JW, Worsley GJ, Yan JY, Yau L, Zuerlein M, Mullikin JC, Hurles ME, McCooke NJ, West JS, Oaks FL, Lundberg PL, Klenerman D, Durbin R, Smith AJ

15.2.21 Berenson, Alex and Wade, Nicholas. (2000) A Call for Sharing of Research Causes Gene Stocks to Plunge

News report on reaction to the joint White House/Downing Street statement regarding the approval of human gene patents.

Berenson, Alex and Wade, Nicholas. A Call for Sharing of Research Causes Gene Stocks to Plunge, New York Times, March 15, 2000

Type of reference	News Story
Authors	Berenson, Alex and Wade, Nicholas

15.2.22 Beres SB, et al. (2002) Genome sequence of a serotype m3 strain of group a streptococcus: Phage-encoded toxins, the high-virulence phenotype, and clone emergence

Sequenced of the genome of strain MGAS315, isolated from a patient with streptococcal toxic shock syndrome, showing the role of recombination in producing highly virulent clones.

Beres SB, et al. Genome sequence of a serotype m3 strain of group a streptococcus: Phage-encoded toxins, the high-virulence phenotype, and clone emergence. Proceedings of the National Academy of Sciences of the United States of America 2002.99(15):10078-83. Epub 2002/07/18. doi: 10.1073/pnas.152298499. PubMed PMID: 12122206; PMCID: PMC126627.http://www.ncbi.nlm.nih.gov/pmc/articles/PMC126627

Type of reference	Article

Authors	Beres SB, Sylva GL, Barbian KD, Lei B, Hoff JS, Mammarella ND, Liu MY, Smoot JC, Porcella SF, Parkins LD, Campbell DS, Smith TM, McCormick JK, Leung DY, Schlievert PM, Musser JM

15.2.23 Berget SM,et al. (1978) Spliced segments at the 5' termini of adenovirus-2 late mRNA: a role for heterogeneous nuclear RNA in mammalian cells

Classic discovery of gene splicing by Phil Sharp and colleagues, which eventually led to Sharp and Rich Roberts sharing the Nobel Prize in Physiology or Medicine in 1993 for the discovery of split genes.

Berget SM, et al. Spliced segments at the 5' termini of adenovirus-2 late mRNA: a role for heterogeneous nuclear RNA in mammalian cells. Cold Spring Harb Symp Quant Biol. 1978;42 Pt 1:523-9. PMID: 277361

Type of reference	Article
Authors	Berget SM, Berk AJ, Harrison T, Sharp PA

15.2.24 Berg P. (2006) Origins of the human genome project: Why sequence the human genome when 96% of it is junk?

Personal commentary from Nobel laureate Paul Berg on the controversy over the launch of the Human Genome Project, particularly regarding junk DNA, cost, and the threat to “little science” versus “big science.”

Berg P. Origins of the human genome project: Why sequence the human genome when 96% of it is junk? Am J Hum Genet. 2006; 79(4):603-5. DOI: 10.1086/507688. PMID: 16960796 PMCID: PMC1592577

Type of reference	Article
Authors	Berg P

15.2.25 Berman BP, et al. (2002) Exploiting transcription factor binding site clustering to identify cis-regulatory modules involved in pattern formation in the drosophila genome

The clustering of transcription factor binding is used as the basis for computational identification of such regions. The study identified genomic regions in Drosophila containing high concentrations of predicted transcription factor binding sites.

Berman BP, et al. Exploiting transcription factor binding site clustering to identify cis-regulatory modules involved in pattern formation in the drosophila genome. Proceedings of the National Academy of Sciences of the United States of America 2002.99(2):757-62. Epub 2002/01/24. doi: 10.1073/pnas.231608898. PubMed PMID: 11805330; PMCID: PMC117378.http://www.ncbi.nlm.nih.gov/pmc/articles/PMC117378

Type of reference	Article
Authors	Berman BP, Nibu Y, Pfeiffer BD, Tomancak P, Celniker SE, Levine M, Rubin GM, Eisen MB

15.2.26 Blattner FR, et al. (1997) The complete genome sequence of escherichia coli k-12

Fred Blattner and colleagues produce the complete 5-Mb genome sequence of the Escherichia coli bacterium, the workhorse of genetic engineering.

Blattner FR, et al. The complete genome sequence of escherichia coli k-12. Science. 1997;277(5331):1453-62. DOI: 10.1126/science.277.5331.1453. PMID: 9278503

Type of reference	Article
Authors	Blattner FR, Plunkett G, Bloch CA, Perna NT, Burland V, Riley M, ColladoVides J, Glasner JD, Rode CK, Mayhew GF, Gregor J, Davis NW, Kirkpatrick HA, Goeden MA, Rose DJ, Mau B, Shao Y

15.2.27 Boffelli D, et al. (2003) Phylogenetic shadowing of primate sequences to find functional regions of the human genome

Comparative genomics of New and Old World monkeys to identify functional regions of the human genome.

Boffelli D, et al. Phylogenetic shadowing of primate sequences to find functional regions of the human genome. Science (New York, NY) 2003.299(5611):1391-4. Epub 2003/03/01. doi: 10.1126/science.1081331. PubMed PMID: 12610304.http://dx.doi.org/10.1126/science.1081331

Type of reference	Article
Authors	Boffelli D, McAuliffe J, Ovcharenko D, Lewis KD, Ovcharenko I, Pachter L, Rubin EM

15.2.28 Bonetta L (2001) Sackings leave gene database floundering

The archival Genome Database (GDB) was transferred to Johns Hopkins University, where it originated, but is no longer accessible.

Bonetta L. Sackings leave gene database floundering. Nature. 2001;414(6862):384. DOI: 10.1038/35106703. PMID: 11719765

Type of reference	News Story
Authors	Bonetta L

15.2.29 Bonfield JK, et al. (1995) A new DNA sequence assembly program

GAP (Genome Assembly Program) – a new program for DNA sequence assembly.

Bonfield JK, et al. A new DNA sequence assembly program. Nucleic acids research 1995.23(24):4992-9. Epub 1995/12/25. PubMed PMID: 8559656; PMCID: PMC307504.http://www.ncbi.nlm.nih.gov/pmc/articles/PMC307504

Type of reference	Article
Authors	Bonfield JK, Smith K, Staden R

15.2.30 Bork P, et al. (1995) Exploring the mycoplasma capricolum genome: A minimal cell reveals its physiology

Early bioinformatics analysis of the small *mycoplasma capricolum* genome before its complete genome sequence was obtained by researchers at TIGR.

Bork P, et al. Exploring the mycoplasma capricolum genome: A minimal cell reveals its physiology. Mol Microbiol. 1995;16(5):955-67. DOI: 10.1111/j.1365-2958.1995.tb02321.x. PMID: 7476192

Type of reference	Article
Authors	Bork P, Ouzounis C, Casari G, Schneider R, Sander C, Dolan M, Gilbert W, Gillevet PM

15.2.31 Botstein D, et al. (1980) Construction of a genetic-linkage map in man using restriction fragment length polymorphisms

Seminal paper outlining strategy for building a genetic map of the human genome using restriction fragment length polymorphisms (RFLPs).

Botstein D, et al. Construction of a genetic-linkage map in man using restriction fragment length polymorphisms. American Journal of Human Genetics. 1980;32(3):314-31. PMID: 6247908

Type of reference	Article
Authors	Botstein D, White RL, Skolnick M, Davis RW

15.2.32 Bouffard GG, et al. (1997) A physical map of human chromosome 7: An integrated YAC contig map with average STS spacing of 79 kb

Physical map of human chromosome 7 near the halfway mark of the Human Genome Project.

Bouffard GG, et al. A physical map of human chromosome 7: An integrated YAC contig map with average STS spacing of 79 kb. Genome Res. 1997;7(7):673-92. PMID: 9253597

Type of reference	Article
Authors	Bouffard GG, Idol JR, Braden VV, Iyer LM, Cunningham AF, Weintraub LA, Touchman JW, MohrTidwell RM, Peluso DC, Fulton RS, Ueltzen MS, Weissenbach J, Magness CL, Green ED

15.2.33 Brennecke J, Cohen SM. (2003) Towards a complete description of the microRNA complement of animal genomes

Minireview highlighting progress in analyzing microRNAs focusing on *C. elegans* and *D. melanogaster* genomes.

Brennecke J, Cohen SM. Towards a complete description of the microRNA complement of animal genomes. Genome biology 2003.4(9):228. Epub 2003/09/04. doi: 10.1186/gb-2003-4-9-228. PubMed PMID: 12952528; PMCID: PMC193649.

Type of reference	Review article

Authors	Brennecke J, Cohen SM

15.2.34 Brodsky MH, et al. (2000) Mus304 encodes a novel DNA damage checkpoint protein required during drosophila development

Discovery of a new DNA damage checkpoint gene in the *Drosophila* eye.

Brodsky MH, et al. Mus304 encodes a novel DNA damage checkpoint protein required during drosophila development. Genes & development 2000.14(6):666-78. Epub 2000/03/25. PubMed PMID: 10733527; PMCID: PMC316460.http://www.ncbi.nlm.nih.gov/pmc/articles/PMC316460

Type of reference	Article
Authors	Brodsky MH, Sekelsky JJ, Tsang G, Hawley RS, Rubin GM

15.2.35 Broker TR, et al. (1978) Adenovirus-2 messengers--an example of baroque molecular architecture

Study by Rich Roberts and colleagues on the “baroque” molecular architecture of split genes.

Broker TR, et al. Adenovirus-2 messengers--an example of baroque molecular architecture. Cold Spring Harbor symposia on quantitative biology. 1978;42 Pt 1:531-53. Epub 1978/01/01. PMID: 277362

Type of reference	Article
Authors	Broker TR, Chow LT, Dunn AR, Gelinas RE, Hassell JA, Klessig DF, Lewis JB, Roberts RJ, Zain BS

15.2.36 Broman KW, et al. (1998) Comprehensive human genetic maps: Individual and sex-specific variation in recombination

Genetic linkage maps constructed using 1 million genotypes from eight CEPH families, incorporating 8,000 short tandem-repeat polymorphisms (STRPs) primarily from Généthon.

Broman KW, et al. Comprehensive human genetic maps: Individual and sex-specific variation in recombination. American journal of human genetics 1998.63(3):861-9. Epub 1998/08/27. doi: 10.1086/302011. PubMed PMID: 9718341; PMCID: PMC1377399.http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1377399

Type of reference	Article
Authors	Broman KW, Murray JC, Sheffield VC, White RL, Weber JL

15.2.37 Brown MD, et al. (1992) Leber's hereditary optic neuropathy: A model for mitochondrial neurodegenerative diseases

Classification by Douglas Wallace and coworkers of the genetics of Leber's optic neuropathy, a mitochondrial disorder.

Brown MD, et al. Leber's hereditary optic neuropathy: A model for mitochondrial neurodegenerative diseases. FASEB Journal 1992.6(10):2791-9. Epub 1992/07/01. PubMed PMID: 1634041.

Type of reference	Article
Authors	Brown MD, Voljavec AS, Lott MT, MacDonald I, Wallace DC

15.2.38 Bult CJ, et al. (1996) Complete genome sequence of the methanogenic archaeon, methanococcus jannaschii

TIGR and Carl Woese collaborate to produce landmark genome sequence of archaeon M. Jannaschii, confirming existence of third domain of life.

Bult CJ, et al. Complete genome sequence of the methanogenic archaeon, methanococcus jannaschii. Science. 1996;273(5278):1058-73. DOI: 10.1126/science.273.5278.1058. PMID: 8688087

Type of reference	Article
Authors	Bult CJ, White O, Olsen GJ, Zhou LX, Fleischmann RD, Sutton GG, Blake JA, FitzGerald LM, Clayton RA, Gocayne JD, Kerlavage AR, Dougherty BA, Tomb JF, Adams MD, Reich CI, Overbeek R, Kirkness EF, Weinstock KG, Merrick JM, Glodek A, Scott JL, Geoghagen NSM, Weidman JF, Fuhrmann JL, Nguyen D, Utterback TR, Kelley JM, Peterson JD, Sadow PW, Hanna MC, Cotton MD, Roberts KM, Hurst MA, Kaine BP, Borodovsky M, Klenk HP, Fraser CM, Smith HO, Woese CR, Venter JC

15.2.39 Burge C, Karlin S. (1997) Prediction of complete gene structures in human genomic DNA

New software program identifies gene coding regions in genomic DNA sequence.

Burge C, Karlin S. Prediction of complete gene structures in human genomic DNA. J Mol Biol. 1997;268(1):78-94. DOI: 10.1006/jmbi.1997.0951. PMID: 9149143

Type of reference	Article
Authors	Burge C, Karlin S

15.2.40 Burke DT, et al. (1987) Cloning of large segments of exogenous DNA into yeast by means of artificial chromosome vectors

Development of yeast artificial chromosomes as new vectors for cloning much larger DNA inserts than traditional bacterial plasmids.

Burke DT, Carle GF, Olson MV. Cloning of large segments of exogenous DNA into yeast by means of artificial chromosome vectors. Science. 1987 May 15;236(4803):806-12.

Type of reference	Article
Authors	Burke DT, Carle GF, Olson MV

15.2.41 Burris J, et al. (1998) The Human Genome Project after a decade: policy issues

Overview of public policy issues facing the HGP.

Burris J, Cook-Deegan R, Alberts B. (1998) The Human Genome Project after a decade: policy issues. Nat Genet. 1998 Dec;20(4):333-5.

Type of reference	Article
Authors	Burris J, Cook-Deegan R, Alberts B

15.2.42 Butler D. (1999) Venter's Drosophila 'success' set to boost human genome efforts

Coverage of Craig Venter’s collaboration with academic researchers embarking on the Drosophila genome project.

Butler D. Venter's Drosophila 'success' set to boost human genome efforts. Nature. 1999 Oct 21;401(6755):729-30.

Type of reference	News story
Authors	Butler D.

15.2.43 Butler D. (1999) ‘Finishing' success marks major genome sequencing milestone...as researchers pounce on glut of data

Reporting of an important landmark in the International Genome Project consortium’s progress towards a first draft of the human genome.

Butler D. ‘Finishing' success marks major genome sequencing milestone...as researchers pounce on glut of data. Nature. 1999 Dec 2;402(6761):447-8.

Type of reference	News story
Authors	Butler D.

15.2.44 C. elegans Sequencing Consortium (1998) Genome sequence of the nematode C. elegans: A platform for investigating biology

Landmark publication of the nematode genome sequence by John Sulston, Bob Waterston and colleagues at the Sanger Centre, UK. (Sulston later won the Nobel Prize for his early nematode work.)

C. elegans Sequencing Consortium. Genome sequence of the nematode c. Elegans: A platform for investigating biology. Science. 1998;282(5396):2012-8. DOI: 10.1126/science.282.5396.2012. PMID: 9851916

Type of reference	Article
Authors	C. elegans Sequencing Consortium

15.2.45 Carninci P, et al. (1996) High-efficiency full-length cDNA cloning by biotinylated CAP trapper

A method for constructing high-content full-length cDNA libraries based on the introduction of a biotin group of the cap structure of eukaryotic mRNA, followed by selection of full-length cDNA.

Carninci P, et al. High-efficiency full-length cDNA cloning by biotinylated CAP trapper. Genomics. 1996;37(3):327-36. DOI: 10.1006/geno.1996.0567. PMID: 8938445

Type of reference	Article
Authors	Carninci P, Kvam C, Kitamura A, Ohsumi T, Okazaki Y, Itoh M, Kamiya M, Shibata K, Sasaki N, Izawa M, Muramatsu M, Hayashizaki Y, Schneider C

15.2.46 Casjens S, et al. (2000) A bacterial genome in flux: The twelve linear and nine circular extrachromosomal DNAs in an infectious isolate of the Lyme disease spirochete Borrelia burgdorferi

Completion of the genome sequence of Borrelia burgdorferi, the 1.5-Mb bacterial genome that includes 21 extrachromosomal DNA elements. This paper reported the sequence of the final three linear and seven circular plasmids.

Casjens S, et al. A bacterial genome in flux: The twelve linear and nine circular extrachromosomal DNAs in an infectious isolate of the Lyme disease spirochete Borrelia burgdorferi. Molecular microbiology 2000.35(3):490-516. Epub 2000/02/15. PubMed PMID: 10672174.

Type of reference	Article
Authors	Casjens S, Palmer N, van Vugt R, Huang WM, Stevenson B, Rosa P, Lathigra R, Sutton G, Peterson J, Dodson RJ, Haft D, Hickey E, Gwinn M, White O, Fraser CM

15.2.47 Cavalli-Sforza LL, et al. (1991) Call for a worldwide survey of human genetic diversity: A vanishing opportunity for the human genome project

Proposal for a Human Genetic Diversity Project that was essentially a decade ahead of its time. Population variation was studied in earnest following the completion of the Human Genome Project through the International HapMap Project and other programs.

Cavalli-Sforza LL, et al. Call for a worldwide survey of human genetic diversity: A vanishing opportunity for the human genome project. Genomics 1991.11(2):490-1. Epub 1991/10/01. PubMed PMID: 1769670.http://www.ncbi.nlm.nih.gov/pubmed/1769670

Type of reference	Article
Authors	Cavalli-Sforza LL, Wilson AC, Cantor CR, Cook-Deegan RM, King MC

15.2.48 Charlesworth D, et al. (1995) The pattern of neutral molecular variation under the background selection model

Stochastic simulations of the infinite sites model used to study the behavior of genetic diversity at a neutral locus in a genomic region without recombination, but subject to selection against deleterious alleles maintained by recurrent mutation.

Charlesworth D, et al. The pattern of neutral molecular variation under the background selection model. Genetics 1995.141(4):1619-32. Epub 1995/12/01. PubMed PMID: 8601499; PMCID: PMC1206892.http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1206892

Type of reference	Article
Authors	Charlesworth D, Charlesworth B, Morgan MT

15.2.49 Chiang SL, Rubin EJ. (2002) Construction of a mariner-based transposon for epitope-tagging and genomic targeting

Describes a mariner-based method for creating a large number of insertion mutants that can be converted to in-frame epitope fusions in a single step.

Chiang SL, Rubin EJ. Construction of a mariner-based transposon for epitope-tagging and genomic targeting. Gene 2002.296(1-2):179-85. Epub 2002/10/18. PubMed PMID: 12383515.

Type of reference	Article
Authors	Chiang SL, Rubin EJ

15.2.50 Choudhuri S (2003) The Path from Nuclein to Human Genome: A Brief History of DNA with a Note on Human Genome Sequencing and Its Impact on Future Research in Biology

Summary of the major landmarks in more than a century of DNA research.

Choudhuri S. The Path from Nuclein to Human Genome: A Brief History of DNA with a Note on Human Genome Sequencing and Its Impact on Future Research in Biology. Bulletin of Science Technology Society. October 2003 vol. 23 no. 5 360-367. DOI: 10.1177/0270467603259770

Type of reference	Review article
Authors	Supratim Choudhuri

15.2.51 Chow LC, et al (1977) An amazing sequence arrangement at the 5' ends of adenovirus 2 messenger RNA

Electron microscopy reveals split genes in adenovirus, identified by Rich Roberts and colleagues.

Chow LC, et al. An amazing sequence arrangement at the 5' ends of adenovirus 2 messenger RNA. 1977. Rev Med Virol. 2000;10(6):362-71; discussion 55-6. Epub 2001/02/24. DOI: 10.1002/1099-1654(200011/12)10:6<355::AID-RMV294>3.0.CO;2-A. PMID: 11187030

Type of reference	Article
Authors	Chow LC, Gelinas RE, Broker TR, Roberts RJ

15.2.52 Church GM, Gilbert W. (1984) Genomic sequencing

New methods for DNA sequence analysis in mouse genomic DNA presented by George Church, one of his first of numerous contributions to advancing genomic technology.

Church GM, Gilbert W. Genomic sequencing. Proceedings of the National Academy of Sciences of the United States of America 1984.81(7):1991-5. Epub 1984/04/01. PubMed PMID: 6326095; PMCID: PMC345422.http://www.ncbi.nlm.nih.gov/pmc/articles/PMC345422

Type of reference	Article
Authors	Church GM, Gilbert W.

15.2.53 Cliften P, et al. (2003) Finding functional features in saccharomyces genomes by phylogenetic footprinting

Search for functional regions in the yeast genome enables revision of the yeast gene catalogue and identification of sequence motifs that are potential targets of transcriptional regulatory proteins.

Cliften P, et al. Finding functional features in saccharomyces genomes by phylogenetic footprinting. Science (New York, NY) 2003.301(5629):71-6. Epub 2003/05/31. doi: 10.1126/science.1084337. PubMed PMID: 12775844.http://dx.doi.org/10.1126/science.1084337

Type of reference	Article
Authors	Cliften P, Sudarsanam P, Desikan A, Fulton L, Fulton B, Majors J, Waterston R, Cohen BA, Johnston M.

15.2.54 Clinton, W. and Blair, T. (2000) Joint Statement by President Clinton and Prime Minister Tony Blair of the United Kingdom on Availability of Human Genome Data

Statement issued jointly by President Bill Clinton and British Prime Minister Tony Blair in March 2000 called for human genome information to be made freely and publicly available. The implication that genes could and should not be patented wiped billions of dollars off the valuation of biotech stocks.

Joint Statement by President Clinton and Prime Minister Tony Blair of the United Kingdom on Availability of Human Genome Data, U.S. GPO, March 14, 2000.

Type of reference	Joint statement
Authors	Clinton W, Blair T

15.2.55 Cohen AS, et al. (1988) Rapid separation and purification of oligonucleotides by high-performance capillary gel electrophoresis

Development of capillary electrophoresis by three groups marks an important stepping stone in the evolution of automated Sanger sequencing and the underlying technology for the Human Genome Project.

Cohen AS, Najarian DR, Paulus A, Guttman A, Smith JA, Karger BL. Rapid separation and purification of oligonucleotides by high-performance capillary gel electrophoresis. Proc Natl Acad Sci U S A. 1988 Dec;85(24):9660-3.

Type of reference	Article
Authors	Cohen AS, Najarian DR, Paulus A, Guttman A, Smith JA, Karger BL

15.2.56 Cohen BA, et al. (2000) A computational analysis of whole-genome expression data reveals chromosomal domains of gene expression

Demonstration that adjacent pairs of genes (and nearby non-adjacent gene pairs) show correlated expression independent of their orientation, suggesting chromosomal domains of gene expression.

Cohen BA, et al. A computational analysis of whole-genome expression data reveals chromosomal domains of gene expression. Nature genetics 2000.26(2):183-6. Epub 2000/10/04. doi: 10.1038/79896. PubMed PMID: 11017073.http://dx.doi.org/10.1038/79896

Type of reference	Article
Authors	Cohen BA, Mitra RD, Hughes JD, Church GM

15.2.57 Cohen D, et al. (1993) A first-generation physical map of the human genome

An early physical map of the human genome produced by the Genethon team in Paris.

Cohen D, et al. A first-generation physical map of the human genome. Nature 1993.366(6456):698-701. Epub 1993/12/16. doi: 10.1038/366698a0. PubMed PMID: 8259213, Available from: http://www.ncbi.nlm.nih.gov/pubmed/8259213. doi: http://dx.doi.org/10.1038/366698a0

Type of reference	Article
Authors	Cohen D, Chumakov I, Weissenbach J.

15.2.58 Cole ST, et al. (1998) Deciphering the biology of mycobacterium tuberculosis from the complete genome sequence

The genome sequence of the tuberculosis bacterium.

Cole ST, et al. Deciphering the biology of mycobacterium tuberculosis from the complete genome sequence. Nature. 1998;393(6685):537-44. DOI: 10.1038/31159. PMID: 9634230

Type of reference	Article

Authors	Cole ST, Brosch R, Parkhill J, Garnier T, Churcher C, Harris D, Gordon SV, Eiglmeier K, Gas S, Barry CE, Tekaia F, Badcock K, Basham D, Brown D, Chillingworth T, Connor R, Davies R, Devlin K, Feltwell T, Gentles S, Hamlin N, Holroyd S, Hornby T, Jagels K, Krogh A, McLean J, Moule S, Murphy L, Oliver K, Osborne J, Quail MA, Rajandream MA, Rogers J, Rutter S, Seeger K, Skelton J, Squares R, Squares S, Sulston JE, Taylor K, Whitehead S, Barrell BG

15.2.59 Collins FS, et al. (1998) A DNA polymorphism discovery resource for research on human genetic variation

Establishment of a DNA Polymorphism Discovery Resource, based on samples from 450 U.S. residents of diverse ethnic backgrounds. This Resource was designed to aid discovery of human genetic variation related to health and disease.

Collins FS, et al. A DNA polymorphism discovery resource for research on human genetic variation. Genome Res. 1998;8(12):1229-31. DOI: 10.1101/gr.8.12.1229. PMID: 9872978

Type of reference	Article
Authors	Collins FS, Brooks LD, Chakravarti A

15.2.60 Collins FS, et al. (1998) New goals for the U.S. Human Genome Project: 1998-2003

5-year plan published by the National Human Genome Research Institute, two weeks after the Venter genome start-up announcement.

Collins FS, Patrinos A, Jordan E, Chakravarti A, Gesteland R, Walters L. New goals for the U.S. Human Genome Project: 1998-2003. Science. 1998 Oct 23;282(5389):682-9. PMID: 9784121

Type of reference	Article
Authors	Collins FS, Patrinos A, Jordan E, Chakravarti A, Gesteland R, Walters L.

15.2.61 Collins FS, et al. (2003) A vision for the future of genomics research

Plans for the future analysis of the human genome sequence and biology in the wake of the completion of the Human Genome Project.

Collins FS, et al. A vision for the future of genomics research. Nature 2003.422(6934):835-47. Epub 2003/04/16. doi: 10.1038/nature01626. PubMed PMID: 12695777.http://dx.doi.org/10.1038/nature01626

Type of reference	Article
Authors	Collins FS, Green ED, Guttmacher AE, Guyer MS

15.2.62 Collins FS, et al. (2003) The human genome project: Lessons from large-scale biology

Biological and medical insights from the completion of the Human Genome Project.

Collins FS, et al. The human genome project: Lessons from large-scale biology. Science (New York, NY) 2003.300(5617):286-90. Epub 2003/04/12. doi: 10.1126/science.1084564. PubMed PMID: 12690187.http://dx.doi.org/10.1126/science.1084564

Type of reference	Review article
Authors	Collins FS, Morgan M, Patrinos A

15.2.63 Collins FS, et al. (2004) Finishing the euchromatic sequence of the human genome

Publication of the "finished" human genome sequence. Work continues to full the impenetrable gaps caused by highly repetitive DNA.

Collins FS, et al. Finishing the euchromatic sequence of the human genome. Nature. 2004;431(7011):931-45. DOI: 10.1038/nature03001. PMID: 15496913

Type of reference	Article
Authors	Collins FS, Lander ES, Rogers J, Waterston RH, Int Human Genome Sequencing C

15.2.64 Committee on Mapping and Sequencing the Human Genome; Commission on Life Sciences; Division on Earth and Life Studies; National Research Council (1988) Mapping and Sequencing the Human Genome

Important report on the feasibility of sequencing the human genome, convened by the National Academy of Sciences.

Committee on Mapping and Sequencing the Human Genome; Commission on Life Sciences; Division on Earth and Life Studies; National Research Council (1988) Mapping and Sequencing the Human Genome, http://www.nap.edu/catalog/1097/mapping-and-sequencing-the-human-genome.

Type of reference	Article
Authors	National Research Council

15.2.65 Congress of the United States, Office of Technology Assessment (1988) Mapping Our Genes - Genome Projects: How Big, How Fast?

Congress of the United States, Office of Technology Assessment. (1988) Mapping Our Genes - Genome Projects: How Big, How Fast? Baltimore, MD, Johns Hopkins University Press

Type of reference	Article
Authors	United States Congress. Office of Technology Assessment (OTA)
External Link	https://repository.library.georgetown.edu/handle/10822/549129

15.2.66 Couronne O, et al. (2003) Strategies and tools for whole-genome alignments

Strategies for comparative alignment and analysis of the human and mouse draft genomes.

Couronne O, et al. Strategies and tools for whole-genome alignments. Genome research 2003.13(1):73-80. Epub 2003/01/17. doi: 10.1101/gr.762503. PubMed PMID: 12529308; PMCID: PMC430965.http://www.ncbi.nlm.nih.gov/pmc/articles/PMC430965

Type of reference	Article
Authors	Couronne O, Poliakov A, Bray N, Ishkhanov T, Ryaboy D, Rubin E, Pachter L, Dubchak I.

15.2.67 Crea R, et al. (1978) Chemical synthesis of genes for human insulin

Landmark chemical synthesis of the genes for insulin.

Crea R, et al. Chemical synthesis of genes for human insulin. Proc Natl Acad Sci U S A. 1978; 75(12):5765-9. DOI: 10.1073/pnas.75.12.5765. PMID: 282602; PMCID: 393054

Type of reference	Article
Authors	Crea R, Kraszewski A, Hirose T, Itakura K.

15.2.68 Dausset J, et al. (1990) Centre d'etude du polymorphisme humain (ceph): Collaborative genetic mapping of the human genome

A review of the empowering resource known as CEPH, which provided a source of DNA from large, multigeneration families that facilitated progress in genetic linkage mapping throughout the 1980s.

Dausset J, et al. Centre d'etude du polymorphisme humain (ceph): Collaborative genetic mapping of the human genome. Genomics 1990.6(3):575-7. Epub 1990/03/01. PubMed PMID: 2184120.http://www.ncbi.nlm.nih.gov/pubmed/2184120

Type of reference	Article
Authors	Dausset J, Cann H, Cohen D, Lathrop M, Lalouel JM, White R.

15.2.69 De Gregorio E, et al. (2002) The Toll and Imd pathways are the major regulators of the immune response in Drosophila

Microarray analysis by Gerry Rubin and colleagues classifies hundreds of immune system genes and characterizes the role of Toll and Imd pathways in microbial infections.

De Gregorio E, et al. The Toll and Imd pathways are the major regulators of the immune response in Drosophila. The EMBO journal 2002.21(11):2568-79. Epub 2002/05/29. doi: 10.1093/emboj/21.11.2568. PubMed PMID: 12032070; PMCID: PMC126042.

Type of reference	Article
Authors	De Gregorio E, Spellman PT, Tzou P, Rubin GM, Lemaitre B.

15.2.70 DeLisi, C. (1988). The Human Genome Project: The ambitious proposal to map and decipher the complete sequence of human DNA. American Scientist, 76(5), 488-493.

DeLisi, C. (1988). The Human Genome Project: The ambitious proposal to map and decipher the complete sequence of human DNA. *American Scientist, 76*(5), 488-493. Retrieved from http://www.jstor.org/stable/27855388

Type of reference	Article
Authors	DeLisi, Charles
Publisher	*American Scientist, 76*(5), 488-493.
External Links	http://www.jstor.org/stable/27855388

15.2.71 DeLisi C. (2008) Meetings that changed the world: Santa Fe 1986: Human genome baby-steps

Charles DeLisi reviews the pivotal meeting in Santa Fe in 1986 that sowed the seeds for the Human Genome Project.

DeLisi C. (2008) Meetings that changed the world: Santa Fe 1986: Human genome baby-steps. Nature. 2008 Oct 16;455(7215):876-7.

Type of reference	Commentary
Authors	DeLisi C.

15.2.72 Deloukas P, et al. (1998) A physical map of 30,000 human genes

A physical map of the genome containing an estimated 30,000 human genes at the halfway mark of the Human Genome Project.

Deloukas P, et al. A physical map of 30,000 human genes. Science. 1998;282(5389):744-6. DOI: 10.1126/science.282.5389.744. PMID: 9784132

Type of reference	Article
Authors	Deloukas P, Schuler GD, Gyapay G, Beasley EM, Soderlund C, Rodriguez-Tome P, Hui L, Matise TC, McKusick KB, Beckmann JS, Bentolila S, Bihoreau MT, Birren BB, Browne J, Butler A, Castle AB, Chiannilkulchai N, Clee C, Day PJR, Dehejia A, Dibling T, Drouot N, Duprat S, Fizames C, Fox S, Gelling S, Green L, Harrison P, Hocking R, Holloway E, Hunt S, Keil S, Lijnzaad P, Louis-Dit-Sully C, Ma J, Mendis A, Miller J, Morissette J, Muselet D, Nusbaum HC, Peck A, Rozen S, Simon D, Slonim DK, Staples R, Stein LD, Stewart EA, Suchard MA, Thangarajah T, Vega-Czarny N, Webber C, Wu X, Hudson J, Auffray C, Nomura N, Sikela JM, Polymeropoulos MH, James MR, Lander ES, Hudson TJ, Myers RM, Cox DR, Weissenbach J, Boguski MS, Bentley DR

15.2.73 Deloukas P, et al. (2004) The DNA sequence and comparative analysis of human chromosome 10

The sequence of human chromosome 10.

Deloukas P, et al. The DNA sequence and comparative analysis of human chromosome 10. Nature. 2004;429(6990):375-81. DOI: 10.1038/nature02462. PMID: 15164054

Type of reference	Article
Authors	Deloukas P, Earthrowl ME, Grafham DV, Rubenfield M, French L, Steward CA, Sims SK, Jones MC, Searle S, Scott C, Howe K, Hunt SE, Andrews TD, Gilbert JGR, Swarbreck D, Ashurst JL, Taylor A, Battles J, Bird CP, Ainscough R, Almeida JP, Ashwell RIS, Ambrose KD, Babbage AK, Bagguley CL, Bailey J, Banerjee R, Bates K, Beasley H, Bray-Allen S, Brown AJ, Brown JY, Burford DC, Burrill W, Burton J, Cahill P, Camire D, Carter NP, Chapman JC, Clark SY, Clarke G, Clee CM, Clegg S, Corby N, Coulson A, Dhami P, Dutta I, Dunn M, Faulkner L, Frankish A, Frankland JA, Garner P, Garnett J, Gribble S, Griffiths C, Grocock R, Gustafson E, Hammond S, Harley JL, Hart E, Heath PD, Ho TP, Hopkins B, Horne J, Howden PJ, Huckle E, Hynds C, Johnson C, Johnson D, Kana A, Kay M, Kimberley AM, Kershaw JK, Kokkinaki M, Laird GK, Lawlor S, Lee HM, Leongamornlert DA, Laird G, Lloyd C, Lloyd DM, Loveland J, Lovell J, McLaren S, McLay KE, McMurray A, Mashreghi-Mohammadi M, Matthews L, Milne S, Nickerson T, Nguyen M, Oveton-Larty E, Palmer SA, Pearce AV, Peck AI, Pelan S, Phillimore B, Porter K, Rice CM, Rogosin A, Ross MT, Sarafidou T, Sehra HK, Shownkeen R, Skuce CD, Smith M, Standring L, Sycamore N, Tester J, Thorpe A, Torcasso W, Tracey A, Tromans A, Tsolas J, Wall M, Walsh J, Wang H, Weinstock K, West AP, Willey DL, Whitehead SL, Wilming L, Wray PW, Young L, Chen Y, Lovering RC, Moschonas NK, Siebert R, Fechtel K, Bentley D, Durbin R, Hubbard T, Doucette-Stamm L, Beck S, Smith DR, Rogers J

15.2.74 Dietrich W, et al. (1992) A genetic map of the mouse suitable for typing intraspecific crosses

A preliminary genetic map of the mouse genome at an average marker spacing 4.3 cM.

Dietrich W, et al. A genetic map of the mouse suitable for typing intraspecific crosses. Genetics. 1992;131(2):423-47. PMID: 1353738

Type of reference	Article
Authors	Dietrich W, Katz H, Lincoln SE, Shin HS, Friedman J, Dracopoli NC, Lander ES

15.2.75 Dietrich WF, et al. (1996) A comprehensive genetic map of the mouse genome

Culmination of a five-year effort to produce a genetic map of the laboratory mouse. The map contained more than 7,300 markers, including 6,580 simple sequence length polymorphisms integrated at an average spacing of 0.2 centimorgans (400 kilobases).

Dietrich WF, et al. A comprehensive genetic map of the mouse genome. Nature 1996.380(6570):149-52. Epub 1996/03/14. doi: 10.1038/380149a0. PubMed PMID: 8600386.http://dx.doi.org/10.1038/380149a0

Type of reference	Article
Authors	Dietrich WF, Miller J, Steen R, Merchant MA, Damron-Boles D, Husain Z, Dredge R, Daly MJ, Ingalls KA, O'Connor TJ

15.2.76 Doggett NA, et al. (1995) An integrated physical map of human chromosome 16

An integrated physical, genetic and cytogenetic map of human chromosome 16 including YACs and a high-resolution cosmid contig, providing almost complete coverage of the euchromatic arms of the chromosome.

Doggett NA, et al. An integrated physical map of human chromosome 16. Nature. 1995;377(6547 Suppl):335-65. DOI: 10.1038/377335a0. PMID: 7566100

Type of reference	Article
Authors	Doggett NA, Goodwin LA, Tesmer JG, Meincke LJ, Bruce DC, Clark LM, Altherr MR, Ford AA, Chi HC, Marrone BL, Longmire JL, Lane SA, Whitmore SA, Lowenstein MG, Sutherland RD, Mundt MO, Knill EH, Bruno WJ, Macken CA, Torney DC, Wu JR, Griffith J, Sutherland GR, Deaven LL, Callen DF, Moyzis RK

15.2.77 Donis-Keller H, et al. (1987) A genetic linkage map of the human genome

Controversial early genetic linkage map from Massachusetts biotech firm Collaborative Research, leading company executives to claim they “owned” chromosome 7.

Donis-Keller H, et al. A genetic linkage map of the human genome. Cell. 1987;51(2):319-37. DOI: 10.1016/0092-8674(87)90158-9. PMID: 3664638

Type of reference	Article
Authors	Donis-Keller H, Green P, Helms C, Cartinhour S, Weiffenbach B, Stephens K, Keith TP, Bowden DW, Smith DR, Lander ES, Botstein D, Akots G, Rediker KS, Gravius T, Brown VA, Rising MB, Parker C, Powers JA, Watt DE, Kauffman ER, Bricker A, Phipps P, Mullerkahle H, Fulton TR, Ng S, Schumm JW, Braman JC, Knowlton RG, Barker DF, Crooks SM, Lincoln SE, Daly MJ, Abrahamson J

15.2.78 Drake N (2011) What is the human genome worth?

Analysis of the economic impact of the Human Genome Project.

Drake N. What is the human genome worth? Nature. 5/11/2011. DOI:10.1038/news.2011.281

Type of reference	News story
Authors	Nadia Drake

15.2.79 Dulbecco R. (1986) A turning point in cancer research: sequencing the human genome

Important commentary from Nobel laureate championing the value of human genome sequencing for cancer discovery.

Dulbecco R. (1986) A turning point in cancer research: sequencing the human genome. Science. 1986 Mar 7;231(4742):1055-6.

Type of reference	Commentary
Authors	Dulbecco, R.

15.2.80 Dunham A, et al (2004) The DNA sequence and analysis of human chromosome 13

The sequence of human chromosome 13.

Dunham A, et al. The DNA sequence and analysis of human chromosome 13. Nature. 2004;428(6982):522-8. DOI: 10.1038/nature02379. PMID: 15057823

Type of reference	Article
Authors	Dunham A, Matthews LH, Burton J, Ashurst JL, Howe KL, Ashcroft KJ, Beare DM, Burford DC, Hunt SE, Griffiths-Jones S, Jones MC, Keenan SJ, Oliver K, Scott CE, Ainscough R, Almeida JP, Ambrose KD, Andrews DT, Ashwell RIS, Babbage AK, Bagguley CL, Bailey J, Bannerjee R, Barlow KF, Bates K, Beasley H, Bird CP, Bray-Allen S, Brown AJ, Brown JY, Burrill W, Carder C, Carter NP, Chapman JC, Clamp ME, Clark SY, Clarke G, Clee CM, Clegg SCM, Cobley V, Collins JE, Corby N, Coville GJ, Deloukas P, Dhami P, Dunham I, Dunn M, Earthrowl ME, Ellington AG, Faulkner L, Frankish AG, Frankland J, French L, Garner P, Garnett J, Gilbert JGR, Gilson CJ, Ghori J, Grafham DV, Gribble SM, Griffiths C, Hall RE, Hammond S, Harley JL, Hart EA, Heath PD, Howden PJ, Huckle EJ, Hunt PJ, Hunt AR, Johnson C, Johnson D, Kay M, Kimberley AM, King A, Laird GK, Langford CJ, Lawlor S, Leongamornlert DA, Lloyd DM, Lloyd C, Loveland JE, Lovell J, Martin S, Mashreghi-Mohammadi M, McLaren SJ, McMurray A, Milne S, Moore MJF, Nickerson T, Palmer SA, Pearce AV, Peck AI, Pelan S, Phillimore B, Porter KM, Rice CM, Searle S, Sehra HK, Shownkeen R, Skuce CD, Smith M, Steward CA, Sycamore N, Tester J, Thomas DW, Tracey A, Tromans A, Tubby B, Wall M, Wallis JM, West AP, Whitehead SL, Willey DL, Wilming L, Wray PW, Wright MW, Young L, Coulson A, Durbin R, Hubbard T, Sulston JE, Beck S, Bentley DR, Rogers J, Ross MT

15.2.81 Dunham I, et al (1999) The DNA sequence of human chromosome 22

The first sequence of a complete human chromosome, naturally the petite chromosome 22.

Dunham I, et al. The DNA sequence of human chromosome 22. Nature. 1999;402(6761):489-95. DOI: 10.1038/990031. PMID: 10591208

Type of reference	Article
Authors	Dunham I, Shimizu N, Roe BA, Chissoe S, Hunt AR, Collins JE, Bruskiewich R, Beare DM, Clamp M, Smink LJ, Ainscough R, Almeida JP, Babbage A, Bagguley C, Balley J, Barlow K, Bates KN, Beasley O, Bird CP, Blakey S, Bridgeman AM, Buck D, Burgess J, Burrill WD, Burton J, Carder C, Carter NP, Chen Y, Clark G, Clegg SM, Cobley V, Cole CG, Collier RE, Connor RE, Conroy D, Corby N, Coville GJ, Cox AV, Davis J, Dawson E, Dhami PD, Dockree C, Dodsworth SJ, Durbin RM, Ellington A, Evans KL, Fey JM, Fleming K, French L, Garner AA, Gilbert JGR, Goward ME, Grafham D, Griffiths MN, Hall C, Hall R, Hall-Tamlyn G, Heathcott RW, Ho S, Holmes S, Hunt SE, Jones MC, Kershaw J, Kimberley A, King A, Laird GK, Langford CF, Leversha MA, Lloyd C, Lloyd DM, Martyn ID, Mashreghi-Mohammadi M, Matthews L, McCann OT, McClay J, McLaren S, McMurray AA, Milne SA, Mortimore BJ, Odell

	CN, Pavitt R, Pearce AV, Pearson D, Phillimore BJ, Phillips SH, Plumb RW, Ramsay H, Ramsey Y, Rogers L, Ross MT, Scott CE, Sehra HK, Skuce CD, Smalley S, Smith ML, Soderlund C, Spragon L, Steward CA, Sulston JE, Swann RM, Vaudin M, Wall M, Wallis JM, Whiteley MN, Willey D, Williams L, Williams S, Williamson H, Wilmer TE, Wilming L, Wright CL, Hubbard T, Bentley DR, Beck S, Rogers J, Minoshima S, Kawasaki K, Sasaki T, Asakawa S, Kudoh J, Shintani A, Shibuya K, Yoshizaki Y, Aoki N, Mitsuyama S, Chen F, Chu L, Crabtree J, Deschamps S, Do A, Do T, Dorman A, Fang F, Fu Y, Hu P, Hua A, Kenton S, Lai H, Lao HI, Lewis J, Lewis S, Lin SP, Loh P, Malaj E, Nguyen T, Pan H, Phan S, Qi S, Qian Y, Ray L, Ren Q, Shaull S, Sloan D, Song L, Wang Q, Wang Y, Wang Z, White J, Willingham D, Wu H, Yao Z, Zhan M, Zhang G, Murray J, Miller N, Minx P, Fulton R, Johnson D, Bemis G, Bentley D, Bradshaw H, Bourne S, Cordes M, Du Z, Fulton L, Goela D, Graves T, Hawkins J, Hinds K, Kemp K, Latreille P, Layman D, Ozersky P, Rohlfing T, Scheet P, Walker C, Wamsley A, Wohldmann P, Pepin K, Nelson J, Korf I, Bedell JA, Hillier L, Mardis E, Waterston R, Wilson R, Emanuel BS, Shaikh T, Kurahashi H, Saitta S, Budarf ML, McDermid HE, Johnson A, Wong ACC, Morrow BE, Edelman L, Kim UJ, Shizuya H, Simon MI, Dumanski JP, Peyrard M, Kedra D, Seroussi E, Fransson I, Tapia I, Bruder CE, O'Brien KP

15.2.82 Dunham I, et al (2012) An integrated encyclopedia of DNA elements in the human genome

Groundbreaking international collaboration – the ENCODE Project – featuring nearly 500 scientists publish 24 papers of in-depth analysis of genome function. The major conclusion was that fully 80% of the human genome has some functional activity, meaning it serves as a binding site for a gene regulator.

Dunham I, et al. An integrated encyclopedia of DNA elements in the human genome. Nature. 2012;489(7414):57-74. DOI: 10.1038/nature11247. PMID: 22955616

Type of reference	Article
Authors	Dunham I, Kundaje A, Aldred SF, Collins PJ, Davis C, Doyle F, Epstein CB, Frietze S, Harrow J, Kaul R, Khatun J, Lajoie BR, Landt SG, Lee BK, Pauli F, Rosenbloom KR, Sabo P, Safi A, Sanyal A, Shoresh N, Simon JM, Song L, Trinklein ND, Altshuler RC, Birney E, Brown JB, Cheng C, Djebali S, Dong XJ, Ernst J, Furey TS, Gerstein M, Giardine B, Greven M, Hardison RC, Harris RS, Herrero J, Hoffman MM, Iyer S, Kellis M, Kheradpour P, Lassmann T, Li QH, Lin X, Marinov GK, Merkel A, Mortazavi A, Parker SCJ, Reddy TE, Rozowsky J, Schlesinger F, Thurman RE, Wang J, Ward LD, Whitfield TW, Wilder SP, Wu W, Xi HLS, Yip KY, Zhuang JL, Bernstein BE, Green ED, Gunter C, Snyder M, Pazin MJ, Lowdon RF, Dillon LAL, Adams LB, Kelly CJ, Zhang J, Wexler JR, Good PJ, Feingold EA, Crawford GE, Dekker J, Elnitski L, Farnham PJ, Giddings MC, Gingeras TR, Guigo R, Hubbard TJ, Kent WJ, Lieb JD, Margulies EH, Myers RM, Stamatoyannopoulos JA, Tenenbaum SA, Weng ZP, White KP, Wold B, Yu Y, Wrobel J, Risk BA, Gunawardena HP, Kuiper HC, Maier CW, Xie L, Chen X, Mikkelsen TS, Gillespie S, Goren A, Ram O, Zhang XL, Wang L, Issner R, Coyne MJ, Durham T, Ku M, Truong T, Eaton ML, Davis CA, Dobin A, Tanzer A, Lagarde J, Lin W, Xue CH, Williams BA, Zaleski C, Roeder M, Kokocinski F, Abdelhamid RF, Alioto T, Antoshechkin I, Baer MT, Batut P, Bell I, Bell K, Chakrabortty S, Chrast J, Curado J, Derrien T, Drenkow J, Dumais E, Dumais J, Duttagupta R, Fastuca M, Fejes-Toth K, Ferreira P, Foissac S, Fullwood MJ, Gao H, Gonzalez D, Gordon A, Howald C, Jha S, Johnson R, Kapranov P, King B, Kingswood C, Li GL, Luo OJ, Park E, Preall JB, Presaud K, Ribeca P, Robyr D, Ruan XA, Sammeth M, Sandhu KS, Schaeffer L, See LH, Shahab A, Skancke J, Suzuki AM, Takahashi H, Tilgner H, Trout D, Walters N, Wang HE, Yu YB, Hayashizaki Y, Reymond A, Antonarakis SE, Hannon GJ, Ruan YJ, Carninci P, Sloan CA, Learned K, Malladi VS, Wong MC, Barber G, Cline MS, Dreszer TR, Heitner SG, Karolchik D, Kirkup VM, Meyer LR, Long JC, Maddren M, Raney BJ, Song LY,

	Grasfeder LL, Giresi PG, Battenhouse A, Sheffield NC, Showers KA, London D, Bhinge AA, Shestak C, Schaner MR, Kim SK, Zhang ZZZ, Mieczkowski PA, Mieczkowska JO, Liu Z, McDaniell RM, Ni YY, Rashid NU, Kim MJ, Adar S, Zhang ZC, Wang TY, Winter D, Keefe D, Iyer VR, Zheng MZ, Wang P, Gertz J, Vielmetter J, Partridge EC, Varley KE, Gasper C, Bansal A, Pepke S, Jain P, Amrhein H, Bowling KM, Anaya M, Cross MK, Muratet MA, Newberry KM, McCue K, Nesmith AS, Fisher-Aylor KI, Pusey B, DeSalvo G, Parker SL, Balasubramanian S, Davis NS, Meadows SK, Eggleston T, Newberry JS, Levy SE, Absher DM, Wong WH, Blow MJ, Visel A, Pennachio LA, Petrykowska HM, Abyzov A, Aken B, Barrell D, Barson G, Berry A, Bignell A, Boychenko V, Bussotti G, Davidson C, Despacio-Reyes G, Diekhans M, Ezkurdia I, Frankish A, Gilbert J, Gonzalez JM, Griffiths E, Harte R, Hendrix DA, Hunt T, Jungreis I, Kay M, Khurana E, Leng J, Lin MF, Loveland J, Lu Z, Manthravadi D, Mariotti M, Mudge J, Mukherjee G, Notredame C, Pei BK, Rodriguez JM, Saunders G, Sboner A, Searle S, Sisu C, Snow C, Steward C, Tapanari E, Tress ML, van Baren MJ, Washietl S, Wilming L, Zadissa A, Zhang ZD, Brent M, Haussler D, Valencia A, Addleman N, Alexander RP, Auerbach RK, Bettinger K, Bhardwaj N, Boyle AP, Cao AR, Cayting P, Charos A, Cheng Y, Eastman C, Euskirchen G, Fleming JD, Grubert F, Habegger L, Hariharan M, Harmanci A, Iyengar S, Jin VX, Karczewski KJ, Kasowski M, Lacroute P, Lam H, Lamarre-Vincent N, Lian J, Lindahl-Allen M, Min RQ, Miotto B, Monahan H, Moqtaderi Z, Mu XMJ, O'Geen H, Ouyang ZQ, Patacsil D, Raha D, Ramirez L, Reed B, Shi MY, Slifer T, Witt H, Wu LF, Xu XQ, Yan KK, Yang XQ, Struhl K, Weissman SM, Penalva LO, Karmakar S, Bhanvadia RR, Choudhury A, Domanus M, Ma LJ, Moran J, Victorsen A, Auer T, Centanin L, Eichenlaub M, Gruhl F, Heermann S, Hoeckendorf B, Inoue D, Kellner T, Kirchmaier S, Mueller C, Reinhardt R, Schertel L, Schneider S, Sinn R, Wittbrodt B, Wittbrodt J, Jain G, Balasundaram G, Bates DL, Byron R, Canfield TK, Diegel MJ, Dunn D, Ebersol AK, Frum T, Garg K, Gist E, Hansen RS, Boatman L, Haugen E, Humbert R, Johnson AK, Johnson EM, Kutyavin TV, Lee K, Lotakis D, Maurano MT, Neph SJ, Neri FV, Nguyen ED, Qu HZ, Reynolds AP, Roach V, Rynes E, Sanchez ME, Sandstrom RS, Shafer AO, Stergachis AB, Thomas S, Vernot B, Vierstra J, Vong S, Wang H, Weaver MA, Yan YQ, Zhang MH, Akey JM, Bender M, Dorschner MO, Groudine M, MacCoss MJ, Navas P, Stamatoyannopoulos G, Beal K, Brazma A, Flicek P, Johnson N, Lukk M, Luscombe NM, Sobral D, Vaquerizas JM, Batzoglou S, Sidow A, Hussami N, Kyriazopoulou-Panagiotopoulou S, Libbrecht MW, Schaub MA, Miller W, Bickel PJ, Banfai B, Boley NP, Huang HY, Li JJ, Noble WS, Bilmes JA, Buske OJ, Sahu AD, Kharchenko PV, Park PJ, Baker D, Taylor J, Lin XY, Lochovsky L, Min R, Consortium EP

15.2.83 Edwards RG, Steptoe PC (1978) Birth after the reimplantation of a human embryo

The invention of In vitro fertilization by British physicians Patrick Steptoe and Robert Edwards.

Edwards R.G., Steptoe P.C. Birth after the reimplantation of a human embryo. Lancet. 1978;312:366.

Type of reference	Article
Authors	Edwards R.G. and Steptoe P.C.

15.2.84 Erwin, Shelley (1990 & 1991) Interview with Robert L. Sinsheimer, Caltech Oral Histories, May 30-31, 1990 & March 26, 1991

Interview with Robert Sinsheimer on the events leading up to the launch of the Human Genome Project.

Erwin, Shelley, Interview with Robert L. Sinsheimer, Caltech Oral Histories, May 30-31, 1990 & March 26, 1991, Archives, California Institute of Technology, Pasadena, CA

Type of reference	Interview
Authors	Erwin, Shelley

15.2.85 Ewing B, et al. (1998) Base-calling of automated sequencer traces using phred

Release of key software (phred) from Phil Green and colleagues (University of Washington) for annotating and determining quality of Sanger sequencing data. Both phred and its sister program phrap (used for assembling sequences) had been in wide use since 1995.

Ewing B, et al. Base-calling of automated sequencer traces using phred. I. Accuracy assessment. Genome Research. 1998;8(3):175-85. PMID: 9521921

Type of reference	Article
Authors	Ewing B, Hillier L, Wendl MC, Green P.

15.2.86 FBI (2015) CODIS Brochure

The FBI Laboratory's Combined DNA Index System (CODIS) began as a pilot software project in 1990 serving 14 state and local laboratories. The DNA Identification Act of 1994 established the FBI's authority to maintain a National DNA Index System (NDIS) for law enforcement purposes. Today, over 190 public law enforcement laboratories participate in NDIS across the United States. Internationally, more than 90 law enforcement laboratories in over50 countries use the CODIS software for their own database initiatives. International laboratories using the CODIS software do not have any connectivity to the United States CODIS system.

https://www.fbi.gov/about-us/lab/biometric-analysis/codis/codis_brochure

Type of Reference	Brochure
Authors	Federal Bureau of Investigation

15.2.87 Fleischmann RD, et al. (1995) Whole-genome random sequencing and assembly of Haemophilus influenzae rd

Craig Venter's team at TIGR publishes the first bacterial genome sequence – Haemophilus influenzae. (Harvard Medical School geneticist George Church says the first microbe was actually sequenced a year earlier on behalf of a private biotech but never published.)

Fleischmann RD, et al. Whole-genome random sequencing and assembly of Haemophilus influenzae rd. Science. 1995;269(5223):496-512. DOI: 10.1126/science.7542800. PMID: 7542800

Type of reference	Article
Authors	Fleischmann RD, Adams MD, White O, Clayton RA, Kirkness EF, Kerlavage AR, Bult CJ, Tomb JF, Dougherty BA, Merrick JM, McKenney K, Sutton G, Fitzhugh W, Fields C, Gocayne JD, Scott J, Shirley R, Liu LI, Glodek A, Kelley JM, Weidman JF, Phillips CA, Spriggs T, Hedblom E, Cotton MD, Utterback TR, Hanna MC, Nguyen DT, Saudek DM, Brandon RC, Fine LD, Fritchman JL, Fuhrmann JL, Geoghagen NSM, Gnehm CL, McDonald LA, Small KV, Fraser CM, Smith HO, Venter JC

15.2.88 Florea L, et al. (1998) A computer program for aligning a cDNA sequence with a genomic DNA sequence

Account of computer software for aligning cDNA sequences with the corresponding genomic DNA.

Florea L, et al. A computer program for aligning a cDNA sequence with a genomic DNA sequence. Genome research 1998.8(9):967-74. Epub 1998/09/29. PubMed PMID: 9750195; PMCID: PMC310774.

Type of reference	Article
Authors	Florea L, Hartzell G, Zhang Z, Rubin GM, Miller W.

15.2.89 Fraser CM, et al. (1995) The minimal gene complement of Mycoplasma genitalium

Landmark paper from Fraser, Venter and colleagues at TIGR on the sequencing of the smallest microbial genome, Mycoplasma genitalium, paving the way for studies to create a “minimal genome.”

Fraser CM, et al. The minimal gene complement of Mycoplasma genitalium. Science. 1995;270(5235):397-403. DOI: 10.1126/science.270.5235.397. PMID: 7569993

Type of reference	Article
Authors	Fraser CM, Gocayne JD, White O, Adams MD, Clayton RA, Fleischmann RD, Bult CJ, Kerlavage AR, Sutton G, Kelley JM, Fritchman JL, Weidman JF, Small KV, Sandusky M, Fuhrmann J, Nguyen D, Utterback TR, Saudek DM, Phillips CA, Merrick JM, Tomb JF, Dougherty BA, Bott KF, Hu PC, Lucier TS, Peterson SN, Smith HO, Hutchison CA, Venter JC

15.2.90 Fraser CM, et al. (1997) Genomic sequence of a Lyme disease spirochaete, Borrelia burgdorferi

Full genome sequence of the Lyme disease pathogen, *Borrelia burdorferi*.

Fraser CM, et al. Genomic sequence of a Lyme disease spirochaete, Borrelia burgdorferi. Nature 1997.390(6660):580-6. Epub 1997/12/24. doi: 10.1038/37551. PubMed PMID: 9403685.

Type of reference	Article
Authors	Fraser CM, Casjens S, Huang WM, Sutton GG, Clayton R, Lathigra R, White O, Ketchum KA, Dodson R, Hickey EK, Gwinn M, Dougherty B, Tomb JF, Fleischmann RD, Richardson D, Peterson J, Kerlavage AR, Quackenbush J, Salzberg S, Hanson M, van Vugt R, Palmer N, Adams MD, Gocayne J, Weidman J, Utterback T, Watthey L, McDonald L, Artiach P, Bowman C, Garland S, Fuji C, Cotton MD, Horst K, Roberts K, Hatch B, Smith HO, Venter JC.

15.2.91 Fraser CM, et al. (1998) Complete genome sequence of treponema pallidum, the syphilis spirochete

Genome sequence of the syphilis spirochete from Fraser's team at TIGR.

Fraser CM, et al. Complete genome sequence of treponema pallidum, the syphilis spirochete. Science (New York, NY) 1998.281(5375):375-88. Epub 1998/07/17. PubMed PMID: 9665876.http://www.ncbi.nlm.nih.gov/pubmed/9665876

Type of reference	Article
Authors	Fraser CM, Norris SJ, Weinstock GM, White O, Sutton GG, Dodson R, Gwinn M, Hickey EK, Clayton R, Ketchum KA, Sodergren E, Hardham JM, McLeod MP, Salzberg S, Peterson J,

	Khalak H, Richardson D, Howell JK, Chidambaram M, Utterback T, McDonald L, Artiach P, Bowman C, Cotton MD, Fujii C, Garland S, Hatch B, Horst K, Roberts K, Sandusky M, Weidman J, Smith HO, Venter JC

15.2.92 Galindo K, Smith DP. (2001) A large family of divergent drosophila odorant-binding proteins expressed in gustatory and olfactory sensilla

Analysis of the large olfactory receptor gene family and the corresponding products in *Drosophila*.

Galindo K, Smith DP. A large family of divergent drosophila odorant-binding proteins expressed in gustatory and olfactory sensilla. Genetics 2001.159(3):1059-72. Epub 2001/12/01. PubMed PMID: 11729153; PMCID: PMC1461854.http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1461854

Type of reference	Article
Authors	Galindo K, Smith DP

15.2.93 Garcia-Sancho M (2007) Mapping and sequencing information: The social context for the genomics revolution

Analysis of the “information society” in driving genomic research, focusing on John Sulston’s seminal work in mapping the nematode genome.

Garcia-Sancho M. Mapping and sequencing information: The social context for the genomics revolution. Endeavour. 2007;31(1):18-23. DOI: 10.1016/j.endeavour.2007.01.006. PMID: 17336383

Type of reference	Article
Authors	Garcia-Sancho M

15.2.94 Gemmill RM, et al. (1995) An integrated YAC contig map for human-chromosome-3

A physical map of human chromosome 3 using yeast artificial chromosomes.

Gemmill RM, et al. An integrated YAC contig map for human-chromosome-3. Cytogenetics and Cell Genetics. 1995;68(3-4):137- http://www.karger.com/Article/Abstract/133907

Type of reference	Article
Authors	Gemmill RM, Chumakov I, Scott P, Waggoner B, Rigault P, Cypser J, Chen Q, Weissenbach J, Gardiner K, Pekarski Y, Legall I, Guillon S, Li E, Robinson L, Hahner L, Todd S, Cohen D, Drabkin HA

15.2.95 Giaever G, et al. (2002) Functional profiling of the Saccharomyces cerevisiae genome

The systematic construction of a nearly complete collection of gene-deletion mutants of *Saccharomyces cerevisiae*. DNA sequences dubbed 'molecular bar codes' uniquely identify each strain.

Giaever G, et al. Functional profiling of the Saccharomyces cerevisiae genome. Nature 2002.418(6896):387-91. Epub 2002/07/26. doi: 10.1038/nature00935. PubMed PMID: 12140549.

Type of reference	Article
Authors	Giaever G, Chu AM, Ni L, Connelly C, Riles L, Veronneau S, Dow S, Lucau-Danila A, Anderson K, Andre B, Arkin AP, Astromoff A, El-Bakkoury M, Bangham R, Benito R, Brachat S, Campanaro S, Curtiss M, Davis K, Deutschbauer A, Entian KD, Flaherty P, Foury F, Garfinkel DJ, Gerstein M, Gotte D, Guldener U, Hegemann JH, Hempel S, Herman Z, Jaramillo DF, Kelly DE, Kelly SL, Kotter P, LaBonte D, Lamb DC, Lan N, Liang H, Liao H, Liu L, Luo C, Lussier M, Mao R, Menard P, Ooi SL, Revuelta JL, Roberts CJ, Rose M, Ross-Macdonald P, Scherens B, Schimmack G, Shafer B, Shoemaker DD, Sookhai-Mahadeo S, Storms RK, Strathern JN, Valle G, Voet M, Volckaert G, Wang CY, Ward TR, Wilhelmy J, Winzeler EA, Yang Y, Yen G, Youngman E, Yu K, Bussey H, Boeke JD, Snyder M, Philippsen P, Davis RW, Johnston M

15.2.96 Gilbert W, Muller-Hill B (1966) Isolation of the lac repressor

Classic experiments identifying the lac repressor sequence in bacteria.

Gilbert W, Muller-Hill B. Isolation of the lac repressor. Proc Natl Acad Sci U S A. 1966;56(6):1891-8. Epub 1966/12/01. PMID: 16591435

Type of reference	Article
Authors	Gilbert W, Muller-Hill B

15.2.97 Gilbert W (1981) DNA sequencing and gene structure Nobel lecture

Gilbert reflects on the development of the Maxam-Gilbert chemical DNA sequencing method.

Gilbert W. DNA sequencing and gene structure Nobel lecture, 8 december 1980. Biosci Rep. 1981;1(5):353-75. DOI: 10.1007/bf01116186. PMID: 7028155

Type of reference	Article
Authors	Gilbert W

15.2.98 Gitschier, Jane. (2005-2015) A Collection of Interviews by Jane Gitschier

Series of in-depth interviews conducted by geneticist Jane Gitschier with a host of key scientists in the world of genetics and the Human Genome Project.

Gitschier, Jane. A Collection of Interviews by Jane Gitschier, PLoS Genetics, 2005-2015, http://collections.plos.org/jane-gitschier-interviews

Type of reference	Interviews

15.2.99 Gitschier, Jane. (2006) Knight in Common Armor: An Interview with Sir John Sulston

Jane Gitschier interviews Sir John Sulston, key figure in the UK genome project, nematode developmental biology and gene mapping.

Gitschier, Jane. Knight in Common Armor: An Interview with Sir John Sulston, PLoS Genetics, December 29, 2006.

Type of reference	Article
Authors	Gitschier, Jane

15.2.100 Goad W (1979) Proposal to establish a national center for collection, and computer storage and analysis of nucleic acid sequences

Goad W. Proposal to establish a national center for collection, and computer storage and analysis of nucleic acid sequences. Unpublished document: Robert Cook-Deegan Collection, Kennedy Institute of Ethics; 1979 December 17; 60 p. Available at: http://hdl.handle.net/10822/536891

Type of reference	Article
Authors	Goad, Walter B
Subjects	Genome Mapping

15.2.101 Goeddel DV, et al. (1979) Expression in Escherichia coli of chemically synthesized genes for human insulin

Landmark study on the chemical synthesis and expression of recombinant insulin.

Goeddel DV, et al. Expression in Escherichia coli of chemically synthesized genes for human insulin. Proc Natl Acad Sci U S A. 1979;76(1):106-10. DOI: 10.1073/pnas.76.1.106. PMID: 85300

Type of reference	Article
Authors	Goeddel DV, Kleid DG, Bolivar F, Heyneker HL, Yansura DG, Crea R, Hirose T, Kraszewski A, Itakura K, Riggs AD

15.2.102 Goffeau A, et al. (1996) Life with 6000 genes

A European-led consortium publishes the complete sequence of the yeast genome – the first eukaryotic genome to be published, weighing in at 6,000 genes.

Goffeau A, et al. Life with 6000 genes. Science. 1996;274(5287):546, 63-7. DOI: 10.1126/science.274.5287.546. PMID: 8849441

Type of reference	Article

Authors	Goffeau A, Barrell BG, Bussey H, Davis RW, Dujon B, Feldmann H, Galibert F, Hoheisel JD, Jacq C, Johnston M, Louis EJ, Mewes HW, Murakami Y, Philippsen P, Tettelin H, Oliver SG

15.2.103 Goff SA (2005) A draft sequence of the rice genome (oryza sativa l. Ssp. Japonica)

Draft sequence of the rice genome.

Goff SA. A draft sequence of the rice genome (oryza sativa l. Ssp. Japonica) (april, pg 92, 2002). Science. 2005;309(5736):879-. PubMed PMID: 11935018

Type of reference	Article
Authors	Goff SA

15.2.104 Gray NS, et al. (1998) Exploiting chemical libraries, structure, and genomics in the search for kinase inhibitors

Development of novel kinase inhibitors and analysis of cellular effects via a genome-wide screen.

Gray NS, et al. Exploiting chemical libraries, structure, and genomics in the search for kinase inhibitors. Science (New York, NY) 1998.281(5376):533-8. Epub 1998/07/24. PubMed PMID: 9677190.http://www.ncbi.nlm.nih.gov/pubmed/9677190

Type of reference	Article
Authors	Gray NS, Wodicka L, Thunnissen AM, Norman TC, Kwon S, Espinoza FH, Morgan DO, Barnes G, LeClerc S, Meijer L, Kim SH, Lockhart DJ, Schultz PG

15.2.105 Green ED, et al. (2015) Human Genome Project: Twenty-five years of big biology

A look back at 25 years of genomics research since the launch of the Human Genome Project by the director of the National Human Genome Research Institute.

Green ED, et al. Human Genome Project: Twenty-five years of big biology. Nature. 2015 Oct 1;526(7571):29-31. DOI: 10.1038/526029a. PubMed PMID: 26432225

Type of reference	Article
Authors	Green ED, Watson JD, Collins FS

15.2.106 Green P (1999) Documentation for phrap and cross_match

Phrap ("phragment assembly program," or "phil's revised assembly program"; a homonym of "frappe" = French for "swat") – a program for assembling shotgun DNA sequence data.

Green P. Documentation for phrap and cross_match (Version 0.990319). Available at: http://www.phrap.org/phredphrap/phrap.html

Type of reference	Article
Authors	Green, Phil

15.2.107 Gregory SG, et al. (2006) The DNA sequence and biological annotation of human chromosome 1

The sequence of human chromosome 1.

Gregory SG, et al. The DNA sequence and biological annotation of human chromosome 1. Nature. 2006;441(7091):315-21. DOI: 10.1038/nature04727. PMID: 16710414

Type of reference	Article
Authors	Gregory SG, Barlow KF, McLay KE, Kaul R, Swarbreck D, Dunham A, Scott CE, Howe KL, Woodfine K, Spencer CCA, Jones MC, Gillson C, Searle S, Zhou Y, Kokocinski F, McDonald L, Evans R, Phillips K, Atkinson A, Cooper R, Jones C, Hall RE, Andrews TD, Lloyd C, Ainscough R, Almeida JP, Ambrose KD, Anderson F, Andrew RW, Ashwell RIS, Aubin K, Babbage AK, Bagguley CL, Bailey J, Beasley H, Bethel G, Bird CP, Bray-Allen S, Brown JY, Brown AJ, Buckley D, Burton J, Bye J, Carder C, Chapman JC, Clark SY, Clarke G, Clee C, Cobley V, Collier RE, Corby N, Coville GJ, Davies J, Deadman R, Dunn M, Earthrowl M, Ellington AG, Errington H, Frankish A, Frankland J, French L, Garner P, Garnett J, Gay L, Ghori MRJ, Gibson R, Gilby LM, Gillett W, Glithero RJ, Grafham DV, Griffiths C, Griffiths-Jones S, Grocock R, Hammond S, Harrison ESI, Hart E, Haugen E, Heath PD, Holmes S, Holt K, Howden PJ, Hunt AR, Hunt SE, Hunter G, Isherwood J, James R, Johnson C, Johnson D, Joy A, Kay M, Kershaw JK, Kibukawa M, Kimberley AM, King A, Knights AJ, Lad H, Laird G, Lawlor S, Leongamornlert DA, Lloyd DM, Loveland J, Lovell J, Lush MJ, Lyne R, Martin S, Mashreghi-Mohammadi M, Matthews L, Matthews NSW, McLaren S, Milne S, Mistry S, Moore MJF, Nickerson T, O'Dell CN, Oliver K, Palmeiri A, Palmer SA, Parker A, Patel D, Pearce AV, Peck AI, Pelan S, Phelps K, Phillimore BJ, Plumb R, Rajan J, Raymond C, Rouse G, Saenphimmachak C, Sehra HK, Sheridan E, Shownkeen R, Sims S, Skuce CD, Smith M, Steward C, Subramanian S, Sycamore N, Tracey A, Tromans A, Van Helmond Z, Wall M, Wallis JM, White S, Whitehead SL, Wilkinson JE, Willey DL, Williams H, Wilming L, Wray PW, Wu Z, Coulson A, Vaudin M, Sulston JE, Durbin R, Hubbard T, Wooster R, Dunham I, Carter NP, McVean G, Ross MT, Harrow J, Olson MV, Beck S, Rogers J, Bentley DR

15.2.108 Griffin TJ, et al. (1997) Genetic analysis by peptide nucleic acid affinity maldi-tof mass spectrometry

Novel method for detection of multiple point mutations, using allele-specific, peptide nucleic acid (PNA) hybridization probes, and analysis by mass spectrometry.

Griffin TJ, et al. Genetic analysis by peptide nucleic acid affinity maldi-tof mass spectrometry. Nature biotechnology 1997.15(13):1368-72. Epub 1998/01/07. doi: 10.1038/nbt1297-1368. PubMed PMID: 9415888.http://dx.doi.org/10.1038/nbt1297-1368

Type of reference	Article
Authors	Griffin TJ, Tang W, Smith LM

15.2.109 Griffin TJ, et al. (1999) Direct genetic analysis by matrix-assisted laser desorption/ionization mass spectrometry

An approach to analyzing single-nucleotide polymorphisms (SNPs) that coupled an invasive cleavage assay for nucleic acids with detection by mass spectrometry.

Griffin TJ, et al. Direct genetic analysis by matrix-assisted laser desorption/ionization mass spectrometry. Proceedings of the National Academy of Sciences of the United States of America 1999.96(11):6301-6. Epub 1999/05/26. PubMed PMID: 10339582; PMCID: PMC26876.http://www.ncbi.nlm.nih.gov/pmc/articles/PMC26876

Type of reference	Article
Authors	Griffin TJ, Hall JG, Prudent JR, Smith LM

15.2.110 Grimwood J, et al. (2004) The DNA sequence and biology of human chromosome 19

The sequence of human chromosome 19.

Grimwood J, et al. The DNA sequence and biology of human chromosome 19. Nature. 2004;428(6982):529-35. DOI: 10.1038/nature02399. PMID: 15057824

Type of reference	Article

Authors	Grimwood J, Gordon LA, Olsen A, Terry A, Schmutz J, Lamerdin J, Hellsten U, Goodstein D, Couronne O, Gyamfi MT, Aerts A, Altherr M, Ashworth L, Bajorek E, Black S, Branscomb E, Caenepeel S, Carrano A, Caoile C, Chan YM, Christensen M, Cleland CA, Copeland A, Dalin E, Dehal P, Denys M, Detter JC, Escobar J, Flowers D, Fotopulos D, Garcia C, Georgescu AM, Glavina T, Gomez M, Gonzales E, Groza M, Hammon N, Hawkins T, Haydu L, Ho I, Huang W, Israni S, Jett J, Kadner K, Kimball H, Kobayashi A, Larionov V, Leem SH, Lopez F, Lou YL, Lowry S, Malfatti S, Martinez D, McCready P, Medina C, Morgan J, Nelson K, Nolan M, Ovcharenko I, Pitluck S, Pollard M, Popkie AP, Predki P, Quan G, Ramirez L, Rash S, Retterer J, Rodriguez A, Rogers S, Salamov A, Salazar A, She XW, Smith D, Slezak T, Solovyev V, Thayer N, Tice H, Tsai M, Ustaszewska A, Vo N, Wagner M, Wheeler J, Wu K, Xie G, Yang J, Dubchak I, Furey TS, DeJong P, Dickson M, Gordon D, Eichler EE, Pennacchio LA, Richardson P, Stubbs L, Rokhsar DS, Myers RM, Rubin EM, Lucas SM

15.2.111 Gudbjartsson DF, et al. (2015) Large-scale whole-genome sequencing of the Icelandic population

Genome sequencing of more than 2,600 Icelanders by Decode Genetics, identifying homozygous loss-of-function mutations in 1,100 genes and pinpointing some 2,000 individuals carrying a deleterious BRCA2 mutation.

Gudbjartsson DF, et al. Large-scale whole-genome sequencing of the Icelandic population. Nat Genet. 2015;47(5):435-44. DOI: 10.1038/ng.3247. PMID: 25807286

Type of reference	Article
Authors	Gudbjartsson DF, Helgason H, Gudjonsson SA, Zink F, Oddson A, Gylfason A, Besenbacher S, Magnusson G, Halldorsson BV, Hjartarson E, Sigurdsson GT, Stacey SN, Frigge ML, Holm H, Saemundsdottir J, Helgadottir HT, Johannsdottir H, Sigfusson G, Thorgeirsson G, Sverrisson JT, Gretarsdottir S, Walters GB, Rafnar T, Thjodleifsson B, Bjornsson ES, Olafsson S, Thorarinsdottir H, Steingrimsdottir T, Gudmundsdottir TS, Theodors A, Jonasson JG, Sigurdsson A, Bjornsdottir G, Jonsson JJ, Thorarensen O, Ludvigsson P, Gudbjartsson H, Eyjolfsson GI, Sigurdardottir O, Olafsson I, Arnar DO, Magnusson OT, Kong A, Masson G, Thorsteinsdottir U, Helgason A, Sulem P, Stefansson K

15.2.112 Gusella JF, et al. (1983) A polymorphic DNA marker genetically linked to Huntington's disease

Landmark linkage mapping of gene for fatal neurodegenerative dominant disorder Huntington's disease to chromosome 4, establishing the power of RFLP mapping for human genetics. The G8 marker linked to HD was just the 12th probe used by Gusella and colleagues.

Gusella JF, et al. A polymorphic DNA marker genetically linked to Huntington's disease. Nature. 1983;306(5940):234-8. DOI: 10.1038/306234a0. PMID: 6316146

Type of reference	Article

Authors	Gusella JF, Wexler NS, Conneally PM, Naylor SL, Anderson MA, Tanzi RE, Watkins PC, Ottina K, Wallace MR, Sakaguchi AY, Young AB, Shoulson I, Bonilla E, Martin JB

15.2.113 Gyapay G, et al. (1994) The 1993-94 Genethon human genetic linkage map

Genetic map published with an average marker spacing of 0.7 cM. The 5-year goal was achieved 1 year ahead of schedule.

Gyapay G, et al. The 1993-94 Genethon human genetic linkage map. Nat Genet. 1994;7(2 Spec No):246-339. DOI: 10.1038/ng0694supp-246. PMID: 7545953

Type of reference	Article
Authors	Gyapay G, Morissette J, Vignal A, Dib C, Fizames C, Millasseau P, Marc S, Bernardi G, Lathrop M, Weissenbach J.

15.2.114 Haga SB, Willard HF (2006) Defining the spectrum of genome policy

Overview of contemporary issues in genomics policy and strategies to improve policy making.

Haga SB, Willard HF. Defining the spectrum of genome policy. Nat Rev Genet. 2006 Dec; 7(12):966-72. Review. DOI: 10.1038/nrg2003. PMID: 17139328

Type of reference	Commentary
Authors	Haga SB, Willard HF

15.2.115 Hall JM, et al. (1990) Linkage of early-onset familial breast cancer to chromosome 17q21

Landmark paper identifying location of hereditary early-onset breast and ovarian cancer gene BRCA1 on chromosome 17.

Hall JM, Lee MK, Newman B, Morrow JE, Anderson LA, Huey B, King MC. Linkage of early-onset familial breast cancer to chromosome 17q21. Science. 1990 Dec 21;250(4988):1684-9.

Type of reference	Article
Authors	Hall JM, Lee MK, Newman B, Morrow JE, Anderson LA, Huey B, King MC

15.2.116 Hamosh A, et al. (2000) Online Mendelian inheritance in man (OMIM)

Victor McKusick's classic catalog of human genetic traits is put online.

Hamosh A, et al. Online Mendelian inheritance in man (OMIM). Hum Mutat. 2000; 15(1):57-61. DOI: 10.1002/(SICI)1098-1004(200001)15:1<57::AID-HUMU12>3.0.CO;2-G. PMID: 10612823

Type of reference	Article
Authors	Hamosh A, Scott AF, Amberger J, Valle D, McKusick VA

15.2.117 Hamosh A, et al. (2002) Online Mendelian Inheritance in Man (OMIM), a knowledgebase of human genes and genetic disorders

Updated summary of Victor McKusick's online catalog.

Hamosh A, et al. Online Mendelian Inheritance in Man (OMIM), a knowledgebase of human genes and genetic disorders. Nucleic Acids Res. 2002 Jan 1;30(1):52-5. DOI: 10.1093/nar/30.1.52, PMID: 11752252

Type of reference	Article
Authors	Hamosh A, Scott AF, Amberger J, Bocchini C, Valle D, McKusick VA

15.2.118 Harrison TJ (2000) Spliced segments at the 5′ terminus of Adenovirus 2 late mRNA

1977, Sharp and Roberts, Adenovirus studies yield discovery of "split genes" Nobel 1993.

Harrison TJ. Spliced segments at the 5′ terminus of adenovirus 2 late mRNA. Susan M. Berget, Claire Moore and Phillip A. Sharp; an amazing sequence arrangement at the 5′ ends of adenovirus 2 messenger RNA. Louise t. Chow, richard e. Gelinas, thomas r. Broker and richard t. Roberts. Reviews in Medical Virology. 2000;10(6):355-62. doi: 10.1002/1099-1654(200011/12)10:6<355::AID-RMV294>3.0.CO;2-A. PubMed PMID: 11114075

Type of reference	Article
Authors	Harrison TJ

15.2.119 Hartley, D A, et al. (1984) A cytological map of the human X chromosome--evidence for non-random recombination

Cytogenetic map of the human X chromosome, providing an important physical reference to the accompanying genetic linkage maps under development.

Hartley, D A, K E Davies, D Drayna, R L White, and R Williamson. (1984) A cytological map of the human X chromosome--evidence for non-random recombination. Nucleic Acids Res. 1984 Jul 11; 12(13): 5277–5285.

Type of reference	Article
Authors	Hartley, D A, K E Davies, D Drayna, R L White, and R Williamson

15.2.120 Hattori M, et al. (2000) The DNA sequence of human chromosome 21

Sequence of human chromosome 21, the third chromosome completely sequenced to the high quality specified by the HGP.

Hattori M, et al. The DNA sequence of human chromosome 21. Nature. 2000;405(6784):311-9. DOI: 10.1038/35012518. PMID: 10830953

Type of reference	Article
Authors	Hattori M, Fujiyama A, Taylor TD, Watanabe H, Yada T, Park HS, Toyoda A, Ishii K, Totoki Y, Choi DK, Soeda E, Ohki M, Takagi T, Sakaki Y, Taudien S, Blechschmidt K, Polley A, Menzel U, Delabar J, Kumpf K, Lehmann R, Patterson D, Reichwald K, Rump A, Schillhabel M, Schudy A, Zimmermann W, Rosenthal A, Kudoh J, Shibuya K, Kawasaki K, Asakawa S, Shintani A, Sasaki T, Nagamine K, Mitsuyama S, Antonarakis SE, Minoshima S, Shimizu N, Nordsiek G, Hornischer K, Brandt P, Scharfe M, Schon O, Desario A, Reichelt J, Kauer G, Blocker H, Ramser J, Beck A, Klages S, Hennig S, Riesselmann L, Dagand E, Haaf T, Wehrmeyer S, Borzym K, Gardiner K, Nizetic D, Francis F, Lehrach H, Reinhardt R, Yaspo ML, Groner Y

15.2.121 Heidelberg JF, et al. (2000) DNA sequence of both chromosomes of the cholera pathogen vibrio cholerae

Genome sequence of the cholera pathogen.

Heidelberg JF, et al. DNA sequence of both chromosomes of the cholera pathogen vibrio cholerae. Nature 2000.406(6795):477-83. Epub 2000/08/22. doi: 10.1038/35020000. PubMed PMID: 10952301.http://dx.doi.org/10.1038/35020000

Type of reference	Article
Authors	Heidelberg JF, Eisen JA, Nelson WC, Clayton RA, Gwinn ML, Dodson RJ, Haft DH, Hickey EK, Peterson JD, Umayam L, Gill SR, Nelson KE, Read TD, Tettelin H, Richardson D, Ermolaeva MD, Vamathevan J, Bass S, Qin H, Dragoi I, Sellers P, McDonald L, Utterback T, Fleishmann RD, Nierman WC, White O, Salzberg SL, Smith HO, Colwell RR, Mekalanos JJ, Venter JC, Fraser CM

15.2.122 Heilig R, et al. (2003) The DNA sequence and analysis of human chromosome 14

The sequence of human chromosome 14 - the fourth chromosome to be sequenced.

Heilig R, et al. The DNA sequence and analysis of human chromosome 14. Nature. 2003;421(6923):601-7. DOI: 10.1038/nature01348. PMID: 12508121

Type of reference	Article
Authors	Heilig R, Eckenberg R, Petit JL, Fonknechten NR, Da Silva C, Cattolico L, Levy M, Barbe V, de Berardinis V, Ureta-Vidal A, Pelletier E, Vico V, Anthouard V, Rowen L, Madan A, Qin SZ, Sun H, Du H, Pepin K, Artiguenave F, Robert C, Cruaud C, Bruls T, Jaillon O, Friedlander L, Samson G, Brottier P, Cure S, Segurens B, Aniere F, Samain S, Crespeau H, Abbasi N, Alach N, Boscus D, Dickhoff R, Dors M, Dubois I, Friedman C, Gouyvenoux M, James R, Malrey-Estrada B, Mangenot S, Martins N, Menard M, Oztas S, Ratcliffe A, Shaffer T, Trask B, Vacherle B, Bellemere C, Belser C, Besnard-Gonnet M, Bartol-Mavel D, Boutard M, Briez-Silla S, Combette S, Dufosse-Laurent V, Ferron C, Lechaplais C, Louesse C, Muselet D, Magdelenat G, Pateau E, Petit E, Sirvain-Trukniewicz P, Trybou A, Vega-Czarny N, Bataille E, Bluet E, Bordelais I, Dubois M, Dumont C, Guerin T, Haffray S, Hammadi R, Muanga J, Pellouin V, Robert D, Wunderle E, Gauguet G, Roy A, Sainte-Marthe L, Verdier J, Verdier-Discala C, Hillier L, Fulton L, McPherson J, Matsuda F, Wilson R, Scarpelli C, Gyapay G, Wincker P, Saurin W, Quetier F, Waterston R, Hood L, Weissenbach J

15.2.123 Heiner CR, et al. (1998) Sequencing multimegabase-template DNA with bigdye terminator chemistry

Direct sequencing of large-template DNA using custom primers on automated instruments.

Heiner CR, et al. Sequencing multimegabase-template DNA with bigdye terminator chemistry. Genome research 1998.8(5):557-61. Epub 1998/05/20. PubMed PMID: 9582199; PMCID: PMC310720.http://www.ncbi.nlm.nih.gov/pmc/articles/PMC310720

Type of reference	Article
Authors	Heiner CR, Hunkapiller KL, Chen SM, Glass JI, Chen EY

15.2.124 Hillier LW, et al. (2005) Generation and annotation of the DNA sequences of human chromosomes 2 and 4

The sequences of human chromosomes 2 and 4.

Hillier LW, et al. Generation and annotation of the DNA sequences of human chromosomes 2 and 4. Nature. 2005;434(7034):724-31. DOI: 10.1038/nature03466. PMID: 15815621

Type of reference	Article
Authors	Hillier LW, Graves TA, Fulton RS, Fulton LA, Pepin KH, Minx P, Wagner-McPherson C, Layman D, Wylie K, Sekhon M, Becker MC, Fewell GA, Delehaunty KD, Miner TL, Nash WE, Kremitzki C, Oddy L, Du H, Sun H, Bradshaw-Cordum H, Ali J, Carter J, Cordes M, Harris A, Isak A, van Brunt A, Nguyen C, Du FY, Courtney L, Kalicki J, Ozersky P, Abbott S, Armstrong J, Belter EA, Caruso L, Cedroni M, Cotton M, Davidson T, Desai A, Elliott G, Erb T, Fronick C, Gaige T, Haakenson W, Haglund K, Holmes A, Harkins R, Kim K, Kruchowski SS, Strong CM, Grewal N, Goyea E, Hou S, Levy A, Martinka S, Mead K, McLellan MD, Meyer R, Maher JR, Tomlinson C, Kohlberg SD, Kozlowicz-Reilly A, Shah N, Swearengen-Shahid S, Snider J, Strong JT, Thompson J, Yoakum M, Leonard S, Pearman C, Trani L, Radionenko M, Waligorski JE, Wang CY, Rock SM, Tin-Wollam AM, Maupin R, Latreille P, Wendl MC, Yang SP, Pohl C, Wallis JW, Spieth J, Bieri TA, Berkowicz N, Nelson JO, Osborne J, Ding L, Sabo A, Shotland Y, Sinha P, Wohldmann PE, Cook LL, Hickenbotham MT, Eldred J, Williams D, Jones TA, She XW, Ciccarelli FD, Izaurralde E, Taylor J, Schmutz J, Myers RM, Cox DR, Huang XQ, McPherson JD, Mardis ER, Clifton SW, Warren WC, Chinwalla AT, Eddy SR, Marra MA, Ovcharenko I, Furey TS, Miller W, Eichler EE, Bork P, Suyama M, Torrents D, Waterston RH, Wilson RK

15.2.125 Hillier LW, et al (2003) The DNA sequence of human chromosome 7

The full sequence of human chromosome 7.

Hillier LW, et al. The DNA sequence of human chromosome 7. Nature. 2003;424(6945):157-64. DOI: 10.1038/nature01782. PMID: 12853948

Type of reference	Article
Authors	Hillier LW, Fulton RS, Fulton LA, Graves TA, Pepin KH, Wagner-McPherson C, Layman D, Maas J, Jaeger S, Walker R, Wylie K, Sekhon M, Becker MC, O'Laughlin MD, Schaller ME, Fewell GA, Delehaunty KD, Miner TL, Nash WE, Cordes M, Du H, Sun H, Edwards J, Bradshaw-Cordum H, Ali J, Andrews S, Isak A, VanBrunt A, Nguyen C, Du FY, Lamar B, Courtney L, Kalicki J, Ozersky P, Bielicki L, Scott K, Holmes A, Harkins R, Harris A, Strong CM, Hou SF, Tomlinson C, Dauphin-Kohlberg S, Kozlowicz-Reilly A, Leonard S, Rohlfing T, Rock SM, Tin-Wollam AM, Abbott A, Minx P, Maupin R, Strowmatt C, Latreille P, Miller N, Johnson D, Murray J, Woessner JP, Wendl MC, Yang SP, Schultz BR, Wallis JW, Spieth J, Bieri TA, Nelson JO, Berkowicz N, Wohldmann PE, Cook LL, Hickenbotham MT, Eldred J, Williams D, Bedell JA, Mardis ER, Clifton SW, Chissoe SL, Marra MA, Raymond C, Haugen E, Gillett W, Zhou Y, James R, Phelps K, Iadanoto S, Bubb K, Simms E, Levy R, Clendenning J, Kaul R, Kent WJ, Furey TS, Baertsch RA, Brent MR, Keibler E, Flicek P, Bork P, Suyama M, Bailey JA, Portnoy ME, Torrents D, Chinwalla AT, Gish WR, Eddy SR, McPherson JD, Olson MV, Eichler EE, Green ED, Waterston RH, Wilson RK

15.2.126 Holley RW, et al. (1965) Nucleotide sequences in the yeast alanine transfer ribonucleic acid

Robert Holley deciphers the sequence of yeast alanine transfer RNA, The work resulted in a share of the 1968 Nobel Prize along with Nirenberg and Khorana.

Holley RW, et al. Nucleotide sequences in the yeast alanine transfer ribonucleic acid. Journal of Biological Chemistry. 1965;240:2122-8. Epub 1965/05/01. PMID: 14299636

Type of reference	Article
Authors	Holley RW, Everett GA, Madison JT, Zamir A

15.2.127 Holley RW, et al. (1965) Structure of an Alanine transfer RNA

Holley deciphers the structure of yeast alanine transfer RNA,

Holley RW, et al. Structure of an Alanine transfer RNA. Federation Proceedings. 1965;24(2p1):216-&.

Type of reference	Article
Authors	Holley RW, Apgar J, Everett GA, Madison JT, Merrill SH, Penswick JR, Zamir A

15.2.128 Hood L, Rowen L. (2013) The human genome project: Big science transforms biology and medicine. Genome Medicine

Hood L, Rowen L. The human genome project: Big science transforms biology and medicine. Genome Medicine 2013.5(9):79. Epub 2013/09/18. doi: 10.1186/gm483. PubMed PMID: 24040834; PMCID: PMC4066586

Type of reference	Article
Authors	Hood L, Rowen L

15.2.129 Huang D, Koshland D. (2003) Chromosome integrity in Saccharomyces cerevisiae: The interplay of DNA replication initiation factors, elongation factors, and origins

Analysis of chromosome integrity determinants in yeast.

Huang D, Koshland D. Chromosome integrity in Saccharomyces cerevisiae: The interplay of DNA replication initiation factors, elongation factors, and origins. Genes & development 2003.17(14):1741-54. Epub 2003/07/17. doi: 10.1101/gad.1089203. PubMed PMID: 12865298; PMCID: PMC196182.

Type of reference	Article
Authors	Huang D, Koshland D

15.2.130 Hubbard T, et al. (2002) The Ensembl genome database project

Description of the Ensemble genome database, hosted at the European Bioinformatics Institute in the UK.

Hubbard T, et al. The Ensembl genome database project. Nucleic Acids Research 2002.30(1):38-41. Epub 2001/12/26. PubMed PMID: 11752248; PMCID: PMC99161.

Type of reference	Article
Authors	Hubbard T, Barker D, Birney E, Cameron G, Chen Y, Clark L, Cox T, Cuff J, Curwen V, Down T, Durbin R, Eyras E, Gilbert J, Hammond M, Huminiecki L, Kasprzyk A, Lehvaslaiho H, Lijnzaad P, Melsopp C, Mongin E, Pettett R, Pocock M, Potter S, Rust A, Schmidt E, Searle S, Slater G, Smith J, Spooner W, Stabenau A, Stalker J, Stupka E, Ureta-Vidal A, Vastrik I, Clamp M

15.2.131 Hudson TJ, et al. (1995) An STS-based map of the human genome

A landmark early physical map of the human genome utilizing 15,000 markers, from the Whitehead Institute Genome Center.

Hudson TJ, et al. An STS-based map of the human genome. Science. 1995;270(5244):1945-54. DOI: 10.1126/science.270.5244.1945. PMID: 8533086

Type of reference	Article
Authors	Hudson TJ, Stein LD, Gerety SS, Ma JL, Castle AB, Silva J, Slonim DK, Baptista R, Kruglyak L, Xu SH, Hu XT, Colbert AME, Rosenberg C, Reevedaly MP, Rozen S, Hui L, Wu XY, Vestergaard C, Wilson KM, Bae JS, Maitra S, Ganiatsas S, Evans CA, Deangelis MM, Ingalls KA, Nahf RW, Horton LT, Anderson MO, Collymore AJ, Ye WJ, Kouyoumjian V, Zemsteva IS, Tam J, Devine R, Courtney DF, Renaud MT, Nguyen H, Oconnor TJ, Fizames C, Faure S, Gyapay G, Dib C, Morissette J, Orlin JB, Birren BW, Goodman N, Weissenbach J, Hawkins TL, Foote S, Page DC, Lander ES

15.2.132 Hughes AL, et al. (2002) Genomewide pattern of synonymous nucleotide substitution in two complete genomes of Mycobacterium tuberculosis

Comparative analysis of genome variants in two M. tuberculosis strains and evolutionary implications.

Hughes AL, et al. Genomewide pattern of synonymous nucleotide substitution in two complete genomes of Mycobacterium tuberculosis. Emerging infectious diseases 2002.8(11):1342-6. Epub 2002/11/28. doi: 10.3201/eid0811.020064. PubMed PMID: 12453367; PMCID: PMC2738538.

Type of reference	Article
Authors	Hughes AL, Friedman R, Murray M

15.2.133 Humphray SJ, et al. (2004) DNA sequence and analysis of human chromosome 9

The sequence of human chromosome 9.

Humphray SJ, et al. DNA sequence and analysis of human chromosome 9. Nature. 2004;429(6990):369-74. DOI: 10.1038/nature02465. PMID: 15164053

Type of reference	Article
Authors	Humphray SJ, Oliver K, Hunt AR, Plumb RW, Loveland JE, Howe KL, Andrews TD, Searle S, Hunt SE, Scott CE, Jones MC, Ainscough R, Almeida JP, Ambrose KD, Ashwell RIS, Babbage AK, Babbage S, Bagguley CL, Bailey J, Banerjee R, Barker DJ, Barlow KF, Bates K, Beasley H, Beasley O, Bird CP, Bray-Allen S, Brown AJ, Brown JY, Burford D, Burrill W, Burton J, Carder C, Carter NP, Chapman JC, Chen Y, Clarke G, Clark SY, Clee CM, Clegg S, Collier RE, Corby N, Crosier M, Cummings AT, Davies J, Dhami P, Dunn M, Dutta I, Dyer LW, Earthrowl ME, Faulkner L, Fleming CJ, Frankish A, Frankland JA, French L, Fricker DG, Garner P, Garnett J, Ghori J, Gilbert JGR, Glison C, Grafham DV, Gribble S, Griffiths C, Jones SG, Grocock R, Guy J, Hall RE, Hammond S, Harley JL, Harrison ESI, Hart EA, Heath PD, Henderson CD, Hopkins BL, Howard PJ, Howden PJ, Huckle E, Johnson C, Johnson D, Joy AA, Kay M, Keenan S, Kershaw JK, Kimberley AM, King A, Knights A, Laird GK, Langford C, Lawlor S, Leongamornlert DA, Leversha M, Lloyd C, Lloyd DM, Lovell J, Martin S, Mashreghi-Mohammadi M, Matthews L, McLaren S, McLay KE, McMurray A, Milne S, Nickerson T, Nisbett J, Nordsiek G, Pearce AV, Peck AI, Porter KM, Pandian R, Pelan S, Phillimore B, Povey S, Ramsey Y, Rand V, Scharfe M, Sehra HK, Shownkeen R, Sims SK, Skuce CD, Smith M, Steward CA, Swarbreck D, Sycamore N, Tester J, Thorpe A, Tracey A, Tromans A, Thomas DW, Wall M, Wallis JM, West AP, Whitehead SL, Willey DL, Williams SA, Wilming L, Wray PW, Young L, Ashurst JL, Coulson A, Blocker H, Durbin R, Sulston JE, Hubbard T, Jackson MJ, Bentley DR, Beck S, Rogers J, Dunham I

15.2.134 Hunkapiller T, et al. (1991) Large-scale and automated DNA sequence determination

Automated DNA sequencing instrumentation utilizing fluorescent dyes developed by Lee Hood and colleagues. The authors predicted that this new automated instrumentation and improved computation could deliver large genome projects of 100 Mb or more within the decade.

Hunkapiller T, et al. Large-scale and automated DNA sequence determination. Science. 1991;254(5028):59-67. DOI: 10.1126/science.1925562. PMID: 1925562

Type of reference	Article
Authors	Hunkapiller T, Kaiser RJ, Koop BF, Hood L

15.2.135 Hutchison CA, et al. (1999) Global transposon mutagenesis and a minimal mycoplasma genome

TIGR researchers led by Clyde Hutchinson present progress in identification of minimal set of bacterial genes required to sustain life.

Hutchison CA, et al. Global transposon mutagenesis and a minimal mycoplasma genome. Science. 1999;286(5447):2165-9. DOI: 10.1126/science.286.5447.2165. PMID: 10591650

Type of reference	Article
Authors	Hutchison CA, Peterson SN, Gill SR, Cline RT, White O, Fraser CM, Smith HO, Venter JC

15.2.136 International HapMap Consortium. (2005) A haplotype map of the human genome. Nature

International HapMap Consortium. A haplotype map of the human genome. Nature 2005.437(7063):1299-320. Epub 2005/10/29. doi: 10.1038/nature04226. PubMed PMID: 16255080; PMCID: PMC1880871

Type of reference	Article

15.2.137 Ioannou PA, et al. (1994) A new bacteriophage P1-derived vector for the propagation of large human DNA fragments

New cloning vector for manipulation and analysis of large DNA inserts.

Ioannou PA, et al. A new bacteriophage P1-derived vector for the propagation of large human DNA fragments. Nat Genet. 1994;6(1):84-9. DOI: 10.1038/ng0194-84. PMID: 8136839

Type of reference	Article
Authors	Ioannou PA, Amemiya CT, Garnes J, Kroisel PM, Shizuya H, Chen C, Batzer MA, Dejong PJ

15.2.138 Ito T, et al. (1992) Sequence-specific DNA purification by triplex affinity capture

DNA isolation technique developed by Charles Cantor and colleagues.

Ito T, et al. Sequence-specific DNA purification by triplex affinity capture. Proceedings of the National Academy of Sciences of the United States of America 1992.89(2):495-8. Epub 1992/01/15. PubMed PMID: 1731318; PMCID: PMC48265.http://www.ncbi.nlm.nih.gov/pmc/articles/PMC48265

Type of reference	Article
Authors	Ito T, Smith CL, Cantor CR

15.2.139 Jacob HJ, et al. (1995) A genetic linkage map of the laboratory rat, rattus norvegicus

Genetic linkage map of the lab rat, a useful mammalian model organism in its own right, from the Whitehead Institute.

Jacob HJ, et al. A genetic linkage map of the laboratory rat, rattus norvegicus. Nature genetics 1995.9(1):63-9. Epub 1995/01/01. doi: 10.1038/ng0195-63. PubMed PMID: 7704027.

Type of reference	Article
Authors	Jacob HJ, Brown DM, Bunker RK, Daly MJ, Dzau VJ, Goodman A, Koike G, Kren V, Kurtz T, Lernmark A, Levan G, Mao Y, Pettersson A, Pravenec M, Simon JS, Szpirer C, Szpirer J, Trolliet MR, Winer ES, Lander ES

15.2.140 Jeffreys AJ, et al. (1985) Hypervariable 'minisatellite' regions in human DNA

A serendipitous finding in September 1984 by Sir Alec Jeffreys (Leciester, UK) leads to the discovery of DNA fingerprinting and a myriad of scientific, medical and forensic applications.

Jeffreys AJ, et al. Hypervariable 'minisatellite' regions in human DNA. Nature. 1985;314(6006):67-73. DOI: 10.1038/314067a0. PMID: 3856104

Type of reference	Article
Authors	Jeffreys AJ, Wilson V, Thein SL

15.2.141 Jordan E, Carrico C (1982) DNA database

Creation of a universal database for DNA sequences.

Jordan E, Carrico C. DNA database. Science. 1982;218(4568):108- DOI: 10.1126/science.7123222, PMID: 7123222

Type of reference	Article
Authors	Jordan E, Carrico C

15.2.142 Kalidas S, Smith DP. (2002) Novel genomic cDNA hybrids produce effective RNA interference in adult Drosophila

A simple strategy to knock out gene function in Drosophila.

Kalidas S, Smith DP. Novel genomic cDNA hybrids produce effective RNA interference in adult Drosophila. Neuron 2002.33(2):177-84. Epub 2002/01/24. PubMed PMID: 11804566.

Type of reference	Article
Authors	Kalidas S, Smith DP

15.2.143 Kaminker JS, et al. (2002) The transposable elements of the Drosophila melanogaster euchromatin: A genomics perspective

Characterization of nearly 100 transposable element gene families in Drosophila.

Kaminker JS, et al. The transposable elements of the Drosophila melanogaster euchromatin: A genomics perspective. Genome Biology 2002.3(12):Research0084. Epub 2003/01/23. PubMed PMID: 12537573; PMCID: PMC151186.

Type of reference	Article
Authors	Kaminker JS, Bergman CM, Kronmiller B, Carlson J, Svirskas R, Patel S, Frise E, Wheeler DA, Lewis SE, Rubin GM, Ashburner M, Celniker SE

15.2.144 Kan YW, Dozy AM (1978) Antenatal diagnosis of sickle-cell anemia by DNA analysis of amniotic-fluid cells

Kan and Dozy describe the first use of a linked DNA marker for prenatal diagnosis, in the case of a child with beta-thalassemia.

Kan, Y. W., and Dozy, A. M., 1978a, Antenatal diagnosis of sickle-cell anemia by DNA analysis of amniotic-fluid cells, Lancet 2:910.

Type of reference	Article
Authors	Kan YW, Dozy AM

15.2.145 Karolchik D, et al. (2003) The UCSC genome browser database

Account of the UC Santa Cruz genome browser database, which was developed just in time for the initial human genome announcement in June 2000.

Karolchik D, et al. The UCSC genome browser database. Nucleic Acids Research 2003.31(1):51-4. Epub 2003/01/10. PubMed PMID: 12519945; PMCID: PMC165576.

Type of reference	Article
Authors	Karolchik D, Baertsch R, Diekhans M, Furey TS, Hinrichs A, Lu YT, Roskin KM, Schwartz M, Sugnet CW, Thomas DJ, Weber RJ, Haussler D, Kent WJ

15.2.146 Kasianowicz JJ, et al. (1996) Characterization of individual polynucleotide molecules using a membrane channel

Passage of single-stranded DNA through a membrane-bound bacterial nanopore proposed as novel method for DNA sequencing.

Kasianowicz JJ, Brandin E, Branton D, Deamer DW. Characterization of individual polynucleotide molecules using a membrane channel. Proc Natl Acad Sci U S A. 1996 Nov 26;93(24):13770-3.

Type of reference	Article
Authors	Kasianowicz JJ, Brandin E, Branton D, Deamer DW

15.2.147 Kaul S, et al. (2000) Analysis of the genome sequence of the flowering plant arabidopsis thaliana

Draft genome sequence of Arabidopsis, a hugely important plant model organisms (125 Mb).

Kaul S, et al. Analysis of the genome sequence of the flowering plant arabidopsis thaliana. Nature. 2000;408(6814):796-815. DOI: 10.1038/35048692, PMID: 11130711

Type of reference	Article
Authors	Kaul S, Koo HL, Jenkins J, Rizzo M, Rooney T, Tallon LJ, Feldblyum T, Nierman W, Benito MI, Lin XY, Town CD, Venter JC, Fraser CM, Tabata S, Nakamura Y, Kaneko T, Sato S, Asamizu E, Kato T, Kotani H, Sasamoto S, Ecker JR, Theologis A, Federspiel NA, Palm CJ, Osborne BI, Shinn P, Conway AB, Vysotskaia VS, Dewar K, Conn L, Lenz CA, Kim CJ, Hansen NF, Liu SX, Buehler E, Altafi H, Sakano H, Dunn P, Lam B, Pham PK, Chao Q, Nguyen M, Yu GX, Chen HM, Southwick A, Lee JM, Miranda M, Toriumi MJ, Davis RW, Wambutt R, Murphy G, Dusterhoft A, Stiekema W, Pohl T, Entian KD, Terryn N, Volckaert G, Salanoubat M, Choisne N, Rieger M, Ansorge W, Unseld M, Fartmann B, Valle G, Artiguenave F, Weissenbach J, Quetier F, Wilson RK, de la Bastide M, Sekhon M, Huang E, Spiegel L, Gnoj L, Pepin K, Murray J, Johnson D, Habermann K, Dedhia N, Parnell L, Preston R, Hillier L, Chen E, Marra M, Martienssen R, McCombie WR, Mayer K, White O, Bevan M, Lemcke K, Creasy TH, Bielke C, Haas B, Haase D, Maiti R, Rudd S, Peterson J, Schoof H, Frishman D, Morgenstern B, Zaccaria P, Ermolaeva M, Pertea M, Quackenbush J, Volfovsky N, Wu DY, Lowe TM, Salzberg SL, Mewes HW, Rounsley S, Bush D, Subramaniam S, Levin I, Norris S, Schmidt R, Acarkan A, Bancroft I, Brennicke A, Eisen JA, Bureau T, Legault BA, Le QH, Agrawal N, Yu Z, Copenhaver GP, Luo S, Pikaard CS, Preuss D, Paulsen IT, Sussman M, Britt AB, Selinger DA, Pandey R, Mount DW, Chandler VL, Jorgensen RA, Pikaard C, Juergens G, Meyerowitz EM, Dangl J, Jones JDG, Chen M, Chory J, Somerville MC, (The Arabidopsis Genome Initiative)

15.2.148 Kaye J, et al. (2012) ELSI 2.0 for genomics and society

A call for ELSI research to become more coordinated, responsive to societal needs, and better able to apply the knowledge it produces around the world.

Kaye J, et al. ELSI 2.0 for genomics and society. Science. 2012 May 11;336(6082):673-4. DOI: 10.1126/science.1218015. PMID: 22582247

Type of reference	Article
Authors	Kaye J, Meslin EM, Knoppers BM, Juengst ET, Deschênes M, Cambon-Thomsen A, Chalmers D, De Vries J, Edwards K, Hoppe N, Kent A, Adebamowo C, Marshall P, Kato K

15.2.149 Kelley JM et al. (1999) High throughput direct end sequencing of BAC clones

Sequencing of the ends of bacterial artificial chromosome inserts, as an aid to shotgun sequencing genome assembly.

JM Kelley, CE Field, MB Craven, D Bocskai, UJ Kim, SD Rounsley, and MD Adams. High throughput direct end sequencing of BAC clones. Nucleic Acids Res. 1999 Mar 15; 27(6): 1539–1546. PMCID: PMC148350

Type of reference	Article
Authors	JM Kelley, CE Field, B Craven, D Bocskai, UJ Kim, SD Rounsley, and MD Adams

15.2.150 Kelly TJ, Smith HO (1970) A restriction enzyme from Hemophilus-influenzae 2. Base sequence of recognition site

Characterization of the first specific restriction enzyme by Ham Smith and T.J. Kelly, which would earn Smith the Nobel Prize..

Kelly TJ, Smith HO. A restriction enzyme from Hemophilus-influenzae 2. Base sequence of recognition site. Journal of Molecular Biology. 1970;51(2):393-&. DOI: 10.1016/0022-2836(70)90150-6. PMID: 5312501

Type of reference	Article
Authors	Kelly TJ, Smith HO

15.2.151 Kendrew JC, et al (1958) A Three-dimensional model of the myoglobin molecule obtained by x-ray analysis

The X-Ray crystal structure of myogobin is solved by Crick and Watson's Cavendish Laboratory colleagues, J.C. Kendrew and coworkers.

Kendrew JC, et al. A Three-dimensional model of the myoglobin molecule obtained by x-ray analysis. Nature. 1958;181(4610):662-6. DOI: 10.1038/181662a0. PMID: 13517261

Type of reference	Article
Authors	Kendrew JC, Bodo G, Dintzis HM, Parrish RG, Wyckoff H, Phillips DC
Keywords	Hemoglobins

15.2.152 Kerem B, et al. (1989) Identification of the cystic fibrosis gene: genetic analysis

Historic discovery of the cystic fibrosis gene on chromosome 7 by Lap-Chee Tsui, Francis Collins and colleagues.

Kerem B, Rommens JM, Buchanan JA, Markiewicz D, Cox TK, Chakravarti A, Buchwald M, Tsui LC. (1989) Identification of the cystic fibrosis gene: genetic analysis. Science. 1989 Sep 8;245(4922):1073-80.

Type of reference	Article
Authors	Kerem B, Rommens JM, Buchanan JA, Markiewicz D, Cox TK, Chakravarti A, Buchwald M, Tsui LC

15.2.153 Kevles DJ (1994) Ananda Chakrabarty wins a patent: Biotechnology, law, and society, 1972-1980

Analysis by science historian Daniel Kevles of a milestone in biotech gene patents.

Kevles DJ. Ananda Chakrabarty wins a patent: Biotechnology, law, and society, 1972-1980. Historical studies in the physical and biological sciences : HSPS / Office of History of Science and Technology, University of California, Berkeley. 1994;25(Pt 1):111-35. PMID: 11639955

Type of reference	Article
Authors	Kevles DJ

15.2.154 Kidd JM, et al. (2008) Mapping and sequencing of structural variation from eight human genomes

Characterization of copy number variation in multiple human genomes.

Kidd JM, et al. Mapping and sequencing of structural variation from eight human genomes. Nature. 2008;453(7191):56-64. DOI: 10.1038/nature06862. PMID: 18451855

Type of reference	Article
Authors	Kidd JM, Cooper GM, Donahue WF, Hayden HS, Sampas N, Graves T, Hansen N, Teague B, Alkan C, Antonacci F, Haugen E, Zerr T, Yamada NA, Tsang P, Newman TL, Tuzun E, Cheng Z, Ebling HM, Tusneem N, David R, Gillett W, Phelps KA, Weaver M, Saranga D, Brand A, Tao W, Gustafson E, McKernan K, Chen L, Malig M, Smith JD, Korn JM, McCarroll SA, Altshuler DA, Peiffer DA, Dorschner M, Stamatoyannopoulos J, Schwartz D, Nickerson DA, Mullikin JC, Wilson RK, Bruhn L, Olson MV, Kaul R, Smith DR, Eichler EE

15.2.155 Kim UJ, et al. (1992) Stable propagation of cosmid sized human DNA inserts in an f factor based vector

Improvements in the stability of cosmid libraries in the early years of the Human Genome Project.

Kim UJ, et al. Stable propagation of cosmid sized human DNA inserts in an f factor based vector. Nucleic acids research 1992.20(5):1083-5. Epub 1992/03/11. PubMed PMID: 1549470; PMCID: PMC312094.http://www.ncbi.nlm.nih.gov/pmc/articles/PMC312094

Type of reference	Article
Authors	Kim UJ, Shizuya H, de Jong PJ, Birren B, Simon MI

15.2.156 Kim UJ, et al. (1996) Construction and characterization of a human bacterial artificial chromosome library

Progress in the utilization of bacterial artificial chromosomes as gene cloning vectors.

Kim UJ, et al. Construction and characterization of a human bacterial artificial chromosome library. Genomics 1996.34(2):213-8. Epub 1996/06/01. doi: 10.1006/geno.1996.0268. PubMed PMID: 8661051.http://dx.doi.org/10.1006/geno.1996.0268

Type of reference	Article
Authors	Kim UJ, Birren BW, Slepak T, Mancino V, Boysen C, Kang HL, Simon MI, Shizuya H

15.2.157 Klenk HP, et al. (1997) The complete genome sequence of the hyperthermophilic, sulphate-reducing archaeon archaeoglobus fulgidus

Genome sequence and characterization of a hyperthermophilic Archaeon genome.

Klenk HP, et al. The complete genome sequence of the hyperthermophilic, sulphate-reducing archaeon archaeoglobus fulgidus. Nature 1997.390(6658):364-70. Epub 1997/12/06. doi: 10.1038/37052. PubMed PMID: 9389475.http://dx.doi.org/10.1038/37052

Type of reference	Article
Authors	Klenk HP, Clayton RA, Tomb JF, White O, Nelson KE, Ketchum KA, Dodson RJ, Gwinn M, Hickey EK, Peterson JD, Richardson DL, Kerlavage AR, Graham DE, Kyrpides NC,

	Fleischmann RD, Quackenbush J, Lee NH, Sutton GG, Gill S, Kirkness EF, Dougherty BA, McKenney K, Adams MD, Loftus B, Peterson S, Reich CI, McNeil LK, Badger JH, Glodek A, Zhou L, Overbeek R, Gocayne JD, Weidman JF, McDonald L, Utterback T, Cotton MD, Spriggs T, Artiach P, Kaine BP, Sykes SM, Sadow PW, D'Andrea KP, Bowman C, Fujii C, Garland SA, Mason TM, Olsen GJ, Fraser CM, Smith HO, Woese CR, Venter JC

15.2.158 Knowlton RG, et al. (1985) A polymorphic DNA marker linked to cystic fibrosis is located on chromosome 7.

One of several studies published simultaneously that located the gene mutated in cystic fibrosis to the long arm of chromosome 7.

Knowlton RG, Cohen-Haguenauer O, Van Cong N, Frézal J, Brown VA, Barker D, Braman JC, Schumm JW, Tsui LC, Buchwald M, et al. (1985) A polymorphic DNA marker linked to cystic fibrosis is located on chromosome 7. Nature. 1985 Nov 28-Dec 4;318(6044):380-2.

Type of reference	Article
Authors	Knowlton RG, Cohen-Haguenauer O, Van Cong N, Frézal J, Brown VA, Barker D, Braman JC, Schumm JW, Tsui LC, Buchwald M, et al

15.2.159 Kogelnik AM, et al. (1998) Mitomap: A human mitochondrial genome database--1998 update

A database for human mitochondrial DNA.

Kogelnik AM, et al. Mitomap: A human mitochondrial genome database--1998 update. Nucleic acids research 1998.26(1):112-5. Epub 1998/02/21. PubMed PMID: 9399813; PMCID: PMC147233

Type of reference	Article
Authors	Kogelnik AM, Lott MT, Brown MD, Navathe SB, Wallace DC

15.2.160 Krauter K, et al. (1995) A second-generation YAC contig map of human chromosome 12

A detailed physical map of chromosome 12 using yeast artificial chromosomes.

Krauter K, et al. A second-generation YAC contig map of human chromosome 12. Nature. 1995;377(6547 Suppl):321-33. Epub 1995/09/28. DOI: 10.1038/377321a0. PMID: 7566099

Type of reference	Article
Authors	Krauter K, Montgomery K, Yoon SJ, LeBlanc-Straceski J, Renault B, Marondel I, Herdman V, Cupelli L, Banks A, Lieman J

15.2.161 Kundaje A, et al. (2015) Integrative analysis of 111 reference human epigenomes

111 reference human epigenomes profiled for histone modification patterns, DNA accessibility, DNA methylation and RNA expression. See full collection of related articles in "The Epigenome Roadmap": http://www.nature.com/collections/vbqgtr

Kundaje A, et al. Integrative analysis of 111 reference human epigenomes. Nature. 2015;518(7539):317-30. DOI: 10.1038/nature14248. PMID: 25693563

Type of reference	Article
Authors	Kundaje A, Meuleman W, Ernst J, Bilenky M, Yen A, Heravi-Moussavi A, Kheradpour P, Zhang Z, Wang J, Ziller MJ, Amin V, Whitaker JW, Schultz MD, Ward LD, Sarkar A, Quon G, Sandstrom RS, Eaton ML, Wu YC, Pfenning AR, Wang X, Claussnitzer M, Liu Y, Coarfa C, Harris RA, Shoresh N, Epstein CB, Gjoneska E, Leung D, Xie W, Hawkins RD, Lister R, Hong C, Gascard P, Mungall AJ, Moore R, Chuah E, Tam A, Canfield TK, Hansen RS, Kaul R, Sabo PJ, Bansal MS, Carles A, Dixon JR, Farh KH, Feizi S, Karlic R, Kim AR, Kulkarni A, Li D, Lowdon R, Elliott G, Mercer TR, Neph SJ, Onuchic V, Polak P, Rajagopal N, Ray P, Sallari RC, Siebenthall KT, Sinnott-Armstrong NA, Stevens M, Thurman RE, Wu J, Zhang B, Zhou X, Beaudet AE, Boyer LA, De Jager PL, Farnham PJ, Fisher SJ, Haussler D, Jones SJM, Li W, Marra MA, McManus MT, Sunyaev S, Thomson JA, Tlsty TD, Tsai LH, Wang W, Waterland RA, Zhang MQ, Chadwick LH, Bernstein BE, Costello JF, Ecker JR, Hirst M, Meissner A, Milosavljevic A, Ren B, Stamatoyannopoulos JA, Wang T, Kellis M, Roadmap Epigenomics C

15.2.162 Kunkel LM, et al. (1986) Analysis of deletions in DNA from patients with Becker and Duchenne muscular dystrophy

Key study from Kunkel's team in pinpointing the gene mutated in two forms of inherited X-linked muscular dystrophy.

Kunkel LM, et al. Analysis of deletions in DNA from patients with Becker and Duchenne muscular dystrophy. Nature. 1986;322(6074):73-7. DOI: 10.1038/322073a0. PMID: 3014348

Type of reference	Article
Authors	Kunkel LM, Hejtmancik JF, Caskey CT, Speer A, Monaco AP, Middlesworth W, Colletti CA, Bertelson C, Muller U, Bresan M, Shapiro F, Tantravahi U, Speer J, Latt SA, Bartlett R, Pericak-Vance MA, Roses AD, Thompson WV, Ray PN, Worton RG, Fischbeck KH, Gallano P, Coulon M, Duros C, Boue J, Junien C, Chelly J, Hamard G, Jeanpierre M, Lambert M, Kaplan JC, Emery A, Dorkins H, McGlade S, Davies KE, Boehm C, Arveiler B, Lemaire C, Morgan GJ, Denton MJ, Amos J, Bobrow M, Benham F, Boswinkel E, Cole C, Dubowitz V, Hart K, Hodgson S, Johnson L, Walker A, Roncuzzi L, Ferlini A, Nobile C, Romeo G, Wilcox DE, Affara NA, Ferguson-Smith MA, Lindolf M, Kaariainen H, De La Chapelle A, Ionasescu V, Searby C, Ionasescu R, Bakker E, Von Ommen GJ, Pearson PL, Greenberg CR, Hamerton JL, Wrogemann K, Doherty RA, Polakowska R, Hyser C, Quirk S, Thomas N, Harper JF, Darras BT, Francke U.

15.2.163 Lai EC, et al. (2003) Computational identification of Drosophila microrna genes

Lai EC, et al. Computational identification of Drosophila microrna genes. Genome biology 2003.4(7):R42. Epub 2003/07/08. doi: 10.1186/gb-2003-4-7-r42. PubMed PMID: 12844358; PMCID: PMC193629.

Type of reference	Article
Authors	Lai EC, Tomancak P, Williams RW, Rubin GM

15.2.164 Lander ES, et al. (2001) Initial sequencing and analysis of the human genome

The first draft of the human genome sequence, produced by the International Human Genome Sequencing Consortium led by NIH and DOE, featuring contributions from the UK, France, Germany, Japan, China, and elsewhere.

Lander ES, et al. Initial sequencing and analysis of the human genome. Nature. 2001;409(6822):860-921. DOI: 10.1038/35057062. PMID: 11237011

Type of reference	Article
Authors	Lander ES, Int Human Genome Sequencing C, Linton LM, Birren B, Nusbaum C, Zody MC, Baldwin J, Devon K, Dewar K, Doyle M, FitzHugh W, Funke R, Gage D, Harris K, Heaford A, Howland J, Kann L, Lehoczky J, LeVine R, McEwan P, McKernan K, Meldrim J, Mesirov JP, Miranda C, Morris W, Naylor J, Raymond C, Rosetti M, Santos R, Sheridan A, Sougnez C, Stange-Thomann N, Stojanovic N, Subramanian A, Wyman D, Rogers J, Sulston J, Ainscough R, Beck S, Bentley D, Burton J, Clee C, Carter N, Coulson A, Deadman R, Deloukas P, Dunham A, Dunham I, Durbin R, French L, Grafham D, Gregory S, Hubbard T, Humphray S,

	Hunt A, Jones M, Lloyd C, McMurray A, Matthews L, Mercer S, Milne S, Mullikin JC, Mungall A, Plumb R, Ross M, Shownkeen R, Sims S, Waterston RH, Wilson RK, Hillier LW, McPherson JD, Marra MA, Mardis ER, Fulton LA, Chinwalla AT, Pepin KH, Gish WR, Chissoe SL, Wendl MC, Delehaunty KD, Miner TL, Delehaunty A, Kramer JB, Cook LL, Fulton RS, Johnson DL, Minx PJ, Clifton SW, Hawkins T, Branscomb E, Predki P, Richardson P, Wenning S, Slezak T, Doggett N, Cheng JF, Olsen A, Lucas S, Elkin C, Uberbacher E, Frazier M, Gibbs RA, Muzny DM, Scherer SE, Bouck JB, Sodergren EJ, Worley KC, Rives CM, Gorrell JH, Metzker ML, Naylor SL, Kucherlapati RS, Nelson DL, Weinstock GM, Sakaki Y, Fujiyama A, Hattori M, Yada T, Toyoda A, Itoh T, Kawagoe C, Watanabe H, Totoki Y, Taylor T, Weissenbach J, Heilig R, Saurin W, Artiguenave F, Brottier P, Bruls T, Pelletier E, Robert C, Wincker P, Rosenthal A, Platzer M, Nyakatura G, Taudien S, Rump A, Yang HM, Yu J, Wang J, Huang GY, Gu J, Hood L, Rowen L, Madan A, Qin SZ, Davis RW, Federspiel NA, Abola AP, Proctor MJ, Myers RM, Schmutz J, Dickson M, Grimwood J, Cox DR, Olson MV, Kaul R, Shimizu N, Kawasaki K, Minoshima S, Evans GA, Athanasiou M, Schultz R, Roe BA, Chen F, Pan HQ, Ramser J, Lehrach H, Reinhardt R, McCombie WR, de la Bastide M, Dedhia N, Blocker H, Hornischer K, Nordsiek G, Agarwala R, Aravind L, Bailey JA, Bateman A, Batzoglou S, Birney E, Bork P, Brown DG, Burge CB, Cerutti L, Chen HC, Church D, Clamp M, Copley RR, Doerks T, Eddy SR, Eichler EE, Furey TS, Galagan J, Gilbert JGR, Harmon C, Hayashizaki Y, Haussler D, Hermjakob H, Hokamp K, Jang WH, Johnson LS, Jones TA, Kasif S, Kaspryzk A, Kennedy S, Kent WJ, Kitts P, Koonin EV, Korf I, Kulp D, Lancet D, Lowe TM, McLysaght A, Mikkelsen T, Moran JV, Mulder N, Pollara VJ, Ponting CP, Schuler G, Schultz JR, Slater G, Smit AFA, Stupka E, Szustakowki J, Thierry-Mieg D, Thierry-Mieg J, Wagner L, Wallis J, Wheeler R, Williams A, Wolf YI, Wolfe KH, Yang SP, Yeh RF, Collins F, Guyer MS, Peterson J, Felsenfeld A, Wetterstrand KA, Patrinos A, Morgan MJ, Int Human Genome Sequencing C

15.2.165 Lewis BP, et al. (2003) Evidence for the widespread coupling of alternative splicing and nonsense-mediated mRNA decay in humans

Analysis of regulation of protein expression via mechanism involving nonsense-mediated mRNA decay.

Lewis BP, et al. Evidence for the widespread coupling of alternative splicing and nonsense-mediated mRNA decay in humans. Proceedings of the National Academy of Sciences of the United States of America 2003.100(1):189-92. Epub 2002/12/28. doi: 10.1073/pnas.0136770100. PubMed PMID: 12502788; PMCID: PMC140922.

Type of reference	Article
Authors	Lewis BP, Green RE, Brenner SE

15.2.166 Ley TJ, et al. (2008) DNA sequencing of a cytogenetically normal acute myeloid leukaemia genome

The first sequencing of a cancer genome--a patient with acute myeloid leukemia--notable in its own right and for the discovery of a handful of novel cancer mutations.

Ley TJ, et al. DNA sequencing of a cytogenetically normal acute myeloid leukaemia genome. Nature. 2008;456(7218):66-72. DOI: 10.1038/nature07485. PMID: 18987736

Type of reference	Article
Authors	Ley TJ, Mardis ER, Ding L, Fulton B, McLellan MD, Chen K, Dooling D, Dunford-Shore BH, McGrath S, Hickenbotham M, Cook L, Abbott R, Larson DE, Koboldt DC, Pohl C, Smith S, Hawkins A, Abbott S, Locke D, Hillier LW, Miner T, Fulton L, Magrini V, Wylie T, Glasscock J, Conyers J, Sander N, Shi XQ, Osborne JR, Minx P, Gordon D, Chinwalla A, Zhao Y, Ries RE, Payton JE, Westervelt P, Tomasson MH, Watson M, Baty J, Ivanovich J, Heath S, Shannon WD, Nagarajan R, Walter MJ, Link DC, Graubert TA, DiPersio JF, Wilson RK

15.2.167 Liao GC, et al. (2000) Insertion site preferences of the P transposable element in Drosophila melanogaster

Characterization of more than 2,000 P element insertion sites.

Liao GC, et al. Insertion site preferences of the P transposable element in Drosophila melanogaster. Proceedings of the National Academy of Sciences of the United States of America 2000.97(7):3347-51. Epub 2000/03/15. doi: 10.1073/pnas.050017397. PubMed PMID: 10716700; PMCID: PMC16242.

Type of reference	Article
Authors	Liao GC, Rehm EJ, Rubin GM

15.2.168 Loman N, et al. (2015) A complete bacterial genome assembled de novo using only nanopore sequencing data

New correction methods featured in de novo assembly of E. coli genome from a single nanopore contig (99.5% accuracy).

Loman N, et al. A complete bacterial genome assembled de novo using only nanopore sequencing data. Nat Methods. 2015;12(8):733-5. DOI: 10.1038/nmeth.3444. PMID: 26076426

Type of reference	Article
Authors	Loman N, Quick J, Simpson J

15.2.169 Loots GG, et al. (2002) rVista for comparative sequence-based discovery of functional transcription factor binding sites

Computational tool for identification of transcription factor binding sites.

Loots GG, et al. rVista for comparative sequence-based discovery of functional transcription factor binding sites. Genome research 2002.12(5):832-9. Epub 2002/05/09. doi: 10.1101/gr.225502. Article published online before print in April 2002. PubMed PMID: 11997350; PMCID: PMC186580. . Article published online before print in April 2002;

Type of reference	Article
Authors	Loots GG, Ovcharenko I, Pachter L, Dubchak I, Rubin EM

15.2.170 MacDonald ME, et al. (1993) A novel gene containing a trinucleotide repeat that is expanded and unstable on Huntingtons-disease chromosomes

The Huntington's Disease Collaborative Research consortium identifies the Huntington's disease gene and the triplet repeat expansion 10 years after the gene was mapped to chromosome 4.

MacDonald ME, et al. A novel gene containing a trinucleotide repeat that is expanded and unstable on Huntingtons-disease chromosomes. Cell. 1993;72(6):971-83. DOI: 10.1016/0092-8674(93)90585-E. PMID: 8458085

Type of reference	Article
Authors	Macdonald ME, Ambrose CM, Duyao MP, Myers RH, Lin C, Srinidhi L, Barnes G, Taylor SA, James M, Groot N, Macfarlane H, Jenkins B, Anderson MA, Wexler NS, Gusella JF, Bates GP, Baxendale S, Hummerich H, Kirby S, North M, Youngman S, Mott R, Zehetner G, Sedlacek Z, Poustka A, Frischauf AM, Lehrach H, Buckler AJ, Church D, Doucettestamm L, Odonovan MC, Ribaramirez L, Shah M, Stanton VP, Strobel SA, Draths KM, Wales JL, Dervan P, Housman DE, Altherr M, Shiang R, Thompson L, Fielder T, Wasmuth JJ, Tagle D, Valdes J, Elmer L, Allard M, Castilla L, Swaroop M, Blanchard K, Collins FS, Snell R, Holloway T, Gillespie K, Datson N, Shaw D, Harper PS

15.2.171 Maglott DR, et al. (2000) NCBI's LocusLink and RefSeq

Two NCBI web resources for gene analysis.

Maglott DR, et al. NCBI's LocusLink and RefSeq. Nucleic Acids Res. 2000;28(1):126-8. DOI: 10.1093/nar/28.1.126. PMID: 10592200

Type of reference	Article
Authors	Maglott DR, Katz KS, Sicotte H, Pruitt KD

15.2.172 Mardis, ER. (2011) A decade's perspective on DNA sequencing technology

A review on advances in next-gen sequencing technology on the 10th anniversary of the first draft of the Human Genome Project from one of the leaders in cancer genomics.

Mardis, ER. (2011) A decade's perspective on DNA sequencing technology. Nature. 2011 Feb 10;470(7333):198-203. doi: 10.1038/nature09796.

Type of reference	Article
Authors	Mardis, ER

15.2.173 Martin-Gallardo A, et al. (1992) Automated DNA sequencing and analysis of 106 kilobases from human chromosome 19q13.3

Craig Venter and colleagues publish the sequence of a 100-kb stretch of chromosome 19, at the time the largest contiguous stretch of genomic DNA using automated Sanger sequencing, in the inaugural issue of *Nature Genetics*.

Martin-Gallardo A, McCombie WR, Gocayne JD, FitzGerald MG, Wallace S, Lee BM, Lamerdin J, Trapp S, Kelley JM, Liu LI, et al. Automated DNA sequencing and analysis of 106 kilobases from human chromosome 19q13.3. Nat Genet. 1992 Apr;1(1):34-9.

Type of reference	Article
Authors	Martin-Gallardo A, McCombie WR, Gocayne JD, FitzGerald MG, Wallace S, Lee BM, Lamerdin J, Trapp S, Kelley JM, Liu LI

15.2.174 Martin J, et al. (2004) The sequence and analysis of duplication-rich human chromosome 16

The sequence of human chromosome 16.

Martin J, et al. The sequence and analysis of duplication-rich human chromosome 16. Nature. 2004;432(7020):988-94. DOI: 10.1038/nature03187. PMID: 15616553

Type of reference	Article
Authors	Martin J, Han C, Gordon LA, Terry A, Prabhakar S, She XW, Xie G, Hellsten U, Chan YM, Altherr M, Couronne O, Aerts A, Bajorek E, Black S, Blumer H, Branscomb E, Brown NC, Bruno WJ, Buckingham JM, Callen DF, Campbell CS, Campbell ML, Campbell EW, Caoile C, Challacombe JF, Chasteen LA, Chertkov O, Chi HC, Christensen M, Clark LM, Cohn JD, Denys M, Detter JC, Dickson M, Dimitrijevic-Bussod M, Escobar J, Fawcett JJ, Flowers D, Fotopulos D, Glavina T, Gomez M, Gonzales E, Goodstein D, Goodwin LA, Grady DL, Grigoriev I, Groza M, Hammon N, Hawkins T, Haydu L, Hildebrand CE, Huang W, Israni S, Jett J, Jewett PB, Kadner K, Kimball H, Kobayashi A, Krawczyk MC, Leyba T, Longmire JL, Lopez F, Lou YN, Lowry S, Ludeman T, Manohar CF, Mark GA, McMurray KL, Meincke LJ, Morgan J, Moyzis RK, Mundt MO, Munk AC, Nandkeshwar RD, Pitluck S, Pollard M, Predki P, Parson-Quintana B, Ramirez L, Rash S, Retterer J, Ricke DO, Robinson DL, Rodriguez A, Salamov A, Saunders EH, Scott D, Shough T, Stallings RL, Stalvey M, Sutherland RD, Tapia R, Tesmer JG, Thayer N, Thompson LS, Tice H, Torney DC, Tran-Gyamfi M, Tsai M, Ulanovsky LE, Ustaszewska A, Vo N, White PS, Williams AL, Wills PL, Wu JR, Wu K, Yang J, DeJong P, Bruce D, Doggett NA, Deaven L, Schmutz J, Grimwood J, Richardson P, Rokhsar DS, Eichler EE, Gilna P, Lucas SM, Myers RM, Rubin EM, Pennacchio LA

15.2.175 Maugh II TH (1986) Caltech scientists develop super-fast DNA analyzer

News story on development of first automated DNA sequencer.

Maugh II TH. Caltech scientists develop super-fast DNA analyzer. Los Angeles Times. 1986 06/12/1986 Available from: http://articles.latimes.com/1986-06-12/news/mn-10208_1_dna-sequence

Type of reference	Article
Authors	Maugh II TH

15.2.176 Maxam AM, Gilbert W (1977) A new method for sequencing DNA

Chemical method for sequencing DNA that earned Maxam and Gilbert a share of the Nobel Prize, but quickly superseded by Sanger's dideoxy approach.

Maxam AM, Gilbert W. A new method for sequencing DNA. Proc Natl Acad Sci U S A. 1977;74(2):560-4. Epub 1977/02/01. PMID: 265521

Type of reference	Article
Authors	Maxam AM, Gilbert W

15.2.177 McCombie WR, et al. (1992) Expressed genes, Alu repeats and polymorphisms in cosmids sequenced from chromosome 4p16.3

Venter and colleagues publish a 100-kb stretch of chromosome 4, milestones to demonstrate the potential of automated Sanger sequencing.

McCombie WR, Martin-Gallardo A, Gocayne JD, FitzGerald M, Dubnick M, Kelley JM, Castilla L, Liu LI, Wallace S, Trapp S, et al. Expressed genes, Alu repeats and polymorphisms in cosmids sequenced from chromosome 4p16.3. Nat Genet. 1992 Aug;1(5):348-53.

Type of reference	Article
Authors	McCombie WR, Martin-Gallardo A, Gocayne JD, FitzGerald M, Dubnick M, Kelley JM, Castilla L, Liu LI, Wallace S, Trapp S

15.2.178 Meselson M, Yuan R (1968) DNA restriction enzyme from E. Coli

Isolation of a non-specific bacterial restriction enzyme.

Meselson M, Yuan R. DNA restriction enzyme from E. Coli. Nature. 1968;217(5134):1110-4. doi: 10.1038/2171110a0. PubMed PMID: 4868368

Type of reference	Article
Authors	Meselson M, Yuan R

15.2.179 Miesfeld R, et al. (1981) A member of a new repeated sequence family which is conserved throughout eukaryotic evolution is found between the human delta-globin and beta-globin genes

Discovery of a new family of repetitive DNA sequence.

Miesfeld R, et al. A member of a new repeated sequence family which is conserved throughout eukaryotic evolution is found between the human delta-globin and beta-globin genes. Nucleic Acids Research. 1981;9(22):5931-47. DOI: 10.1093/nar/9.22.5931. PMID: 6273813

Type of reference	Article
Authors	Miesfeld R, Krystal M, Arnheim N

15.2.180 Miki Y, et al. (1994) A strong candidate for the breast and ovarian cancer susceptibility gene BRCA1

Sasha Kamb and colleagues at Myriad Genetics identify the BRCA1 hereditary breast and ovarian cancer gene on chromosome 17 by positional cloning, after an intense race with Mary-Claire King, Francis Collins and other research groups.

Miki Y, et al. A strong candidate for the breast and ovarian cancer susceptibility gene BRCA1. Science. 1994;266(5182):66-71. DOI: 10.1126/science.7545954. PMID: 7545954

Type of reference	Article
Authors	Miki Y, Swensen J, Shattuckeidens D, Futreal PA, Harshman K, Tavtigian S, Liu QY, Cochran C, Bennett LM, Ding W, Bell R, Rosenthal J, Hussey C, Tran T, McClure M, Frye C, Hattier T, Phelps R, Haugenstrano A, Katcher H, Yakumo K, Gholami Z, Shaffer D, Stone S, Bayer S, Wray C, Bogden R, Dayananth P, Ward J, Tonin P, Narod S, Bristow PK, Norris FH, Helvering L, Morrison P, Rosteck P, Lai M, Barrett JC, Lewis C, Neuhausen S, Cannonalbright L, Goldgar D, Wiseman R, Kamb A, Skolnick MH

15.2.181 Miklos GL, Rubin GM. (1996) The role of the genome project in determining gene function: Insights from model organisms

Commentary on comparative genomics in the early stages of the Human Genome Project.

Miklos GL, Rubin GM. The role of the genome project in determining gene function: Insights from model organisms. Cell 1996.86(4):521-9. Epub 1996/08/23. PubMed PMID: 8752207.http://www.ncbi.nlm.nih.gov/pubmed/8752207

Type of reference	Review article
Authors	Miklos GL, Rubin GM

15.2.182 Mizutani S, Temin HM (1970) An RNA-dependent DNA polymerase in virions of Rous sarcoma virus

The discovery of reverse transcriptase (crucial in complementary DNA libraries) is announced at the CSHL Symposium, 1975.

Mizutani S, Temin HM. An RNA-dependent DNA polymerase in virions of Rous sarcoma virus. Cold Spring Harbor Symposia on Quantitative Biology. 1970;35:847-9

Type of reference	Article
Authors	Mizutani S, Temin HM

15.2.183 Mlodzik M, et al. (1990) The Drosophila seven-up gene, a member of the steroid receptor gene superfamily, controls photoreceptor cell fates

Mlodzik M, et al. The Drosophila seven-up gene, a member of the steroid receptor gene superfamily, controls photoreceptor cell fates. Cell 1990.60(2):211-24. Epub 1990/01/26. PubMed PMID: 2105166.

Type of reference	Article
Authors	Mlodzik M, Hiromi Y, Weber U, Goodman CS, Rubin GM

15.2.184 Monaco AP, et al. (1985) Detection of deletions spanning the Duchenne muscular dystrophy locus using a tightly linked DNA segment

Lou Kunkel and colleagues describe deletions that pinpoint the location of the gene for Duchenne muscular dystrophy.

Monaco AP, Bertelson CJ, Middlesworth W, Colletti CA, Aldridge J, Fischbeck KH, Bartlett R, Pericak-Vance MA, Roses AD, Kunkel LM. (1985) Detection of deletions spanning the Duchenne muscular dystrophy locus using a tightly linked DNA segment. Nature. 1985 Aug 29-Sep 4;316(6031):842-5.

Type of reference	Article
Authors	Monaco AP, Bertelson CJ, Middlesworth W, Colletti CA, Aldridge J, Fischbeck KH, Bartlett R, Pericak-Vance MA, Roses AD, Kunkel LM

15.2.185 Morgan GT (1995) Identification in the human genome of mobile elements spread by DNA-mediated transposition

Identification of two families of mobile elements.

Morgan GT. Identification in the human genome of mobile elements spread by DNA-mediated transposition. Journal of Molecular Biology 1995.254(1):1-5. Epub 1995/11/17. doi: 10.1006/jmbi.1995.0593. PubMed PMID: 7473754.

Type of reference	Article
Authors	Morgan GT

15.2.186 Moyzis RK, et al. (1988) A highly conserved repetitive DNA-sequence, (TTAGGG)n, present at the telomeres of human-chromosomes

Discovery of telomeres, the repetitive motifs at the end of chromosomes, which has profound implications for the biology of cancer and aging.

Moyzis RK, et al. A highly conserved repetitive DNA-sequence, (TTAGGG)n, present at the telomeres of human-chromosomes. Proceedings of the National Academy of Sciences of the United States of America. 1988;85(18):6622-6. DOI: 10.1073/pnas.85.18.6622. PMID: 3413114

Type of reference	Article
Authors	Moyzis RK, Buckingham JM, Cram LS, Dani M, Deaven LL, Jones MD, Meyne J, Ratliff RL, Wu JR

15.2.187 Muller-Hill B (1990) The isolation of the lac repressor

Isolation of the lac repressor.

Muller-Hill B. The isolation of the lac repressor. Bioessays. 1990;12(1):41-3. DOI: 10.1002/bies.950120110. PMID: 2182002

Type of reference	Article
Authors	Muller-Hill B

15.2.188 Mungall AJ, et al. (2003) The DNA sequence and analysis of human chromosome 6

The complete sequence of human chromosome 6.

Mungall AJ, et al. The DNA sequence and analysis of human chromosome 6. Nature. 2003;425(6960):805-11. DOI: 10.1038/nature02055. PMID: 14574404

Type of reference	Article
Authors	Mungall AJ, Palmer SA, Sims SK, Edwards CA, Ashurst JL, Wilming L, Jones MC, Horton R, Hunt SE, Scott CE, Gilbert JGR, Clamp ME, Bethel G, Milne S, Ainscough R, Almeida JP, Ambrose KD, Andrews TD, Ashwell RIS, Babbage AK, Bagguley CL, Bailey J, Banerjee R, Barker DJ, Barlow KF, Bates K, Beare DM, Beasley H, Beasley O, Bird CP, Blakey S, Bray-Allen S, Brook J, Brown AJ, Brown JY, Burford DC, Burrill W, Burton J, Carder C, Carter NP, Chapman JC, Clark SY, Clark G, Clee CM, Clegg S, Cobley V, Collier RE, Collins JE, Colman LK, Corby NR, Coville GJ, Culley KM, Dhami P, Davies J, Dunn M, Earthrowl ME, Ellington AE, Evans KA, Faulkner L, Francis MD, Frankish A, Frankland J, French L, Garner P, Garnett J, Ghori MJR, Gilby LM, Gillson CJ, Glithero RJ, Grafham DV, Grant M, Gribble S, Griffiths C, Griffiths M, Hall R, Halls KS, Hammond S, Harley JL, Hart EA, Heath PD, Heathcott R, Holmes SJ, Howden PJ, Howe KL, Howell GR, Huckle E, Humphray SJ, Humphries MD, Hunt AR, Johnson CM, Joy AA, Kay M, Keenan SJ, Kimberley AM, King A, Laird GK, Langford C, Lawlor S, Leongamornlert DA, Leversha M, Lloyd CR, Lloyd DM, Loveland JE, Lovell J, Martin S, Mashreghi-Mohammadi M, Maslen GL, Matthews L, McCann OT, McLaren SJ, McLay K, McMurray A, Moore MJF, Mullikin JC, Niblett D, Nickerson T, Novik KL, Oliver K, Overton-Larty EK, Parker A, Patel R, Pearce AV, Peck AI, Phillimore B, Phillips S, Plumb RW, Porter KM, Ramsey Y, Ranby SA, Rice CM, Ross MT, Searle SM, Sehra HK, Sheridan E, Skuce CD, Smith S, Smith M, Spraggon L, Squares SL, Steward CA, Sycamore N, Tamlyn-Hall G, Tester J, Theaker AJ, Thomas DW, Thorpe A, Tracey A, Tromans A, Tubby B, Wall M, Wallis JM, West AP, White SS, Whitehead SL, Whittaker H, Wild A, Willey DJ, Wilmer TE, Wood JM, Wray PW, Wyatt JC, Young L, Younger RM, Bentley DR, Coulson A, Durbin R, Hubbard T, Sulston JE, Dunham I, Rogers J, Beck S

15.2.189 Murray BE, et al. (1990) Comparison of genomic DNAs of different enterococcal isolates using restriction endonucleases with infrequent recognition sites

Fingerprinting of bacterial isolates using pulse-field electrophoresis of restriction digests.

Murray BE, et al. Comparison of genomic DNAs of different enterococcal isolates using restriction endonucleases with infrequent recognition sites. Journal of Clinical Microbiology 1990.28(9):2059-63. Epub 1990/09/01. PubMed PMID: 1977766; PMCID: PMC268103.

Type of reference	Article
Authors	Murray BE, Singh KV, Heath JD, Sharma BR, Weinstock GM

15.2.190 Murray BE, et al. (1993) Generation of restriction map of Enterococcus faecalis OG1 and investigation of growth requirements and regions encoding biosynthetic function

Restriction analysis of E. faecalis.

Murray BE, et al. Generation of restriction map of Enterococcus faecalis OG1 and investigation of growth requirements and regions encoding biosynthetic function. Journal of Bacteriology 1993.175(16):5216-23. Epub 1993/08/01. PubMed PMID: 8349561; PMCID: PMC204989.

Type of reference	Article
Authors	Murray BE, Singh KV, Ross RP, Heath JD, Dunny GM, Weinstock GM

15.2.191 Muzny DM, et al. (2006) The DNA sequence, annotation and analysis of human chromosome 3

The sequence and analysis of human chromosome 3.

Muzny DM, et al. The DNA sequence, annotation and analysis of human chromosome 3. Nature. 2006;440(7088):1194-8. DOI: 10.1038/nature04728. PMID: 16641997

Type of reference	Article
Authors	Muzny DM, Scherer SE, Kaul R, Wang J, Yu J, Sudbrak R, Buhay CJ, Chen R, Cree A, Ding Y, Dugan-Rocha S, Gill R, Gunaratne P, Harris RA, Hawes AC, Hernandez J, Hodgson AV, Hume J, Jackson A, Khan ZM, Kovar-Smith C, Lewis LR, Lozado RJ, Metzker ML, Milosavljevic A, Miner GR, Morgan MB, Nazareth LV, Scott G, Sodergren E, Song XZ, Steffen D, Wei S, Wheeler DA, Wright MW, Worley KC, Yuan Y, Zhang ZD, Adams CQ, Ansari-Lari MA, Ayele M, Brown MJ, Chen G, Chen ZJ, Clendenning J, Clerc-Blankenburg KP, Chen RS, Chen Z, Davis C, Delgado O, Dinh HH, Dong W, Draper H, Ernst S, Fu G, Gonzalez-Garay ML, Garcia DK, Gillett W, Gu J, Hao BL, Haugen E, Havlak P, He X, Hennig S, Hu SN, Huang W, Jackson LR, Jacob LS, Kelly SH, Kube M, Levy R, Li ZW, Liu B, Liu J, Liu W, Lu J, Maheshwari M, Nguyen BV, Okwuonu GO, Palmeiri A, Pasternak S, Perez LM, Phelps KA, Plopper FJH, Qiang BQ, Raymond C, Rodriguez R, Saenphimmachak C, Santibanez J, Shen H, Shen Y, Subramanian S, Tabor PE, Verduzco D, Waldron L, Wang QY, Williams GA, Wong GKS, Yao ZJ, Zhang JK, Zhang XQ, Zhao GP, Zhou JL, Zhou Y, Nelson D, Lehrach H, Reinhardt R, Naylor SL, Yang HM, Olson M, Weinstock G, Gibbs RA. The DNA sequence, annotation and analysis of human chromosome 3

15.2.192 Myers EW, et al. (2000) A whole-genome assembly of Drosophila

Detailed analysis of the Drosophila genome sequence assembly produced by the partnership of academic researchers with Celera Genomics.

Myers EW, et al. A whole-genome assembly of Drosophila. Science 2000.287(5461):2196-204. Epub 2000/03/24. PubMed PMID: 10731133.

Type of reference	Article
Authors	Myers EW, Sutton GG, Delcher AL, Dew IM, Fasulo DP, Flanigan MJ, Kravitz SA, Mobarry CM, Reinert KH, Remington KA, Anson EL, Bolanos RA, Chou HH, Jordan CM, Halpern AL, Lonardi S, Beasley EM, Brandon RC, Chen L, Dunn PJ, Lai Z, Liang Y, Nusskern DR, Zhan M, Zhang Q, Zheng X, Rubin GM, Adams MD, Venter JC

15.2.193 Nadeau JH, et al. (2000) Analysing complex genetic traits with chromosome substitution strains

New approach for mapping of quantitative trait loci in mice using a panel of chromosome substitution strains. Each strain has a single chromosome from the donor strain substituting for the corresponding chromosome in the host strain.

Nadeau JH, et al. Analysing complex genetic traits with chromosome substitution strains. Nature genetics 2000.24(3):221-5. Epub 2000/03/04. doi: 10.1038/73427. PubMed PMID: 10700173.http://dx.doi.org/10.1038/73427

Type of reference	Article
Authors	Nadeau JH, Singer JB, Matin A, Lander ES

15.2.194 Nagaraja R, et al. (1997) X chromosome map at 75-Kb STS resolution, revealing extremes of recombination and GC content

High-resolution map of the human X chromosome.

Nagaraja R, et al. X chromosome map at 75-Kb STS resolution, revealing extremes of recombination and GC content. Genome Research. 1997;7(3):210-22. DOI: 10.1101/Gr.7.3.210. PMID: 9074925

Type of reference	Article
Authors	Nagaraja R, MacMillan S, Kere J, Jones C, Griffin S, Schmatz M, Terrell J, Shomaker M, Jermak C, Hott C, Masisi M, Mumm S, Srivastava A, Pilia G, Featherstone T, Mazzarella R, Kesterson S, McCauley B, Railey B, Burough F, Nowotny V, Durso M, States D, Brownstein B, Schlessinger D

15.2.195 National Geographic (2005) National Geographic and IBM Launch Landmark Project to Map How Humankind Populated the Planet

A multiyear research initiative to analyze historical patterns in DNA from volunteers around the world to better understand human genetic roots and population diversity. The Genographic Project marked an early proof-of-principle for consumer genetics.

Type of reference	Press Release
Link	https://genographic.nationalgeographic.com/press/page/4/

15.2.196 Nature (1995) The Genome Directory

Craig Venter's team at TIGR (including Mark Adams, Claire Fraser) published the vast majority of its EST catalogue -- the "Genome Directory." The report was controversial because a small number of ESTs of potential medical relevance were withheld for collaborative studies with Human Genome Sciences, led by William Haseltine.

Nature. Special "Genome Directory" issue of Nature (vol. 377, issue 6547S, 28 September 1995).

Type of reference	Article

15.2.197 Nelson KE, et al. (1999) Evidence for lateral gene transfer between archaea and bacteria from genome sequence of Thermotoga maritima

Genome sequencing of T. maritime by Fraser, Venter and colleagues reveals high gene conservation between the bacterium and Archaea, providing strong evidence of lateral gene transfer.

Nelson KE, et al. Evidence for lateral gene transfer between archaea and bacteria from genome sequence of Thermotoga maritima. Nature 1999.399(6734):323-9. Epub 1999/06/09. doi: 10.1038/20601. PubMed PMID: 10360571.

Type of reference	Article
Authors	Nelson KE, Clayton RA, Gill SR, Gwinn ML, Dodson RJ, Haft DH, Hickey EK, Peterson JD, Nelson WC, Ketchum KA, McDonald L, Utterback TR, Malek JA, Linher KD, Garrett MM, Stewart AM, Cotton MD, Pratt MS, Phillips CA, Richardson D, Heidelberg J, Sutton GG, Fleischmann RD, Eisen JA, White O, Salzberg SL, Smith HO, Venter JC, Fraser CM

15.2.198 NIH/CEPH Collaborative Mapping Group (1992) A comprehensive genetic-linkage map of the human genome

An early low-density genetic map of the human genome, with average DNA marker spacing of 5 cM.

NIH/CEPH Collaborative Mapping Group. A comprehensive genetic-linkage map of the human genome. Science. 1992;258(5079):67-86. DOI: 10.1126/science.1439770. PubMed PMID: 1359639

Type of reference	Article
Authors	Guyer M

15.2.199 NIH/NHGRI (2003) Beyond genes: Scientists venture deeper into the human genome

The ENCODE project is established to identify all the functional elements in the human genome.

Type of reference	Press Release
Link	http://www.eurekalert.org/pub_releases/2003-10/nhgr-bgs100903.php

15.2.200 NIH (2007) Reference Epigenome Mapping Center (REMC) as part of the NIH Roadmap Epigenomics Program

NIH, Reference Epigenome Mapping Center (REMC) as part of the NIH Roadmap Epigenomics Program. 2007. Available as: http://grants.nih.gov/grants/guide/rfa-files/RFA-RM-07-013.html

Type of reference	Article
Authors	NIH

15.2.201 NIH and DOE (1988) Memorandum of Understanding between the National Institutes of Health and the Department of Energy

NIH and DOE (1988) Memorandum of Understanding between the National Institutes of Health and the Department of Energy

Authors	National Institutes of Health and Department of Energy

Link	http://www2.lbl.gov/Workplace/CFO/assets/docs/ospip/OSPIP_Process_Meetings/2008-10/2e_NIH_MOU.pdf

15.2.202 NIH-DOE (1990) Understanding Our Genetic Inheritance. The U.S. Human Genome Project: The First Five Years FY 1991-1995

The 15-year Human Genome Project formally begins. NIH and DOE publish a 5-year plan. Goals include a complete genetic map, a physical map with markers every 100 kb, and sequencing of an aggregate of 20 Mb of DNA in model organisms by 2005.

Type of reference	Article
Link	http://web.ornl.gov/sci/techresources/Human_Genome/project/5yrplan/firstfiveyears.pdf

15.2.203 NIH Methods for Discovering and Scoring Single Nucleotide Polymorphisms.

Forerunner of the HapMap project.

Type of reference	RFA
Link	https://grants.nih.gov/grants/guide/rfa-files/RFA-HG-98-001.html

15.2.204 NIH News Release (2002) International consortium launches genetic variation mapping project

Launch of the $100-million public-private project to catalog single nucleotide polymorphisms in 3 diverse human populations.

NIH News Release. International consortium launches genetic variation mapping project. (10/29/2002) Available at: http://www.nih.gov/news/pr/oct2002/nhgri-29.htm

Type of reference	Article
Authors	NIH News Release

15.2.205 NIH Staff (2008) 'Working Draft' of Human Genome Announced at White House

NIH Staff, 'Working Draft' of Human Genome Announced at White House, NIH Record, August 8, 2008

Type of reference	Article/Press Release

Link	https://nihrecord.nih.gov/newsletters/08_08_2000/story03.htm

15.2.206 Nirenberg M, Matthaei JH (1961) Dependence of cell-free protein synthesis in E. coli upon naturally occurring or synthetic polyribonucleotides

Nirenberg and Matthaei establish that UUU encodes for phenylalanine.

Nirenberg M, Matthaei JH. Dependence of cell-free protein synthesis in e coli upon naturally occurring or synthetic polyribonucleotides. Proceedings of the National Academy of Sciences of the United States of America. 1961;47(10):1588-&. DOI: 10.1073/pnas.47.10.1588. PMID: 14479932

Type of reference	Article
Authors	Nirenberg M, Matthaei JH

15.2.207 Novina CD, et al. (2002) siRNA-directed inhibition of HIV-1 infection

Demonstration of potential therapeutic applications of short interfering RNA by Phil Sharp and coworkers.

Novina CD, et al. siRNA-directed inhibition of HIV-1 infection. Nature medicine 2002.8(7):681-6. Epub 2002/06/04. doi: 10.1038/nm725. PubMed PMID: 12042777.

Type of reference	Article
Authors	Novina CD, Murray MF, Dykxhoorn DM, Beresford PJ, Riess J, Lee SK, Collman RG, Lieberman J, Shankar P, Sharp PA

15.2.208 Nusbaum C, et al. (2005) DNA sequence and analysis of human chromosome 18

The sequence of human chromosome 18.

Nusbaum C, et al. DNA sequence and analysis of human chromosome 18. Nature. 2005;437(7058):551-5. DOI: 10.1038/nature03983. PMID: 16177791

Type of reference	Article
Authors	Nusbaum C, Zody MC, Borowsky ML, Kamal M, Kodira CD, Taylor TD, Whittaker CA, Chang JL, Cuomo CA, Dewar K, FitzGerald MG, Yang XP, Abouelleil A, Allen NR, Anderson S, Bloom T, Bugalter B, Butler J, Cook A, DeCaprio D, Engels R, Garber M, Gnirke A, Hafez N, Hall JL, Norman CH, Itoh T, Jaffe DB, Kuroki Y, Lehoczky J, Lui A, Macdonald P, Mauceli E, Mikkelsen TS, Naylor JW, Nicol R, Nguyen C, Noguchi H, O'Leary SB, Piqani B, Smith CL, Talamas JA, Topham K, Totoki Y, Toyoda A, Wain HM, Young SK, Zeng QD, Zimmer AR, Fujiyama A, Hattori M, Birren BW, Sakaki Y, Lander ES

15.2.209 Nusbaum C, et al. (2006) DNA sequence and analysis of human chromosome 8

The sequence of chromosome 8.

Nusbaum C, et al. DNA sequence and analysis of human chromosome 8. Nature. 2006;439(7074):331-5. DOI: 10.1038/nature04406. PMID: 16421571

Type of reference	Article
Authors	Nusbaum C, Mikkelsen TS, Zody MC, Asakawa S, Taudien S, Garber M, Kodira CD, Schueler MG, Shimizu A, Whittaker CA, Chang JL, Cuomo CA, Dewar K, FitzGerald MG, Yang XP, Allen NR, Anderson S, Asakawa T, Blechschmidt K, Bloom T, Borowsky ML, Butler J, Cook A, Corum B, DeArellano K, DeCaprio D, Dooley KT, Dorris L, Engels R, Glockner G, Hafez N, Hagopian DS, Hall JL, Ishikawa SK, Jaffe DB, Kamat A, Kudoh J, Lehmann R, Lokitsang T, Macdonald P, Major JE, Matthews CD, Mauceli E, Menzel U, Mihalev AH, Minoshima S, Murayama Y, Naylor JW, Nicol R, Nguyen C, O'Leary SB, O'Neill K, Parker SCJ, Polley A, Raymond CK, Reichwald K, Rodriguez J, Sasaki T, Schilhabel M, Siddiqui R, Smith CL, Sneddon TP, Talamas JA, Tenzin P, Topham K, Venkataraman V, Wen GP, Yamazaki S, Young SK, Zeng QD, Zimmer AR, Rosenthal A, Birren BW, Platzer M, Shimizu N, Lander ES

15.2.210 Ober C, et al. (1998) Genome-wide search for asthma susceptibility loci in a founder population. The collaborative study on the genetics of asthma

An early effort in genome wide mapping for loci in a complex trait by focusing on individuals in an isolated founder population.

Ober C, et al. Genome-wide search for asthma susceptibility loci in a founder population. The collaborative study on the genetics of asthma. Human Molecular Genetics 1998.7(9):1393-8. Epub 1998/08/13. PubMed PMID: 9700192.

Type of reference	Article

Authors	Ober C, Cox NJ, Abney M, Di Rienzo A, Lander ES, Changyaleket B, Gidley H, Kurtz B, Lee J, Nance M, Pettersson A, Prescott J, Richardson A, Schlenker E, Summerhill E, Willadsen S, Parry R

15.2.211 Ohler U, et al. (2002) Computational analysis of core promoters in the Drosophila genome

Advances in computational prediction of Drosophila promoter sites.

Ohler U, et al. Computational analysis of core promoters in the Drosophila genome. Genome Biology 2002.3(12):Research0087. Epub 2003/01/23. PubMed PMID: 12537576; PMCID: PMC151189.

Type of reference	Article
Authors	Ohler U, Liao GC, Niemann H, Rubin GM

15.2.212 Olson M, et al. (1989) A common language for physical mapping of the human genome

Maynard Olson, Lee Hood and colleagues propose a new genetic mapping strategy for the human genome using sequence-tagged sites.

Olson M, Hood L, Cantor C, Botstein D. A common language for physical mapping of the human genome. Science. 1989 Sep 29;245(4925):1434-5.

Type of reference	Article
Authors	Olson M, Hood L, Cantor C, Botstein D

15.2.213 Parkhill J, et al. (2000) Complete DNA sequence of a serogroup A strain of Neisseria meningitidis Z2491

Genome sequence of the meningitis pathogen reveals prevalence of repetitive DNA sequences that likely contribute to antigenic variation.

Parkhill J, et al. Complete DNA sequence of a serogroup A strain of Neisseria meningitidis Z2491. Nature 2000.404(6777):502-6. Epub 2000/04/13. doi: 10.1038/35006655. PubMed PMID: 10761919.

Type of reference	Article
Authors	Parkhill J, Achtman M, James KD, Bentley SD, Churcher C, Klee SR, Morelli G, Basham D, Brown D, Chillingworth T, Davies RM, Davis P, Devlin K, Feltwell T, Hamlin N, Holroyd S, Jagels K, Leather S, Moule S, Mungall K, Quail MA, Rajandream MA, Rutherford KM, Simmonds M, Skelton J, Whitehead S, Spratt BG, Barrell BG

15.2.214 Parkhill J, et al. (2001) Genome sequence of yersinia pestis, the causative agent of plague

Parkhill J, et al. Genome sequence of yersinia pestis, the causative agent of plague. Nature 2001.413(6855):523-7. Epub 2001/10/05. doi: 10.1038/35097083. PubMed PMID: 11586360.http://dx.doi.org/10.1038/35097083

Type of reference	Article
Authors	Parkhill J, Wren BW, Thomson NR, Titball RW, Holden MT, Prentice MB, Sebaihia M, James KD, Churcher C, Mungall KL, Baker S, Basham D, Bentley SD, Brooks K, Cerdeno-Tarraga AM, Chillingworth T, Cronin A, Davies RM, Davis P, Dougan G, Feltwell T, Hamlin N, Holroyd S, Jagels K, Karlyshev AV, Leather S, Moule S, Oyston PC, Quail M, Rutherford K, Simmonds M, Skelton J, Stevens K, Whitehead S, Barrell BG

15.2.215 Pearson PL (1991) The genome data base (GDB)--a human gene mapping repository

Creation of the Genome Database (GDB) launched at Johns Hopkins Medical School to store gene mapping data.

Pearson PL. The genome data base (GDB)--a human gene mapping repository. Nucleic Acids Res. 1991;19 Suppl:2237-9. PMID: 2041809

Type of reference	Article
Authors	Pearson PL

15.2.216 Pennacchio LA, Rubin EM. (2001) Genomic strategies to identify mammalian regulatory sequences

Review of computational approaches to identify regulatory gene sequences in mammalian genomes.

Pennacchio LA, Rubin EM. Genomic strategies to identify mammalian regulatory sequences. Nature reviews Genetics 2001.2(2):100-9. Epub 2001/03/17. doi: 10.1038/35052548. PubMed PMID: 11253049.

Type of reference	Review article
Authors	Pennacchio LA, Rubin EM

15.2.217 Pennacchio LA, Rubin EM. (2003) Comparative genomic tools and databases: Providing insights into the human genome

Review of web resources and genome browses for analysis of the draft human genome.

Pennacchio LA, Rubin EM. Comparative genomic tools and databases: Providing insights into the human genome. Journal of Clinical Investigation 2003.111(8):1099-106. Epub 2003/04/17. doi: 10.1172/jci17842. PubMed PMID: 12697725; PMCID: PMC152942.

Type of reference	Review article
Authors	Pennacchio LA, Rubin EM

15.2.218 Pennisi E. (1999) Fruit fly researchers sign pact with Celera

News story on the announcement of a public-private collaboration to sequence the Drosophila genome.

Pennisi E. Fruit fly researchers sign pact with Celera. Science. 1999 Feb 5;283(5403):767.

Type of reference	News story

15.2.219 Perna NT, et al. (2001) Genome sequence of enterohaemorrhagic Escherichia coli O157:H7

Genome sequence of a pathogenic strain of E. coli reveals high degree of lateral gene transfer.

Perna NT, et al. Genome sequence of enterohaemorrhagic Escherichia coli O157:H7. Nature 2001.409(6819):529-33. Epub 2001/02/24. doi: 10.1038/35054089. PubMed PMID: 11206551.

Type of reference	Article
Authors	Perna NT, Plunkett G, 3rd, Burland V, Mau B, Glasner JD, Rose DJ, Mayhew GF, Evans PS, Gregor J, Kirkpatrick HA, Posfai G, Hackett J, Klink S, Boutin A, Shao Y, Miller L, Grotbeck EJ, Davis NW, Lim A, Dimalanta ET, Potamousis KD, Apodaca J, Anantharaman TS, Lin J, Yen G, Schwartz DC, Welch RA, Blattner FR

15.2.220 Peterson J, et al. (2009) The NIH human microbiome project

The launch of a major project to understand the vast microbial ecosystem living in and on the human body – the microbiome.

Peterson J, et al. The NIH human microbiome project. Genome Res. 2009;19(12):2317-23. doi: 10.1101/gr.096651.109. PMID: 19819907

Type of reference	Article
Authors	Peterson J, Garges S, Giovanni M, McInnes P, Wang L, Schloss JA, Bonazzi V, McEwen JE, Wetterstrand KA, Deal C, Baker CC, Di Francesco V, Howcroft TK, Karp RW, Lunsford RD, Wellington CR, Belachew T, Wright M, Giblin C, David H, Mills M, Salomon R, Mullins C, Akolkar B, Begg L, Davis C, Grandison L, Humble M, Khalsa J, Little AR, Peavy H, Pontzer C, Portnoy M, Sayre MH, Starke-Reed P, Zakhari S, Read J, Watson B, Guyer M, Grp NHW

15.2.221 Polymeropoulos MH, et al. (1997) Mutation in the alpha-synuclein gene identified in families with parkinson's disease

First example of gene mutations associated with hereditary form of Parkinson's disease.

Polymeropoulos MH, et al. Mutation in the alpha-synuclein gene identified in families with parkinson's disease. Science. 1997;276(5321):2045-7. DOI: 10.1126/science.276.5321.2045. PMID: 9197268

Type of reference	Article
Authors	Polymeropoulos MH, Lavedan C, Leroy E, Ide SE, Dehejia A, Dutra A, Pike B, Root H, Rubenstein J, Boyer R, Stenroos ES, Chandrasekharappa S, Athanassiadou A, Papapetropoulos T, Johnson WG, Lazzarini AM, Duvoisin RC, Di Iorio G, Golbe LI, Nussbaum RL

15.2.222 Pruitt K, et al. (1999) RefSeq and LocusLink: NCBI's new curated resources for human genes

New genome web resources from the National Center for Biotechnology Information.

Pruitt K, et al. RefSeq and LocusLink: NCBI's new curated resources for human genes. American Journal of Human Genetics. 1999;65(4):A27-A

Type of reference	Article
Authors	Pruitt K, Maglott D, Sicotte H, Katz K, Schuler G

15.2.223 Ptashne M (1967) Isolation of the lambda Phage Repressor

The isolation of the bacteriophage lambda repressor.

Ptashne M. Isolation of the lambda Phage Repressor. Proc Natl Acad Sci U S A. 1967 Feb;57(2):306-13. PMID: 16591470

Type of reference	Article
Authors	Ptashne M

15.2.224 Quackenbush J, et al. (1995) An STS content map of human chromosome 11: Localization of 910 YAC clones and 109 islands

A detailed physical map of chromosome 11 utilizing yeast artificial chromosomes (YACs).

Quackenbush J, et al. An STS content map of human chromosome 11: Localization of 910 YAC clones and 109 islands. Genomics. 1995;29(2):512-25. PMID: 8666402

Type of reference	Article
Authors	Quackenbush J, Davies C, Bailis JM, Khristich JV, Diggle K, Marchuck Y, Tobin J, Clark SP, Rodkins A, Marcano S, Churukian AC, Hutchinson JS, Probst S, Romberg L, Wei YH, Nowak NJ, Garner HR, Smith MW, Selleri L, Evans GA

15.2.225 Read TD, et al. (2002) Comparative genome sequencing for discovery of novel polymorphisms in Bacillus anthracis

Insights from the genome sequence of an anthrax strain isolated from a victim of bioterrorism reveals potential of genome analysis as a powerful tool for investigation of infectious disease outbreaks.

Read TD, et al. Comparative genome sequencing for discovery of novel polymorphisms in Bacillus anthracis. Science 2002.296(5575):2028-33. Epub 2002/05/11. doi: 10.1126/science.1071837. PubMed PMID: 12004073.

Type of reference	Article
Authors	Read TD, Salzberg SL, Pop M, Shumway M, Umayam L, Jiang L, Holtzapple E, Busch JD, Smith KL, Schupp JM, Solomon D, Keim P, Fraser CM

15.2.226 Reeve JN, et al. (1997) Methanogenesis: Genes, genomes, and who's on first?

Review of the genes involved in the complex metabolic pathway, methanogenesis.

Reeve JN, et al. Methanogenesis: Genes, genomes, and who's on first? Journal of Bacteriology 1997.179(19):5975-86. Epub 1997/10/27. PubMed PMID: 9324240; PMCID: PMC179496.

Type of reference	Article
Authors	Reeve JN, Nolling J, Morgan RM, Smith DR

15.2.227 Riordan JR, et al. (1989) Identification of the cystic fibrosis gene: cloning and characterization of complementary DNA

One of a series of back-to-back papers characterizing the cystic fibrosis gene, one of the most coveted disease genes in human genetics leading up to the Human Genome Project.

Riordan JR, Rommens JM, Kerem B, Alon N, Rozmahel R, Grzelczak Z, Zielenski J, Lok S, Plavsic N, Chou JL, et al. (1989) Identification of the cystic fibrosis gene: cloning and characterization of complementary DNA. Science. 1989 Sep 8;245(4922):1066-73.

Type of reference	Article
Authors	Riordan JR, Rommens JM, Kerem B, Alon N, Rozmahel R, Grzelczak Z, Zielenski J, Lok S, Plavsic N, Chou JL

15.2.228 Roberts L (1990) Large-scale sequencing trials begin

Four research groups agrees to sequence 3 megabases of DNA at 75 cents/base within three years.

Roberts L. Large-scale sequencing trials begin. Science. 1990 Dec 7;250(4986):1336-8. http://www.ncbi.nlm.nih.gov/pubmed/2255904

Type of reference	Article
Authors	Roberts, Leslie

15.2.229 Roberts RG, et al. (1993) Exon structure of the human dystrophin gene

Characterization of the genomic structure of the giant dystrophin gene mutated in Duchenne and Becker muscular dystrophy.

Roberts RG, et al. Exon structure of the human dystrophin gene. Genomics 1993.16(2):536-8. Epub 1993/05/01. doi: 10.1006/geno.1993.1225. PubMed PMID: 8314593.

Type of reference	Article
Authors	Roberts RG, Coffey AJ, Bobrow M, Bentley DR

15.2.230 Roberts RG, et al. (1994) Searching for the 1 in 2,400,000: A review of dystrophin gene point mutations

Review of the dystrophin gene structure and mutations in patients with X-linked muscular dystrophy.

Roberts RG, et al. Searching for the 1 in 2,400,000: A review of dystrophin gene point mutations. Human Mutation 1994.4(1):1-11. Epub 1994/01/01. doi: 10.1002/humu.1380040102. PubMed PMID: 7951253.

Type of reference	Article
Authors	Roberts RG, Gardner RJ, Bobrow M

15.2.231 Rogers J (1977) Atomic Structure of a Living Organism

The forerunner to Sanger sequence – the so-called plus-minus method used to sequence the phage φX174.

Rogers J. Atomic Structure of a Living Organism. New Scientist, March 10, 1977, 583. Available at: https://books.google.com/books?id=9iF_j-z4P_AC&lpg=PP1&pg=PA583#v=onepage&q&f=false

Type of reference	Article
Authors	John Rogers

15.2.232 Rohrer GA, et al. (1994) A microsatellite linkage map of the porcine genome

Genetic map of the pig genome.

Rohrer GA, et al. A microsatellite linkage map of the porcine genome. Genetics 1994.136(1):231-45. Epub 1994/01/01. PubMed PMID: 8138161; PMCID: PMC1205775, Available from: ; PMCID:

Type of reference	Article
Authors	Rohrer GA, Alexander LJ, Keele JW, Smith TP, Beattie CW

15.2.233 Rommens JM, et al. (1989) Identification of the cystic fibrosis gene: chromosome walking and jumping

How the CF gene on chromosome 7 was isolated and identified using positional cloning.

Rommens JM, Iannuzzi MC, Kerem B, Drumm ML, Melmer G, Dean M, Rozmahel R, Cole JL, Kennedy D, Hidaka N, et al. (1989) Identification of the cystic fibrosis gene: chromosome walking and jumping. Science. 1989 Sep 8;245(4922):1059-65.

Type of reference	Article
Authors	Rommens JM, Iannuzzi MC, Kerem B, Drumm ML, Melmer G, Dean M, Rozmahel R, Cole JL, Kennedy D, Hidaka N

15.2.234 Ross MT, et al. (2005) The DNA sequence of the human X chromosome

The complete sequence of the human X chromosome.

Ross MT, et al. The DNA sequence of the human X chromosome. Nature. 2005;434(7031):325-37. DOI: 10.1038/nature03440. PMID: 15772651

Type of reference	Article
Authors	Ross MT, Grafham DV, Coffey AJ, Scherer S, McLay K, Muzny D, Platzer M, Howell GR, Burrows C, Bird CP, Frankish A, Lovell FL, Howe KL, Ashurst JL, Fulton RS, Sudbrak R, Wen GP, Jones MC, Hurles ME, Andrews TD, Scott CE, Searle S, Ramser J, Whittaker A, Deadman R, Carter NP, Hunt SE, Chen R, Cree A, Gunaratne P, Havlak P, Hodgson A, Metzker ML, Richards S, Scott G, Steffen D, Sodergren E, Wheeler DA, Worley KC, Ainscough R, Ambrose KD, Ansari-Lari MA, Aradhya S, Ashwell RIS, Babbage AK, Bagguley CL, Ballabio A, Banerjee R, Barker GE, Barlow KF, Barrett IP, Bates KN, Beare DM, Beasley H, Beasley O, Beck A, Bethel G, Blechschmidt K, Brady N, Bray-Allen S, Bridgeman AM, Brown AJ, Brown MJ, Bonnin D, Bruford EA, Buhay C, Burch P, Burford D, Burgess J, Burrill W, Burton J, Bye JM, Carder C, Carrel L, Chako J, Chapman JC, Chavez D, Chen E, Chen G, Chen Y, Chen ZJ, Chinault C, Ciccodicola A, Clark SY, Clarke G, Clee CM, Clegg S, Clerc-Blankenburg K, Clifford K, Cobley V, Cole CG, Conquer JS, Corby N, Connor RE, David R, Davies J, Davis C, Davis J, Delgado O, DeShazo D, Dhami P, Ding Y, Dinh H, Dodsworth S, Draper H, Dugan-Rocha S, Dunham A, Dunn M, Durbin KJ, Dutta I, Eades T, Ellwood M, Emery-Cohen A, Errington H, Evans KL, Faulkner L, Francis F, Frankland J, Fraser AE, Galgoczy P, Gilbert J, Gill R, Glockner G, Gregory SG, Gribble S, Griffiths C, Grocock R, Gu YH, Gwilliam R, Hamilton C, Hart EA, Hawes A, Heath PD, Heitmann K, Hennig S, Hernandez J, Hinzmann B, Ho S, Hoffs M, Howden PJ, Huckle EJ, Hume J, Hunt PJ, Hunt AR, Isherwood J, Jacob L, Johnson D, Jones S, de Jong PJ, Joseph SS, Keenan S, Kelly S, Kershaw JK, Khan Z, Kioschis P, Klages S, Knights AJ, Kosiura A, Kovar-Smith C, Laird GK, Langford C, Lawlor S, Leversha M, Lewis L, Liu W, Lloyd C, Lloyd DM, Loulseged H, Loveland JE, Lovell JD, Lozado R, Lu J, Lyne R, Ma J, Maheshwari M, Matthews LH, McDowall J, McLaren S, McMurray A, Meidl P, Meitinger T, Milne S, Miner G, Mistry SL, Morgan M, Morris S, Muller I, Mullikin JC, Nguyen N, Nordsiek G, Nyakatura G, O'Dell CN, Okwuonu G, Palmer S, Pandian R, Parker D, Parrish J, Pasternak S, Patel D, Pearce AV, Pearson DM, Pelan SE, Perez L, Porter KM, Ramsey Y, Reichwald K, Rhodes S, Ridler KA, Schlessinger D, Schueler MG, Sehra HK, Shaw-Smith C, Shen H, Sheridan EM, Shownkeen R, Skuce CD, Smith ML, Sotheran EC, Steingruber HE, Steward CA, Storey R, Swann RM, Swarbreck D, Tabor PE, Taudien S, Taylor T, Teague B, Thomas K, Thorpe A, Timms K, Tracey A, Trevanion S, Tromans AC, d'Urso M, Verduzco D, Villasana D, Waldron L, Wall M, Wang QY, Warren J, Warry GL, Wei XH, West A, Whitehead SL, Whiteley MN, Wilkinson JE, Willey DL, Williams G, Williams L, Williamson A, Williamson H, Wilming L, Woodmansey RL, Wray PW, Yen J, Zhang JK, Zhou JL, Zoghbi H, Zorilla S, Buck D, Reinhardt R, Poustka A, Rosenthal A, Lehrach H, Meindl A, Minx PJ, Hillier LW, Willard HF, Wilson RK, Waterston RH, Rice CM, Vaudin M, Coulson A, Nelson DL, Weinstock G, Sulston JE, Durbin R, Hubbard T, Gibbs RA, Beck S, Rogers J, Bentley DR

15.2.235 Rowen L, et al. (1996) The complete 685-kilobase DNA sequence of the human beta t cell receptor locus

Lee Hood, Lee Rowen and colleagues produce largest contiguous human sequence to date--685 kb of the T-cell receptor locus.

Rowen L, et al. The complete 685-kilobase DNA sequence of the human beta t cell receptor locus. Science. 1996;272(5269):1755-62. DOI: 10.1126/science.272.5269.1755. PMID: 8650574

Type of reference	Article
Authors	Rowen L, Koop BF, Hood L

15.2.236 Rubin GM, et al. (2000) Comparative genomics of the eukaryotes

Comparative analysis of the genes of yeast, nematode and fruit fly.

Rubin GM, et al. Comparative genomics of the eukaryotes. Science 2000.287(5461):2204-15. Epub 2000/03/24. PubMed PMID: 10731134; PMCID: PMC2754258.

Type of reference	Article
Authors	Rubin GM, Yandell MD, Wortman JR, Gabor Miklos GL, Nelson CR, Hariharan IK, Fortini ME, Li PW, Apweiler R, Fleischmann W, Cherry JM, Henikoff S, Skupski MP, Misra S, Ashburner M, Birney E, Boguski MS, Brody T, Brokstein P, Celniker SE, Chervitz SA, Coates D, Cravchik A, Gabrielian A, Galle RF, Gelbart WM, George RA, Goldstein LS, Gong F, Guan P, Harris NL, Hay BA, Hoskins RA, Li J, Li Z, Hynes RO, Jones SJ, Kuehl PM, Lemaitre B, Littleton JT, Morrison DK, Mungall C, O'Farrell PH, Pickeral OK, Shue C, Vosshall LB, Zhang J, Zhao Q, Zheng XH, Lewis S

15.2.237 Rubin GM, Lewis EB. (2000) A brief history of Drosophila's contributions to genome research

Review of the seminal role of fruit fly studies in the history of genetics research.

Rubin GM, Lewis EB. A brief history of Drosophila's contributions to genome research. Science 2000.287(5461):2216-8. Epub 2000/03/24. PubMed PMID: 10731135.

Type of reference	Review article
Authors	Rubin GM, Lewis EB

15.2.238 Rubin GM. (1996) Around the genomes: The Drosophila genome project

Progress on the Drosophila genome project prior to full-scale sequencing.

Rubin GM. Around the genomes: The Drosophila genome project. Genome Research 1996.6(2):71-9. Epub 1996/02/01. PubMed PMID: 8919686.

Type of reference	Article
Authors	Rubin GM

15.2.239 Rubin GM. (2001) The draft sequences. Comparing species

Review of comparative genomic analysis with the arrival of the draft human genome sequence.

Rubin GM. The draft sequences. Comparing species. Nature 2001.409(6822):820-1. Epub 2001/03/10. doi: 10.1038/35057277. PubMed PMID: 11236995.

Type of reference	Review article
Authors	Rubin GM

15.2.240 Ruddle FH, et al. (1994) Evolution of Hox genes

Review of Homeobox genes.

Ruddle FH, et al. Evolution of Hox genes. Annual Review of Genetics 1994.28:423-42. Epub 1994/01/01. doi: 10.1146/annurev.ge.28.120194.002231. PubMed PMID: 7893134, Available from: . doi:

Type of reference	Article
Authors	Ruddle FH, Bartels JL, Bentley KL, Kappen C, Murtha MT, Pendleton JW

15.2.241 Sabeti PC, et al. (2002) Detecting recent positive selection in the human genome from haplotype structure

Multiple approaches converge on identification of regions in the human genome that undergo positive evolutionay selection.

Sabeti PC, et al. Detecting recent positive selection in the human genome from haplotype structure. Nature 2002.419(6909):832-7. Epub 2002/10/25. doi: 10.1038/nature01140. PubMed PMID: 12397357.

Type of reference	Article
Authors	Sabeti PC, Reich DE, Higgins JM, Levine HZ, Richter DJ, Schaffner SF, Gabriel SB, Platko JV, Patterson NJ, McDonald GJ, Ackerman HC, Campbell SJ, Altshuler D, Cooper R, Kwiatkowski D, Ward R, Lander ES

15.2.242 Sachidanandam R, et al. (2001) A map of human genome sequence variation containing 1.42 million single nucleotide polymorphisms

An early map of single nucleotide polymorphic variants in the human genome – a forerunner to the International HapMap project.

Sachidanandam R, et al. A map of human genome sequence variation containing 1.42 million single nucleotide polymorphisms. Nature 2001.409(6822):928-33. Epub 2001/03/10. doi: 10.1038/35057149. PubMed PMID: 11237013.

Type of reference	Article
Authors	Sachidanandam R, Weissman D, Schmidt SC, Kakol JM, Stein LD, Marth G, Sherry S, Mullikin JC, Mortimore BJ, Willey DL, Hunt SE, Cole CG, Coggill PC, Rice CM, Ning Z, Rogers J, Bentley DR, Kwok PY, Mardis ER, Yeh RT, Schultz B, Cook L, Davenport R, Dante M, Fulton L, Hillier L, Waterston RH, McPherson JD, Gilman B, Schaffner S, Van Etten WJ, Reich D, Higgins J, Daly MJ, Blumenstiel B, Baldwin J, Stange-Thomann N, Zody MC, Linton L, Lander ES, Altshuler D

15.2.243 Saiki RK, et al. (1985) Enzymatic amplification of beta-globin genomic sequences and restriction site analysis for diagnosis of sickle cell anemia

Kary Mullis (Cetus Corp) discovers an ingenious method for amplifying DNA -- the polymerase chain reaction -- that earned him the Nobel Prize. This paper describes the first application of PCR for the detection of sickle-cell anemia.

Saiki RK, et al. Enzymatic amplification of beta-globin genomic sequences and restriction site analysis for diagnosis of sickle cell anemia. Science. 1985;230(4732):1350-4. Epub 1985/12/20. DOI: 10.1126/science.2999980 PMID: 2999980

Type of reference	Article
Authors	Saiki RK, Scharf S, Faloona F, Mullis KB, Horn GT, Erlich HA, Arnheim N

15.2.244 Salgado H, et al. (2000) Operons in Escherichia coli: Genomic analyses and predictions

Salgado H, et al. Operons in Escherichia coli: Genomic analyses and predictions. Proceedings of the National Academy of Sciences of the United States of America 2000.97(12):6652-7. Epub 2000/05/24. doi: 10.1073/pnas.110147297. PubMed PMID: 10823905; PMCID: PMC18690.

Type of reference	Article
Authors	Salgado H, Moreno-Hagelsieb G, Smith TF, Collado-Vides J

15.2.245 Sanger F, et al. (1977) DNA sequencing with chain-terminating inhibitors

Fred Sanger and colleagues invent an elegant method for sequencing DNA using dideoxy nucleotides that earned Sanger his second Nobel Prize. This was the technology that made the Human Genome Project possible.

Sanger F, et al. DNA sequencing with chain-terminating inhibitors. Proc Natl Acad Sci U S A. 1977;74(12):5463-7. DOI: 10.1073/pnas.74.12.5463. PMID: 271968

Type of reference	Article
Authors	Sanger F, Nicklen S, Coulson AR

15.2.246 Sanger F, et al. (1977) Nucleotide sequence of bacteriophage φX174 DNA

The first sequence of a living organism--the tiny virus φX174--by Fred Sanger's group. Early 1977 Sanger lab plus-minus method for sequencing φX174.

Sanger F, et al. Nucleotide sequence of bacteriophage φX174 DNA. Nature. 1977;265(5596):687-95. Epub 1977/02/24. PMID: 870828

Type of reference	Article
Authors	Sanger F, Air GM, Barrell BG, Brown NL, Coulson AR, Fiddes CA, Hutchison CA, Slocombe PM, Smith M

15.2.247 Sanger F, Nicklen S, Coulson AR. (1977) DNA sequencing with chain-terminating inhibitors

Sanger F, Nicklen S, Coulson AR. (1977) DNA sequencing with chain-terminating inhibitors. Proc Natl Acad Sci U S A. 1977 Dec;74(12):5463-7.

Type of reference	Article
Authors	Sanger F, Nicklen S, Coulson AR

15.2.248 Sanger F, Tuppy H (1951) The amino-acid sequence in the phenylalanyl chain of insulin. 2. The investigation of peptides from enzymic hydrolysates

Sanger F, Tuppy H. The amino-acid sequence in the phenylalanyl chain of insulin. 2. The investigation of peptides from enzymic hydrolysates. The Biochemical journal. 1951;49(4):481-90. PubMed PMID: 14886311

Type of reference	Article
Authors	Sanger F, Tuppy H.

15.2.249 Sanger F, Tuppy H (1951) The amino-acid sequence in the phenylalanyl chain of insulin. I. The identification of lower peptides from partial hydrolysates

Fred Sanger identifies the complete amino-acid sequence of a protein for the first time, a Nobel-Prize winning discovery.

Sanger F, Tuppy H. The amino-acid sequence in the phenylalanyl chain of insulin. I. The identification of lower peptides from partial hydrolysates. The Biochemical journal. 1951;49(4):463-81. PMID: 14886310, PMCID: 1197535

Type of reference	Article
Authors	Sanger F, Tuppy H.

15.2.250 Sanger F (1981) Determination of nucleotide sequences in DNA

Nobel lecture – Sanger's second – on the analytical method for dideoxy DNA sequencing that bears his name and drove the completion of the Human Genome Project.

Sanger F. Determination of nucleotide sequences in DNA. Bioscience Reports. 1981;1(1):3-18. DOI: 10.1007/bf01115145. PMID: 7302589

Type of reference	Article
Authors	Sanger F

15.2.251 Sanger F (1988) Sequences, sequences, and sequences

Fred Sanger reflects on his life and career accomplishments with characteristic grace and humility.

Sanger F. Sequences, sequences, and sequences. Annu Rev Biochem. 1988;57:1-28. PubMed PMID: 2460023

Type of reference	Review article
Authors	Sanger F

15.2.252 Sasaki T, Burr B (2000) International rice genome sequencing project: The effort to completely sequence the rice genome

Review of early progress on sequencing the rice genome.

Sasaki T, Burr B. International rice genome sequencing project: The effort to completely sequence the rice genome. Curr Opin Plant Biol. 2000;3(2):138-41. DOI: 10.1016/s1369-5266(99)00047-3. PMID: 10712951

Type of reference	Review article
Authors	Sasaki T, Burr B

15.2.253 Sassetti CM, Rubin EJ. (2003) Genetic requirements for mycobacterial survival during infection

Systematic mutatgenesis of non-essential genes in the M. tuberculosis genome identify key genes involved in bacterial infection.

Sassetti CM, Rubin EJ. Genetic requirements for mycobacterial survival during infection. Proceedings of the National Academy of Sciences of the United States of America 2003.100(22):12989-94. Epub 2003/10/22. doi: 10.1073/pnas.2134250100. PubMed PMID: 14569030; PMCID: PMC240732

Type of reference	Article
Authors	Sassetti CM, Rubin EJ

15.2.254 Schena M, et al. (1995) Quantitative monitoring of gene expression patterns with a complementary DNA microarray

Stanford's Pat Brown describes a low cost, "do-it-yourself" approach for construction of gene microarrays.

Schena M, et al. Quantitative monitoring of gene expression patterns with a complementary DNA microarray. Science. 1995;270(5235):467-70. DOI: 10.1126/science.270.5235.467. PMID: 7569999

Type of reference	Article
Authors	Schena M, Shalon D, Davis RW, Brown PO

15.2.255 Scherer SE, et al. (2006) The finished DNA sequence of human chromosome 12

The sequence of human chromosome 12.

Scherer SE, et al. The finished DNA sequence of human chromosome 12. Nature. 2006;440(7082):346-51. DOI: 10.1038/nature04569. PMID: 16541075

Type of reference	Article
Authors	Scherer SE, Muzny DM, Buhay CJ, Chen R, Cree A, Ding Y, Dugan-Rocha S, Gill R, Gunaratne P, Harris RA, Hawes AC, Hernandez J, Hodgson AV, Hume J, Jackson A, Khan

	ZM, Kovar-Smith C, Lewis LR, Lozado RJ, Metzker ML, Milosavljevic A, Miner GR, Montgomery KT, Morgan MB, Nazareth LV, Scott G, Sodergren E, Song XZ, Steffen D, Lovering RC, Wheeler DA, Worley KC, Yuan Y, Zhang ZD, Adams CQ, Ansari-Lari MA, Ayele M, Brown MJ, Chen G, Chen ZJ, Clerc-Blankenburg KP, Davis C, Delgado O, Dinh HH, Draper H, Gonzalez-Garay ML, Havlak P, Jackson LR, Jacob LS, Kelly SH, Li L, Li ZW, Liu J, Liu W, Lu J, Maheshwari M, Nguyen BV, Okwuonu GO, Pasternak S, Perez LM, Plopper FJH, Santibanez J, Shen H, Tabor PE, Verduzco D, Waldron L, Wang QY, Williams GA, Zhang JK, Zhou JL, Nelson D, Kucherlapati R, Weinstock G, Gibbs RA, Baylor Coll Med Human Genome S

15.2.256 Schmutz J, et al. (2004) The DNA sequence and comparative analysis of human chromosome 5

The sequence of human chromosome 5.

Schmutz J, et al. The DNA sequence and comparative analysis of human chromosome 5. Nature. 2004 Sep 16;431(7006):268-74. DOI: 10.1038/nature02919. PMID: 15372022

Type of reference	Article
Authors	Schmutz J, Martin J, Terry A, Couronne O, Grimwood J, Lowry S, Gordon LA, Scott D, Xie G, Huang W, Hellsten U, Tran-Gyamfi M, She X, Prabhakar S, Aerts A, Altherr M, Bajorek E, Black S, Branscomb E, Caoile C, Challacombe JF, Chan YM, Denys M, Detter JC, Escobar J, Flowers D, Fotopulos D, Glavina T, Gomez M, Gonzales E, Goodstein D, Grigoriev I, Groza M, Hammon N, Hawkins T, Haydu L, Israni S, Jett J, Kadner K, Kimball H, Kobayashi A, Lopez F, Lou Y, Martinez D, Medina C, Morgan J, Nandkeshwar R, Noonan JP, Pitluck S, Pollard M, Predki P, Priest J, Ramirez L, Retterer J, Rodriguez A, Rogers S, Salamov A, Salazar A, Thayer N, Tice H, Tsai M, Ustaszewska A, Vo N, Wheeler J, Wu K, Yang J, Dickson M, Cheng JF, Eichler EE, Olsen A, Pennacchio LA, Rokhsar DS, Richardson P, Lucas SM, Myers RM, Rubin EM

15.2.257 Schmutz J et al. (2004) Quality assessment of the human genome sequence. Nature

Schmutz J et al. Quality assessment of the human genome sequence. Nature 2004.429(6990):365-8. doi: 10.1038/nature02390. PubMed PMID: 15164052

Type of reference	Article
Authors	Schmutz J, Wheeler J, Grimwood J, Dickson M, Yang J, Caoile C, Bajorek E, Black S, Chan YM, Denys M, Escobar J, Flowers D, Fotopulos D, Garcia C, Gomez M, Gonzales E, Haydu L, Lopez F, Ramirez L, Retterer J, Rodriguez A, Rogers S, Salazar A, Tsai M, Myers RM

15.2.258 Schneiderman RM (2006) Illumina Buys Solexa

Shortly after the launch of Solexa's commercial sequencing instrument, San Diego-based Illumina acquires British sequencing biotech for $650 million.

http://www.forbes.com/2006/11/13/illumina-pharmaceuticals-earnings-markets-equity-cx_rs_1113markets10.html

Type of reference	Article
Authors	Schneiderman RM

15.2.259 Schrock E, et al. (1996) Multicolor spectral karyotyping of human chromosomes

Advance in fluorescent in situe hybridization of the human genome.

Schrock E, et al. Multicolor spectral karyotyping of human chromosomes. Science 1996.273(5274):494-7. Epub 1996/07/26. PubMed PMID: 8662537.

Type of reference	Article
Authors	Schrock E, du Manoir S, Veldman T, Schoell B, Wienberg J, Ferguson-Smith MA, Ning Y, Ledbetter DH, Bar-Am I, Soenksen D, Garini Y, Ried T

15.2.260 Schwartz DC, Cantor CR (1984) Separation of yeast chromosome-sized DNAs by pulsed field gradient gel electrophoresis

Pulsed field gel electrophoresis (PFGE) becomes a key tool in the construction of long-range physical maps of chromosomes by virtue of its ability to separate large fragments of DNA.

Schwartz DC, Cantor CR. Separation of yeast chromosome-sized DNAs by pulsed field gradient gel electrophoresis. Cell. 1984 May;37(1):67-75.

Type of reference	Article
Authors	Schwartz DC, Cantor CR

15.2.261 Shalon D, et al. (1996) A DNA microarray system for analyzing complex DNA samples using two-color fluorescent probe hybridization

Pat Brown and colleagues develop a powerful microarray method for differential gene expression analysis.

Shalon D, et al. A DNA microarray system for analyzing complex DNA samples using two-color fluorescent probe hybridization. Genome Research 1996.6(7):639-45. Epub 1996/07/01. PubMed PMID: 8796352.

Type of reference	Article
Authors	Shalon D, Smith SJ, Brown PO

15.2.262 Shendure J, et al. (2005) Accurate multiplex polony sequencing of an evolved bacterial genome

New method of DNA sequencing from the George Church lab, which formed the basis of the Polonator instrument.

Shendure J, et al. Accurate multiplex polony sequencing of an evolved bacterial genome. Science. 2005;309(5741):1728-32. DOI: 10.1126/science.1117389. PMID: 16081699

Type of reference	Article
Authors	Shendure J, Porreca GJ, Reppas NB, Lin XX, McCutcheon JP, Rosenbaum AM, Wang MD, Zhang K, Mitra RD, Church GM

15.2.263 Shih C, Weinberg RA (1982) Isolation of a transforming sequence from a human bladder carcinoma cell line

Isolation of the first human cancer gene from Bob Weinberg's group at MIT.

Shih C, Weinberg RA. Isolation of a transforming sequence from a human bladder carcinoma cell line. Cell. 1982;29(1):161-9. DOI: 10.1016/0092-8674(82)90100-3. PMID: 6286138

Type of reference	Article
Authors	Shih C, Weinberg RA

15.2.264 Shizuya H, et al. (1992) Cloning and stable maintenance of 300-kilobase-pair fragments of human DNA in Escherichia coli using an f-factor-based vector

DNA cloning advance for managing larger inserts.

Shizuya H, et al. Cloning and stable maintenance of 300-kilobase-pair fragments of human DNA in Escherichia coli using an F-factor-based vector. Proceedings of the National Academy of Sciences of the United States of America. 1992;89(18):8794-7. DOI: 10.1073/pnas.89.18.8794. PubMed PMID: 1528894

Type of reference	Article
Authors	Shizuya H, Birren B, Kim UJ, Mancino V, Slepak T, Tachiiri Y, Simon M.

15.2.265 Sinsheimer, Robert L. (1989) The Santa Cruz Workshop - May 1985

Recap of the pivotal workshop at UC Santa Cruz hosted by Robert Sinsheimer that paved the way for the Human Genome Project.

Sinsheimer, Robert L. The Santa Cruz Workshop - May 1985, Genomics 5(4): 954-956, November 1989

Type of reference	Review article
Authors	Sinsheimer, Robert L

15.2.266 Sinsheimer, Robert L. (2006) To Reveal the Genomes

Reflections of the key meetings and discussions leading up to the Human Genome Project.

Sinsheimer, Robert L. (2006) To Reveal the Genomes. Am J Hum Genet. 2006 Aug; 79(2): 194–196.

Type of reference	Review article
Authors	Sinsheimer, Robert L

15.2.267 Skaletsky H, et al. (2003) The male-specific region of the human Y chromosome is a mosaic of discrete sequence classes

The full sequence of the human Y chromosome.

Skaletsky H, et al. The male-specific region of the human Y chromosome is a mosaic of discrete sequence classes. Nature. 2003;423(6942):825-37. DOI: 10.1038/nature01722. PMID: 12815422

Type of reference	Article
Authors	Skaletsky H, Kuroda-Kawaguchi T, Minx PJ, Cordum HS, Hillier L, Brown LG, Repping S, Pyntikova T, Ali J, Bieri T, Chinwalla A, Delehaunty A, Delehaunty K, Du H, Fewell G, Fulton L, Fulton R, Graves T, Hou SF, Latrielle P, Leonard S, Mardis E, Maupin R, McPherson J, Miner T, Nash W, Nguyen C, Ozersky P, Pepin K, Rock S, Rohlfing T, Scott K, Schultz B, Strong C, Tin-Wollam A, Yang SP, Waterston RH, Wilson RK, Rozen S, Page DC

15.2.268 Smith DJ, Rubin EM. (1997) Functional screening and complex traits: Human 21q22.2 sequences affecting learning in mice

Transgenic analysis of sequences on chromosome 21 for potential understanding of Down syndrome.

Smith DJ, Rubin EM. Functional screening and complex traits: Human 21q22.2 sequences affecting learning in mice. Human Molecular Genetics 1997.6(10):1729-33. Epub 1997/01/01. PubMed PMID: 9300665.

Type of reference	Article
Authors	Smith DJ, Rubin EM

15.2.269 Smith DR, et al. (1997) Complete genome sequence of Methanobacterium thermoautotrophicum deltaH: Functional analysis and comparative genomics.

Complete genome of Methanobacterium.

Smith DR, et al. Complete genome sequence of Methanobacterium thermoautotrophicum deltaH: Functional analysis and comparative genomics. Journal of Bacteriology 1997.179(22):7135-55. Epub 1997/11/26. PubMed PMID: 9371463; PMCID: PMC179657.

Type of reference	Article
Authors	Smith DR, Doucette-Stamm LA, Deloughery C, Lee H, Dubois J, Aldredge T, Bashirzadeh R, Blakely D, Cook R, Gilbert K, Harrison D, Hoang L, Keagle P, Lumm W, Pothier B, Qiu D, Spadafora R, Vicaire R, Wang Y, Wierzbowski J, Gibson R, Jiwani N, Caruso A, Bush D, Safer H, Patwell D, Prabhakar S, McDougall S, Shimer G, Goyal A, Pietrokovski S, Church GM, Daniels CJ, Mao J, Rice P, Nolling J, Reeve JN

15.2.270 Smith DR. (1996) Microbial pathogen genomes--new strategies for identifying therapeutics and vaccine targets

Review of early progress in bacterial genome sequencing.

Smith DR. Microbial pathogen genomes--new strategies for identifying therapeutics and vaccine targets. Trends in Biotechnology 1996.14(8):290-3. Epub 1996/08/01. doi: 10.1016/0167-7799(96)10038-x. PubMed PMID: 8987460

Type of reference	Review article
Authors	Smith DR

15.2.271 Smith HO, et al. (1995) Frequency and distribution of DNA uptake signal sequences in the Haemophilus influenzae rd genome

Characterization of DNA uptake signal motifs in the H. influenza genome.

Smith HO, et al. Frequency and distribution of DNA uptake signal sequences in the Haemophilus influenzae rd genome. Science 1995.269(5223):538-40. Epub 1995/07/28. PubMed PMID: 7542802.

Type of reference	Article
Authors	Smith HO , Tomb JF, Dougherty BA, Fleischmann RD, Venter JC

15.2.272 Smith HO, et al. (2003) Generating a synthetic genome by whole genome assembly: Phix174 bacteriophage from synthetic oligonucleotides

Landmark in emerging field of synthetic biology.

Smith HO, et al. Generating a synthetic genome by whole genome assembly: Phix174 bacteriophage from synthetic oligonucleotides. Proceedings of the National Academy of Sciences of the United States of America 2003.100(26):15440-5. Epub 2003/12/06. doi: 10.1073/pnas.2237126100. PubMed PMID: 14657399; PMCID: PMC307586.

Type of reference	Article
Authors	Smith HO, Hutchison CA, 3rd, Pfannkoch C, Venter JC

15.2.273 Smith HO, Wilcox KW (1970) A restriction enzyme from Hemophilus influenzae. I. Purification and general properties

The first specific bacterial restriction enzyme isolated by Hamilton Smith, who would win the Nobel Prize..

Smith HO, Wilcox KW. A restriction enzyme from Hemophilus influenzae. I. Purification and general properties. J Mol Biol. 1970;51(2):379-91. DOI: 10.1016/0022-2836(70)90149-x. PMID: 5312500

Type of reference	Article
Authors	Smith HO, Wilcox KW

15.2.274 Smith HO (1979) Nucleotide sequence specificity of restriction endonucleases

Nobel laureate reviews the work that led to the isolation and characterization of bacterial restriction enzymes.

Smith HO. Nucleotide sequence specificity of restriction endonucleases. Science. 1979;205(4405):455-62. DOI: 10.1126/science.377492. PMID: 377492

Type of reference	Review article
Authors	Smith HO

15.2.275 Smith LM, et al. (1985) The synthesis of oligonucleotides containing an aliphatic amino group at the 5' terminus: synthesis of fluorescent DNA primers for use in DNA-sequence analysis

Leroy Hood and colleagues present crucial advance in the development of automated fluorescent DNA sequencing.

Smith LM, et al. The synthesis of oligonucleotides containing an aliphatic amino group at the 5' terminus: synthesis of fluorescent DNA primers for use in DNA-sequence analysis. Nucleic Acids Research. 1985;13(7):2399-412. DOI: 10.1093/nar/13.7.2399. PMID: 4000959

Type of reference	Article
Authors	Smith LM, Fung S, Hunkapiller MW, Hunkapiller TJ, Hood LE

15.2.276 Smith LM, et al. (1986) Fluorescence detection in automated DNA sequence analysis

Leroy Hood, Lloyd Smith and coworkers describe a groundbreaking method for the automation of DNA sequencing using fluorescent dyes rather than radioactive nucleotides.

Smith LM, et al. Fluorescence detection in automated DNA sequence analysis. Nature. 1986;321(6071):674-9. DOI: 10.1038/321674a0. PMID: 3713851

Type of reference	Article
Authors	Smith LM, Sanders JZ, Kaiser RJ, Hughes P, Dodd C, Connell CR, Heiner C, Kent SBH, Hood LE

15.2.277 Smith LM. (1991) High-speed DNA sequencing by capillary gel electrophoresis

Discussion of capillary electrophoresis to aid high-throughput automated DNA sequencing.

Smith LM. High-speed DNA sequencing by capillary gel electrophoresis. Nature 1991.349(6312):812-3. Epub 1991/02/28. doi: 10.1038/349812a0. PubMed PMID: 2000151.

Type of reference	Article
Authors	Smith LM

15.2.278 Smith LM. (1993) The future of DNA sequencing

Perspective from Lloyd Smith on future trends in DNA sequencing at the infancy of the Human Genome Project..

Smith LM. The future of DNA sequencing. Science 1993.262(5133):530-2. Epub 1993/10/22. PubMed PMID: 8211178.

Type of reference	Article
Authors	Smith LM

15.2.279 Smith TF, Zhang X. (1997) The challenges of genome sequence annotation or "the devil is in the details"

Discussion of the contrasting needs of rapid release versus accurate annotation of draft genome sequence data.

Smith TF, Zhang X. The challenges of genome sequence annotation or "the devil is in the details". Nature Biotechnology 1997.15(12):1222-3. Epub 1997/11/14. doi: 10.1038/nbt1197-1222. PubMed PMID: 9359093.

Type of reference	Article
Authors	Smith TF, Zhang X

15.2.280 Solomon E, Bodmer WF (1979) Evolution of sickle variant gene

Walter Bodmer and Ellen Solomon propose the use of RFLPs for systematic mapping of human genes in the genome.

Solomon E, Bodmer WF. Evolution of sickle variant gene. Lancet. 1979 Apr 28;1(8122):923.

Type of reference	Article
Authors	Solomon E, Bodmer WF

15.2.281 Southern EM (1975) Detection of specific sequences among DNA fragments separated by gel-electrophoresis

Ed Southern presents ingeniously simple method for transferring DNA to filters for hybridization experiments.

Southern EM. Detection of specific sequences among DNA fragments separated by gel-electrophoresis. Journal of Molecular Biology. 1975;98(3):503-&. DOI: 10.1016/S0022-2836(75)80083-0. PMID: 1195397

Type of reference	Article
Authors	Southern EM

15.2.282 Spellman PT, Rubin GM. (2002) Evidence for large domains of similarly expressed genes in the Drosophila genome

Spellman PT, Rubin GM. Evidence for large domains of similarly expressed genes in the Drosophila genome. Journal of Biology 2002.1(1):5. Epub 2002/07/30. PubMed PMID: 12144710; PMCID: PMC117248.

Type of reference	Article
Authors	Spellman PT, Rubin GM

15.2.283 Springer M (2006) Applied Biosystems: Celebrating 25 Years of Advancing Science

Applied Biosystems (ABI) launches its first capillary sequencer, the 3700, to compete with the MegaBACE.
http://home.appliedbiosystems.com/about/presskit/pdfs/celebrating_25_years_aln_article.pdf

Type of reference	Article

15.2.284 Stark A, et al. (2003) Identification of Drosophila microRNA targets

Bioinformatic identification of gene regulatory micro RNA-binding sequences

Stark A, et al. Identification of Drosophila microRNA targets. PLoS biology 2003.1(3):E60. Epub 2003/12/24. doi: 10.1371/journal.pbio.0000060. PubMed PMID: 14691535; PMCID: PMC270017.

Type of reference	Article
Authors	Stark A, Brennecke J, Russell RB, Cohen SM

15.2.285 Stehelin D, et al. (1976) DNA related to the transforming gene(s) of avian sarcoma viruses is present in normal avian DNA

Classic discovery by Bishop, Varmus and colleagues of the first cancer genes (in chickens).

Stehelin D, et al. DNA related to the transforming gene(s) of avian sarcoma viruses is present in normal avian DNA. Nature. 1976;260(5547):170-3. Epub 1976/03/11. DOI: 10.1038/260170a0. PubMed PMID: 176594

Type of reference	Article
Authors	Stehelin D, Varmus HE, Bishop JM, Vogt PK

15.2.286 St George-Hyslop PH. (1999) Molecular genetics of Alzheimer disease

Review of progress in Alzheimer's disease genetics, including the amyloid precursor protein and presenilin genes.

St George-Hyslop PH. Molecular genetics of Alzheimer disease. Seminars in neurology 1999.19(4):371-83. Epub 2000/03/15. doi: 10.1055/s-2008-1040852. PubMed PMID: 10716660.

Type of reference	Article
Authors	St George-Hyslop PH

15.2.287 Stover CK, et al. (2000) Complete genome sequence of Pseudomonas aeruginosa pao1, an opportunistic pathogen

Genome sequence of P. aeruginosa, the pathogen commonly associated with cystic fibrosis patient infections.

Stover CK, et al. Complete genome sequence of Pseudomonas aeruginosa pao1, an opportunistic pathogen. Nature 2000.406(6799):959-64. Epub 2000/09/13. doi: 10.1038/35023079. PubMed PMID: 10984043.

Type of reference	Article
Authors	Stover CK, Pham XQ, Erwin AL, Mizoguchi SD, Warrener P, Hickey MJ, Brinkman FS, Hufnagle WO, Kowalik DJ, Lagrou M, Garber RL, Goltry L, Tolentino E, Westbrock-Wadman S, Yuan Y, Brody LL, Coulter SN, Folger KR, Kas A, Larbig K, Lim R, Smith K, Spencer D, Wong GK, Wu Z, Paulsen IT, Reizer J, Saier MH, Hancock RE, Lory S, Olson MV

15.2.288 Strausberg RL. (2001) The cancer genome anatomy project: New resources for reading the molecular signatures of cancer

Bob Strausberg presents the Cancer Genome Anatomy Project from the NCI.

Strausberg RL. The cancer genome anatomy project: New resources for reading the molecular signatures of cancer. Journal of Pathology 2001.195(1):31-40. Epub 2001/09/25. doi: 10.1002/1096-9896(200109)195:1<31::aid-path920>3.0.co;2-w. PubMed PMID: 11568889

Type of reference	Article
Authors	Strausberg RL

15.2.289 Taylor TD, et al. (2006) Human chromosome 11 DNA sequence and analysis including novel gene identification

The sequence and analysis of human chromosome 11.

Taylor TD, et al. Human chromosome 11 DNA sequence and analysis including novel gene identification. Nature. 2006;440(7083):497-500. DOI: 10.1038/nature04632. PMID: 16554811

Type of reference	Article
Authors	Taylor TD, Noguchi H, Totoki Y, Toyoda A, Kuroki Y, Dewar K, Lloyd C, Itoh T, Takeda T, Kim DW, She XW, Barlow KF, Bloom T, Bruford E, Chang JL, Cuomo CA, Eichler E, FitzGerald MG, Jaffe DB, LaButti K, Nicol R, Park HS, Seaman C, Sougnez C, Yang XP, Zimmer AR, Zody MC, Birren BW, Nusbaum C, Fujiyama A, Hattori M, Rogers J, Lander ES, Sakaki Y

15.2.290 Tettelin H, et al. (2000) Complete genome sequence of Neisseria meningitidis serogroup b strain mc58

Genome sequence of N. meningitides.

Tettelin H, et al. Complete genome sequence of Neisseria meningitidis serogroup b strain mc58. Science 2000.287(5459):1809-15. Epub 2000/03/10. PubMed PMID: 10710307.

Type of reference	Article

Authors	Tettelin H, Saunders NJ, Heidelberg J, Jeffries AC, Nelson KE, Eisen JA, Ketchum KA, Hood DW, Peden JF, Dodson RJ, Nelson WC, Gwinn ML, DeBoy R, Peterson JD, Hickey EK, Haft DH, Salzberg SL, White O, Fleischmann RD, Dougherty BA, Mason T, Ciecko A, Parksey DS, Blair E, Cittone H, Clark EB, Cotton MD, Utterback TR, Khouri H, Qin H, Vamathevan J, Gill J, Scarlato V, Masignani V, Pizza M, Grandi G, Sun L, Smith HO, Fraser CM, Moxon ER, Rappuoli R, Venter JC

15.2.291 Tettelin H, et al. (2001) Complete genome sequence of a virulent isolate of Streptococcus pneumoniae

Genome sequence of S. pneumoniae.

Tettelin H, et al. Complete genome sequence of a virulent isolate of Streptococcus pneumoniae. Science 2001.293(5529):498-506. Epub 2001/07/21. doi: 10.1126/science.1061217. PubMed PMID: 11463916.

Type of reference	Article
Authors	Tettelin H, Nelson KE, Paulsen IT, Eisen JA, Read TD, Peterson S, Heidelberg J, DeBoy RT, Haft DH, Dodson RJ, Durkin AS, Gwinn M, Kolonay JF, Nelson WC, Peterson JD, Umayam LA, White O, Salzberg SL, Lewis MR, Radune D, Holtzapple E, Khouri H, Wolf AM, Utterback TR, Hansen CL, McDonald LA, Feldblyum TV, Angiuoli S, Dickinson T, Hickey EK, Holt IE, Loftus BJ, Yang F, Smith HO, Venter JC, Dougherty BA, Morrison DA, Hollingshead SK, Fraser CM

15.2.292 The Hospital for Sick Children (1998) SicKKids improves access to global genome database

Improved access to the Genome Data Base.

The Hospital for Sick Children. SicKKids improves access to global genome database. Nov 5, 1998. Available as: http://www.sickkids.ca/AboutSickKids/Newsroom/Past-News/1998/SickKids-improves-access-to-global-genome-database.html

Type of reference	Press release
Authors	The Hospital for Sick Children

15.2.293 Tomb JF, et al. (1997) The complete genome sequence of the gastric pathogen Helicobacter pylori

Genome sequence of the bacterial pathogen commonly associated with stomach ulcers.

Tomb JF, et al. The complete genome sequence of the gastric pathogen Helicobacter pylori. Nature 1997.388(6642):539-47. Epub 1997/08/07. doi: 10.1038/41483. PubMed PMID: 9252185.

Type of reference	Article
Authors	Tomb JF, White O, Kerlavage AR, Clayton RA, Sutton GG, Fleischmann RD, Ketchum KA, Klenk HP, Gill S, Dougherty BA, Nelson K, Quackenbush J, Zhou L, Kirkness EF, Peterson S, Loftus B, Richardson D, Dodson R, Khalak HG, Glodek A, McKenney K, Fitzegerald LM, Lee N, Adams MD, Hickey EK, Berg DE, Gocayne JD, Utterback TR, Peterson JD, Kelley JM, Cotton MD, Weidman JM, Fujii C, Bowman C, Watthey L, Wallin E, Hayes WS, Borodovsky M, Karp PD, Smith HO, Fraser CM, Venter JC

15.2.294 Tomita M, et al. (1999) E-cell: Software environment for whole-cell simulation

Early work on developing an in silico model of a single cell.

Tomita M, et al. E-cell: Software environment for whole-cell simulation. Bioinformatics (Oxford, England) 1999.15(1):72-84. Epub 1999/03/09. PubMed PMID: 10068694.

Type of reference	Article
Authors	Tomita M, Hashimoto K, Takahashi K, Shimizu TS, Matsuzaki Y, Miyoshi F, Saito K, Tanida S, Yugi K, Venter JC, Hutchison CA, 3rd

15.2.295 Tripp S, Grueber M (2011) Economic Impact of the Human Genome Project

Report on the estimated economic impact of the Human Genome Project.

Tripp S, Grueber M. Economic Impact of the Human Genome Project, Battelle Memorial Institute, May 2011 http://www.battelle.org/docs/default-document-library/economic_impact_of_the_human_genome_project.pdf?sfvrsn=2

Type of reference	Article
Authors	Simon Tripp and Martin Grueber

15.2.296 Tsui LC, et al. (1985) Cystic fibrosis locus defined by a genetically linked polymorphic DNA marker

Four years after the CF gene was mapped to chromosome 7, Lap-Chee Tsui, Francis Collins and Jack Riordan identify the mutated gene that gives rise to the most common recessively inherited genetic disorder affecting people of Northern European descent.

Tsui LC, et al. Cystic fibrosis locus defined by a genetically linked polymorphic DNA marker. Science. 1985;230(4729):1054-7. DOI: 10.1126/science.2997931. PMID: 2997931

Type of reference	Article
Authors	Tsui LC, Buchwald M, Barker D, Braman JC, Knowlton R, Schumm JW, Eiberg H, Mohr J, Kennedy D, Plavsic N, Zsiga M, Markiewicz D, Akots G, Brown V, Helms C, Gravius T, Parker C, Rediker K, Donis-Keller H

15.2.297 Turnbaugh PJ, et al. (2007) The human microbiome project

The Human Microbiome Project is proposed as a "logical conceptual and experimental extension of the Human Genome Project."

Turnbaugh PJ, et al. The human microbiome project. Nature. 2007;449(7164):804-10. DOI: 10.1038/nature06244. PMID: 17943116

Type of reference	Article
Authors	Turnbaugh PJ, Ley RE, Hamady M, Fraser-Liggett CM, Knight R, Gordon JI

15.2.298 U.S. DHHS, NIH, NCHGR; and U.S. DOE, OHER, HGP. (1990) Understanding Our Genetic Inheritance: The U.S. Human Genome Project: The First Five Years, FY 1991-1995

United States Department of Health and Human Services, National Institutes of Health, National Center for Human Genome Research; and U.S. Department of Energy, Office of Health and Environmental Research, Human Genome Program. (1990) Understanding Our Genetic Inheritance: The U.S. Human Genome Project: The First Five Years, FY 1991-1995, National Technical Information Service, Springfield, VA, https://repository.library.georgetown.edu/handle/10822/544984

Type of reference	Report

15.2.299 Uberbacher, E, et al. (1992) Gene recognition and assembly in the GRAIL system: Progress and challenges

Progress in the use of the GRAIL gene-finding software.

Uberbacher, E, et al. Gene recognition and assembly in the GRAIL system: Progress and challenges; Mural, R.J. 2. international conference on bioinformatics, supercomputing, and complex genome analysis, St. Petersburg, FL (United States), 4-7 Jun 1992

Type of reference	Article
Authors	Uberbacher, E.C.; Einstein, J.R.; Guan, X.

15.2.300 Uberbacher EC, Mural RJ (1991) Locating protein-coding regions in human DNA sequences by a multiple sensor-neural network approach

Publication of GRAIL, an important gene-finding algorithm.

Uberbacher EC, Mural RJ. Locating protein-coding regions in human DNA sequences by a multiple sensor-neural network approach. Proc Natl Acad Sci U S A. 1991;88(24):11261-5. DOI: 10.1073/pnas.88.24.11261. PMID: 1763041

Type of reference	Article
Authors	Uberbacher EC, Mural RJ

15.2.301 Unsal K, Morgan GT. (1995) A novel group of families of short interspersed repetitive elements (SINEs) in Xenopus: Evidence of a specific target site for DNA-mediated transposition of inverted-repeat SINEs

Account of novel repetitive elements and insights into vertebrate genome evolution.

Unsal K, Morgan GT. A novel group of families of short interspersed repetitive elements (SINEs) in Xenopus: Evidence of a specific target site for DNA-mediated transposition of

inverted-repeat SINEs. Journal of Molecular Biology 1995.248(4):812-23. Epub 1995/05/12. doi: 10.1006/jmbi.1995.0262. PubMed PMID: 7752242.

Type of reference	Article
Authors	Unsal K, Morgan GT

15.2.302 Venter JC, et al. (1996) A new strategy for genome sequencing

Venter, Hood and colleague espouse the virtues of shotgun sequencing, deployed successfully for bacterial genomes, for the human genome assembly.

Venter JC, et al. A new strategy for genome sequencing. Nature 1996.381(6581):364-6. Epub 1996/05/30. doi: 10.1038/381364a0. PubMed PMID: 8632789.

Type of reference	Article
Authors	Venter JC, Smith HO, Hood L

15.2.303 Venter JC, et al. (1998) Shotgun sequencing of the human genome

Venter lays out the strategy for sequencing the human genome to be used by his private company, subsequently named Celera Genomics.

Venter JC, et al. Shotgun sequencing of the human genome. Science (New York, NY) 1998.280(5369):1540-2. Epub 1998/06/27. PubMed PMID: 9644018

Type of reference	Article
Authors	Venter JC, Adams MD, Sutton GG, Kerlavage AR, Smith HO, Hunkapiller M

15.2.304 Venter JC, et al. (2001) The sequence of the human genome

Craig Venter's team at Celera publish their draft genome assembly simultaneously with the public consortium, including data from the public HGP.

Venter JC, et al. The sequence of the human genome. Science. 2001 Feb 16;291(5507):1304-51.

http://www.ncbi.nlm.nih.gov/pubmed/11181995

Type of reference	Article

15.2.305 Vollrath D, et al. (1992) The human Y chromosome: A 43-interval map based on naturally occurring deletions

David Page's group at the Whitehead Institute produces the first physical map of the Y chromosome.

Vollrath D, et al. The human Y chromosome: A 43-interval map based on naturally occurring deletions. Science. 1992;258(5079):52-9. DOI: 10.1126/science.1439769. PMID: 1439769

Type of reference	Article
Authors	Vollrath D, Foote S, Hilton A, Brown LG, Beerromero P, Bogan JS, Page DC

15.2.306 Wade, Nicholas. (2001) Genome's Riddle: Few Genes, Much Complexity

One of a package of stories reporting the simultaneous publications in February 2001 of the first drafts of the human genome sequence.

Wade, Nicholas. Genome's Riddle: Few Genes, Much Complexity, New York Times, February 13, 2001.

Type of reference	News story
Authors	Wade, Nicholas

15.2.307 Wade, Nicholas. (2001) The Other Secrets of the Genome

Further insights into the publication of the first draft of the human genome.

Wade, Nicholas. The Other Secrets of the Genome, New York Times, February 18, 2001

Type of reference	News story
Authors	Wade, Nicholas

15.2.308 Wade, Nicholas (2000) Genetic Code of Human Life Is Cracked by Scientists

Report on the White House announcement of the completion of the first draft of the Human Genome Project.

Wade, Nicholas. Genetic Code of Human Life Is Cracked by Scientists, New York Times, June 27, 2000

Type of reference	News story
Authors	Wade, Nicholas

15.2.309 Wade N (1998) Scientist's plan: Map all DNA within 3 years

Sensational, exclusive, front-page story in the New York Times reveals stunning news that Venter intends to sequence the human genome in advance of the public NIH/DOE project.

Wade N. Scientist's plan: Map all DNA within 3 years. New York Times. 1998 05/10/1998, Available from: www.nytimes.com/1998/05/10/us/scientist-s-plan-map-all-dna-within-3-years.html.

Type of reference	Article
Authors	Wade N

15.2.310 Wade N (2000) Scientists Complete Rough Draft of Human Genome

President Clinton announces the first draft of the human genome in a White House ceremony on June 26, 2000, with Francis Collins (NIH) and J. Craig Venter (Celera).

https://partners.nytimes.com/library/national/science/062600sci-human-genome.html

Type of reference	Article
Authors	Wade, Nicholas

15.2.311 Wade N (2003) Once Again, Scientists Say Human Genome Is Complete

"All goals achieved" as the NIH announces completion of the Human Genome Project, conveniently on the 50th anniversary of the publication of the double helix (April 25, 1953).

http://www.nytimes.com/2003/04/15/science/once-again-scientists-say-human-genome-is-complete.html?pagewanted=all

Type of reference	Article
Authors	Wade, Nicholas

15.2.312 Wainwright BJ, et al. (1985) Localization of cystic fibrosis locus to human chromosome 7cen-q22

One of several reports localizating the CF gene to chromosome 7, this one by Bob Williamson and colleagues at St Mary's Hospital Medical School in London.

Wainwright BJ, Scambler PJ, Schmidtke J, Watson EA, Law HY, Farrall M, Cooke HJ, Eiberg H, Williamson R. (1985) Localization of cystic fibrosis locus to human chromosome 7cen-q22. Nature. 1985 Nov 28-Dec 4;318(6044):384-5.

Type of reference	Article
Authors	Wainwright BJ, Scambler PJ, Schmidtke J, Watson EA, Law HY, Farrall M, Cooke HJ, Eiberg H, Williamson R

15.2.313 Wallace DC, et al. (1997) Ancient mtDNA sequences in the human nuclear genome: A potential source of errors in identifying pathogenic mutations

Evolutionary analysis by Doug Wallace and colleagues of mitochondrial DNA sequences in the nuclear genome..

Wallace DC, et al. Ancient mtDNA sequences in the human nuclear genome: A potential source of errors in identifying pathogenic mutations. Proceedings of the National Academy of Sciences of the United States of America 1997.94(26):14900-5. Epub 1998/02/07. PubMed PMID: 9405711; PMCID: PMC25135.

Type of reference	Article
Authors	Wallace DC, Stugard C, Murdock D, Schurr T, Brown MD

15.2.314 Wang J, et al. (2008) The diploid genome sequence of an Asian individual

The first Asian genome, using Solexa sequencing. puts BGI and Wang Jun on the map as an international sequencing powerhouse.

Wang J, et al. The diploid genome sequence of an asian individual. Nature. 2008;456(7218):60-5. DOI: 10.1038/nature07484. PMID: 18987735

Type of reference	Article
Authors	Wang J, Wang W, Li RQ, Li YR, Tian G, Goodman L, Fan W, Zhang JQ, Li J, Zhang JB, Guo YR, Feng BX, Li H, Lu Y, Fang XD, Liang HQ, Du ZL, Li D, Zhao YQ, Hu YJ, Yang ZZ, Zheng HC, Hellmann I, Inouye M, Pool J, Yi X, Zhao J, Duan JJ, Zhou Y, Qin JJ, Ma LJ, Li GQ, Yang ZT, Zhang GJ, Yang B, Yu C, Liang F, Li WJ, Li SC, Li DW, Ni PX, Ruan J, Li QB, Zhu HM, Liu DY, Lu ZK, Li N, Guo GW, Zhang JG, Ye J, Fang L, Hao Q, Chen Q, Liang Y, Su YY, San A, Ping C, Yang S, Chen F, Li L, Zhou K, Zheng HK, Ren YY, Yang L, Gao Y, Yang GH, Li Z, Feng XL, Kristiansen K, Wong GKS, Nielsen R, Durbin R, Bolund L, Zhang XQ, Li SG, Yang HM

15.2.315 Waterston R, Sulston JE. (1998) The Human Genome Project: Reaching the finish line

Progress report from Sulston and Waterston on progress in the mapping and sequencing of the human genome, building on strategies that worked successfully in sequencing the nematode genome.

Waterston R, Sulston JE. The Human Genome Project: Reaching the finish line. Science 1998.282(5386):53-4. Epub 1998/10/24. PubMed PMID: 9786797

Type of reference	Article
Authors	Waterston R, Sulston JE

15.2.316 Waterston RH, et al. (2002) Initial sequencing and comparative analysis of the mouse genome

Draft sequence of the mouse genome by Bob Waterston, Eric Lander and colleagues.

Waterston RH, et al. Initial sequencing and comparative analysis of the mouse genome. Nature. 2002;420(6915):520-62. DOI: 10.1038/nature01262. PMID: 12466850

Type of reference	Article
Authors	Waterston RH, Lindblad-Toh K, Birney E, Rogers J, Abril JF, Agarwal P, Agarwala R, Ainscough R, Alexandersson M, An P, Antonarakis SE, Attwood J, Baertsch R, Bailey J, Barlow K, Beck S, Berry E, Birren B, Bloom T, Bork P, Botcherby M, Bray N, Brent MR, Brown DG, Brown SD, Bult C, Burton J, Butler J, Campbell RD, Carninci P, Cawley S, Chiaromonte F, Chinwalla AT, Church DM, Clamp M, Clee C, Collins FS, Cook LL, Copley RR, Coulson A, Couronne O, Cuff J, Curwen V, Cutts T, Daly M, David R, Davies J, Delehaunty KD, Deri J, Dermitzakis ET, Dewey C, Dickens NJ, Diekhans M, Dodge S, Dubchak I, Dunn DM, Eddy SR, Elnitski L, Emes RD, Eswara P, Eyras E, Felsenfeld A, Fewell GA, Flicek P, Foley K, Frankel WN, Fulton LA, Fulton RS, Furey TS, Gage D, Gibbs RA, Glusman G, Gnerre S, Goldman N, Goodstadt L, Grafham D, Graves TA, Green ED, Gregory S, Guigo R, Guyer M, Hardison RC, Haussler D, Hayashizaki Y, Hillier LW, Hinrichs A, Hlavina W, Holzer T, Hsu F, Hua A, Hubbard T, Hunt A, Jackson I, Jaffe DB, Johnson LS, Jones M, Jones TA, Joy A, Kamal M, Karlsson EK, Karolchik D, Kasprzyk A, Kawai J, Keibler E, Kells C, Kent WJ, Kirby A, Kolbe

	DL, Korf I, Kucherlapati RS, Kulbokas EJ, Kulp D, Landers T, Leger JP, Leonard S, Letunic I, Levine R, Li J, Li M, Lloyd C, Lucas S, Ma B, Maglott DR, Mardis ER, Matthews L, Mauceli E, Mayer JH, McCarthy M, McCombie WR, McLaren S, McLay K, McPherson JD, Meldrim J, Meredith B, Mesirov JP, Miller W, Miner TL, Mongin E, Montgomery KT, Morgan M, Mott R, Mullikin JC, Muzny DM, Nash WE, Nelson JO, Nhan MN, Nicol R, Ning Z, Nusbaum C, O'Connor MJ, Okazaki Y, Oliver K, Larty EO, Pachter L, Parra G, Pepin KH, Peterson J, Pevzner P, Plumb R, Pohl CS, Poliakov A, Ponce TC, Ponting CP, Potter S, Quail M, Reymond A, Roe BA, Roskin KM, Rubin EM, Rust AG, Santos R, Sapojnikov V, Schultz B, Schultz J, Schwartz MS, Schwartz S, Scott C, Seaman S, Searle S, Sharpe T, Sheridan A, Shownkeen R, Sims S, Singer JB, Slater G, Smit A, Smith DR, Spencer B, Stabenau A, Strange-Thomann NS, Sugnet C, Suyama M, Tesler G, Thompson J, Torrents D, Trevaskis E, Tromp J, Ucla C, Vidal AU, Vinson JP, von Niederhausern AC, Wade CM, Wall M, Weber RJ, Weiss RB, Wendl MC, West AP, Wetterstrand K, Wheeler R, Whelan S, Wierzbowski J, Willey D, Williams S, Wilson RK, Winter E, Worley KC, Wyman D, Yang S, Yang SP, Zdobnov EM, Zody MC, Lander ES, Mouse Genome Sequencing C

15.2.317 Waterston RH, et al. (2002) On the sequencing of the human genome

A retrospective commentary on the strategies and quality of the two draft genome assemblies reported in February 2001.

Waterston RH, et al. On the sequencing of the human genome. Proceedings of the National Academy of Sciences of the United States of America 2002.99(6):3712-6. Epub 2002/03/07. doi: 10.1073/pnas.042692499. PubMed PMID: 11880605; PMCID: PMC122589.

Type of reference	Article
Authors	Waterston RH, Lander ES, Sulston JE

15.2.318 Watson JD, Cook-Deegan RM (1991) Origins of the Human Genome Project

Early history of the Human Genome Project launch.

Watson JD, Cook-Deegan RM. Origins of the Human Genome Project. FASEB journal : official publication of the Federation of American Societies for Experimental Biology. 1991;5(1):8-11. PMID: 1991595

Type of reference	Article
Authors	Watson JD, Cook-Deegan RM

15.2.319 Watson JD, Crick FH (1953) Molecular structure of nucleic acids; a structure for deoxyribose nucleic acid

"We wish to suggest a model for the structure of deoxyribose-nucleic acid ..." The humble opening to the classic paper that introduced the iconic double helx--proposed by Francis Crick & James Watson, building on key contributions from Rosalind Franklin, Maurice Wilkins, Erwin Chargaff, and others. Crick and Watson shared the Nobel Prize in 1962 with Maurice Wilkins.

Watson JD, Crick FH. Molecular structure of nucleic acids; a structure for deoxyribose nucleic acid. Nature. 1953;171(4356):737-8. DOI: 10.1038/171737a0. PMID: 13054692

Type of reference	Article
Authors	Watson JD, Crick FH

15.2.320 Weissenbach J et al. (1992) A second-generation linkage map of the human genome

A major milestone: the Genenthon team in Paris presents a second-generation linkage map of the human genome.

Jean Weissenbach, Gabor Gyapay, Colette Dib, Alain Vignal, Jean Morissette, Philippe Millasseau, Guy Vaysseix, and Mark Lathrop (1992) A second-generation linkage map of the human genome. Nature 359, 794 - 801 (29 October 1992); doi:10.1038/359794a0

Type of reference	Article
Authors	Jean Weissenbach, Gabor Gyapay, Colette Dib, Alain Vignal, Jean Morissette, Philippe Millasseau, Guy Vaysseix, and Mark Lathrop

15.2.321 Wellcome Trust (2010) History of the Sanger Institute

The flagship sequencing center in the U.K. is named after Nobel laureate Fred Sanger. Directed by Sir John Sulston, the center becomes a crucial contributor in the international Genome Project consortium.

http://www.wellcome.ac.uk/Funding/Biomedical-science/Funded-projects/Major-initiatives/Wellcome-Trust-Sanger-Institute/History/index.htm

Type of reference	Press Release

15.2.322 Wellcome Trust Bermuda Principles

Bermuda Principles, http://www.wellcome.ac.uk/About-us/Policy/Policy-and-position-statements/WTD002751.htm

Type of reference	Press release

15.2.323 White O, et al. (1999) Genome sequence of the radioresistant bacterium Deinococcus radiodurans r1

Genome sequence of the bacterium D. radiodurans, which has the remarkable ability to repair its genome following intense radiation.

White O, et al. Genome sequence of the radioresistant bacterium Deinococcus radiodurans r1. Science 1999.286(5444):1571-7. Epub 1999/11/24. PubMed PMID: 10567266; PMCID: PMC4147723.

Type of reference	Article
Authors	White O, Eisen JA, Heidelberg JF, Hickey EK, Peterson JD, Dodson RJ, Haft DH, Gwinn ML, Nelson WC, Richardson DL, Moffat KS, Qin H, Jiang L, Pamphile W, Crosby M, Shen M, Vamathevan JJ, Lam P, McDonald L, Utterback T, Zalewski C, Makarova KS, Aravind L, Daly MJ, Minton KW, Fleischmann RD, Ketchum KA, Nelson KE, Salzberg S, Smith HO, Venter JC, Fraser CM

15.2.324 White R, et al. (1985) A closely linked genetic marker for cystic fibrosis

Ray White and colleagues at the University of Utah report the linkage mapping of the CF gene to chromosome 7, simultaneously with several other groups.

White R, Woodward S, Leppert M, O'Connell P, Hoff M, Herbst J, Lalouel JM, Dean M, Vande Woude G. (1985) A closely linked genetic marker for cystic fibrosis. Nature. 1985 Nov 28-Dec 4;318(6044):382-4.

Type of reference	Article
Authors	White R, Woodward S, Leppert M, O'Connell P, Hoff M, Herbst J, Lalouel JM, Dean M, Vande Woude G

15.2.325 Wilkins MR, et al. (1996) Progress with proteome projects: Why all proteins expressed by a genome should be identified and how to do it

Australian scientist Marc Wilkins serves as evangelist for analysis of the human proteome – the complementary analysis to the Human Genome Project.

Wilkins MR, et al. Progress with proteome projects: Why all proteins expressed by a genome should be identified and how to do it. Biotechnology & Genetic Engineering Reviews 1996.13:19-50. Epub 1996/01/01. PubMed PMID: 8948108.

Type of reference	Article
Authors	Wilkins MR, Sanchez JC, Gooley AA, Appel RD, Humphery-Smith I, Hochstrasser DF, Williams KL

15.2.326 Wilkinson M (2007) ABI Launch SOLiD Sequencer

Applied Biosystems (Kevin McKernan and colleagues) launch an automated high-throughput, DNA ligase-based sequencing system called SOLiD to compete with Illumina.

http://www.in-pharmatechnologist.com/Processing/ABI-launch-SOLiD-gene-sequencer

Type of reference	News story

15.2.327 Winzeler EA, et al. (1999) Functional characterization of the S. cerevisiae genome by gene deletion and parallel analysis

Functional genomics analysis of the full set of yeast protein-coding genes.

Winzeler EA, et al. Functional characterization of the S. cerevisiae genome by gene deletion and parallel analysis. Science 1999.285(5429):901-6. Epub 1999/08/07. PubMed PMID: 10436161.

Type of reference	Article
Authors	Winzeler EA, Shoemaker DD, Astromoff A, Liang H, Anderson K, Andre B, Bangham R, Benito R, Boeke JD, Bussey H, Chu AM, Connelly C, Davis K, Dietrich F, Dow SW, El Bakkoury M, Foury F, Friend SH, Gentalen E, Giaever G, Hegemann JH, Jones T, Laub M, Liao H, Liebundguth N, Lockhart DJ, Lucau-Danila A, Lussier M, M'Rabet N, Menard P, Mittmann M, Pai C, Rebischung C, Revuelta JL, Riles L, Roberts CJ, Ross-MacDonald P, Scherens B, Snyder M, Sookhai-Mahadeo S, Storms RK, Veronneau S, Voet M, Volckaert G, Ward TR, Wysocki R, Yen GS, Yu K, Zimmermann K, Philippsen P, Johnston M, Davis RW

15.2.328 Yu J, et al. (2002) A draft sequence of the rice genome (oryza sativa l. Ssp. Indica)

Draft sequences of the rice genome produced by the Beijing Genomics Institute and Syngenta.

Yu J, et al. A draft sequence of the rice genome (oryza sativa l. Ssp. Indica). Science. 2002;296(5565):79-92. DOI: 10.1126/science.1068037. PMID: 11935017

Type of reference	Article
Authors	Yu J, Hu SN, Wang J, Wong GKS, Li SG, Liu B, Deng YJ, Dai L, Zhou Y, Zhang XQ, Cao ML, Liu J, Sun JD, Tang JB, Chen YJ, Huang XB, Lin W, Ye C, Tong W, Cong LJ, Geng JN, Han YJ, Li L, Li W, Hu GQ, Huang XG, Li WJ, Li J, Liu ZW, Liu JP, Qi QH, Liu JS, Li T, Wang XG, Lu H, Wu TT, Zhu M, Ni PX, Han H, Dong W, Ren XY, Feng XL, Cui P, Li XR, Wang H, Xu X, Zhai WX, Xu Z, Zhang JS, He SJ, Zhang JG, Xu JC, Zhang KL, Zheng XW, Dong JH, Zeng WY, Tao L, Ye J, Tan J, Ren XD, Chen XW, He J, Liu DF, Tian W, Tian CG, Xia HG, Bao QY, Li G, Gao H, Cao T, Zhao WM, Li P, Chen W, Wang XD, Zhang Y, Hu JF, Liu S, Yang J, Zhang GY, Xiong YQ, Li ZJ, Mao L, Zhou CS, Zhu Z, Chen RS, Hao BL, Zheng WM, Chen SY, Guo W, Li GJ, Liu SQ, Tao M, Zhu LH, Yuan LP, Yang HM

15.2.329 Zody MC, et al. (2006) Analysis of the DNA sequence and duplication history of human chromosome 15

The sequence of human chromosome 15.

Zody MC, et al. Analysis of the DNA sequence and duplication history of human chromosome 15. Nature. 2006;440(7084):671-5. doi: 10.1038/nature04601. PMID: 16572171

Type of reference	Article
Authors	Zody MC, Garber M, Sharpe T, Young SK, Rowen L, O'Neill K, Whittaker CA, Kamal M, Chang JL, Cuomo CA, Dewar K, FitzGerald MG, Kodira CD, Madan A, Qin SZ, Yang XP, Abbasi N, Abouelleil A, Arachchi HM, Baradarani L, Birditt B, Bloom S, Bloom T, Borowsky ML, Burke J, Butler J, Cook A, DeArellano K, DeCaprio D, Dorris L, Dors M, Eichler EE, Engels R, Fahey J, Fleetwood P, Friedman C, Gearin G, Hall JL, Hensley G, Johnson E, Jones C, Kamat A, Kaur A, Locke DP, Munson G, Jaffe DB, Lui A, Macdonald P, Mauceli E, Naylor JW, Nesbitt R, Nicol R, O'Leary SB, Ratcliffe A, Rounsley S, She XW, Sneddon KMB, Stewart S, Sougnez C, Stone SM, Topham K, Vincent D, Wang SG, Zimmer AR, Birren BW, Hood L, Lander ES

15.2.330 Zody MC, et al. (2006) DNA sequence of human chromosome 17 and analysis of rearrangement in the human lineage

The sequence of human chromosome 17.

Zody MC, et al. DNA sequence of human chromosome 17 and analysis of rearrangement in the human lineage. Nature. 2006;440(7087):1045-9. DOI: 10.1038/nature04689. PMID: 16625196

Type of reference	Article
Authors	Zody MC, Garber M, Adams DJ, Sharpe T, Harrow J, Lupski JR, Nicholson C, Searle SM, Wilming L, Young SK, Abouelleil A, Allen NR, Bi WM, Bloom T, Borowsky ML, Bugalter BE, Butler J, Chang JL, Chen CK, Cook A, Corum B, Cuomo CA, de Jong PJ, DeCaprio D, Dewar K, FitzGerald M, Gilbert J, Gibson R, Gnerre S, Goldstein S, Grafham DV, Grocock R, Hafez N, Hagopian DS, Hart E, Norman CH, Humphray S, Jaffe DB, Jones M, Kamal M, Khodiyar VK, LaButti K, Laird G, Lehoczky J, Liu XH, Lokyitsang T, Loveland J, Lui A, Macdonald P, Major JE, Matthews L, Mauceli E, McCarroll SA, Mihalev AH, Mudge J, Nguyen C, Nicol R, O'Leary SB, Osoegawa K, Schwartz DC, Shaw-Smith C, Stankiewicz P, Steward C, Swarbreck D, Venkataraman V, Whittaker CA, Yang XP, Zimmer AR, Bradley A, Hubbard T, Birren BW, Rogers J, Lander ES, Nusbaum C

15.2.331 Zwart H (2008) Understanding the Human Genome Project: A biographical approach

Analysis of autobiographical accounts of the Human Genome Project from Francis Collins, John Sulston and Craig Venter.

Zwart H. Understanding the Human Genome Project: A biographical approach. New Genetics and Society. 2008;27(4):353-76. DOI: 10.1080/14636770802485434

Type of reference	Article
Authors	Zwart H

15.3 Articles (ELSI)

15.3.1 Amani B, Coombe RJ. (2005) The human genome diversity project: The politics of patents at the intersection of race, religion, and research ethics. Law & Policy

Amani B, Coombe RJ. The human genome diversity project: The politics of patents at the intersection of race, religion, and research ethics. Law & Policy 2005.27(1):152-88. doi: 10.1111/j.1467-9930.2004.00195.x.

Type of reference	Article
Authors	Amani B, Coombe RJ

15.3.2 Anderson GC. (1990) Human genome project. The honeymoon is over. Nature

Anderson GC. Human genome project. The honeymoon is over. Nature 1990.346(6282):309. doi: 10.1038/346309a0. PubMed PMID: 2374602

Type of reference	Article
Authors	Anderson GC

15.3.3 Annas GJ, Elias S. (1992) The human genome project: Social policy research priorities. Politics and the Life Sciences

Annas GJ, Elias S. The human genome project: Social policy research priorities. Politics and the Life Sciences 1992.11(2):245-9. PubMed PMID: 11659521

Type of reference	Article
Authors	Annas GJ, Elias S

15.3.4 Annas GJ. (1992) The human genome project as social policy: Implications for clinical medicine. Bulletin of the New York Academy of Medicine

Annas GJ. The human genome project as social policy: Implications for clinical medicine. Bulletin of the New York Academy of Medicine 1992.68(1):126-34. PubMed PMID: 1555019; PMCID: PMC1809873

Type of reference	Article
Authors	Annas GJ

15.3.5 Aschheim E. (1992) The human genome project. JAMA

Aschheim E. The human genome project. JAMA 1992.267(5):653. PubMed PMID: 1731125

Type of reference	Article
Authors	Aschheim E

15.3.6 Barker J. (2004) The human genome diversity project. Cultural Studies

Barker J. The human genome diversity project. Cultural Studies 2004.18(4):571-606. doi: 10.1080/0950238042000232244.

Type of reference	Article
Authors	Barker J

15.3.7 Barnhart BJ. (1988) The human genome project: A DOE perspective. Basic Life Sciences

Barnhart BJ. The human genome project: A DOE perspective. Basic Life Sciences 1988.46:161-6. PubMed PMID: 3223870

Type of reference	Article
Authors	Barnhart BJ

15.3.8 Barnhart BJ. (1989) The Department of Energy (DOE) human genome initiative. Genomics

Barnhart BJ. The Department of Energy (DOE) human genome initiative. Genomics 1989.5(3):657-60. PubMed PMID: 2613248

Type of reference	Article
Authors	Barnhart BJ

15.3.9 Barns I. (1994) The human genome project and the self. Soundings

Barns I. The human genome project and the self. Soundings 1994.77(1-2):99-128. PubMed PMID: 11660596

Type of reference	Article
Authors	Barns I

15.3.10 Baume P. (2002) Ethical issues associated with the human genome project. Medicine Today

Baume P. Ethical issues associated with the human genome project. Medicine Today 2002.3(3):94-6, Available from: http://medicinetoday.com.au/2002/march/regular-series/ethical-issues-associated-human-genome-project

Type of reference	Article
Authors	Baume P

15.3.11 Berry RM. (1996) The human genome project and the end of insurance. University of Florida Journal of Law and Public Policy

Berry RM. The human genome project and the end of insurance. University of Florida Journal of Law and Public Policy 1996.7(2):205-56. PubMed PMID: 11660500

Type of reference	Article
Authors	Berry RM

15.3.12 Boshammer S et al. (1998) Discussing HUGO: The German debate on the ethical implications of the human genome project. The Journal of Medicine and Philosophy

Boshammer S et al. Discussing HUGO: The German debate on the ethical implications of the human genome project. The Journal of Medicine and Philosophy 1998.23(3):324-33. doi: 10.1076/jmep.23.3.324.2584. PubMed PMID: 9736194

Type of reference	Article
Authors	Boshammer S, Kayss M, Runtenberg C, Ach JS

15.3.13 Boyle PJ. (1992) Genetic grammar -- "health," "illness," and the human genome project. The Hastings Center report

Boyle PJ. Genetic grammar -- "health," "illness," and the human genome project. The Hastings Center report 1992.22(4 Suppl):S1. PubMed PMID: 11652050

Type of reference	Article
Authors	Boyle PJ

15.3.14 Brady T. (1995) The ethical implications of the human genome project for the workplace. The International Journal of Applied Philosophy

Brady T. The ethical implications of the human genome project for the workplace. The International Journal of Applied Philosophy 1995.10(1):47-56. PubMed PMID: 11902192

Type of reference	Article
Authors	Brady T

15.3.15 Brenner S. (1992) That lonesome grail: The code of codes: Scientific and social issues in the human genome project. Nature

Brenner S. That lonesome grail: The code of codes: Scientific and social issues in the human genome project. Nature 1992.358(6381):27-8. doi: 10.1038/358027a0. PubMed PMID: 11643003

Type of reference	Article
Authors	Brenner S

15.3.16 Brody H. (1991) Ethics, technology, and the human genome project. The Journal of Clinical Ethics

Brody H. Ethics, technology, and the human genome project. The Journal of Clinical Ethics 1991.2(4):278-81. PubMed PMID: 1804398

Type of reference	Article
Authors	Brody H

15.3.17 Burris J, Cook-Deegan R, Alberts B. (1998) The human genome project after a decade: Policy issues. Nature Genetics

Burris J, Cook-Deegan R, Alberts B. The human genome project after a decade: Policy issues. Nature Genetics 1998.20(4):333-5. doi: 10.1038/3803. PubMed PMID: 9843203

Type of reference	Article
Authors	Burris J, Cook-Deegan R, Alberts B

15.3.18 Burrows BE. (2006) Colonialism and the research endeavour: Reflections on the human genome diversity project. Development

Burrows BE. Colonialism and the research endeavour: Reflections on the human genome diversity project. Development 2006.49(S4):73-7. doi: 10.1057/palgrave.development.1100314.

Type of reference	Article
Authors	Burrows BE

15.3.19 Byk C. (1992) The human genome project and the social contract: A law policy approach. The Journal of Medicine and Philosophy

Byk C. The human genome project and the social contract: A law policy approach. The Journal of Medicine and Philosophy 1992.17(4):371-80. PubMed PMID: 1431656

Type of reference	Article
Authors	Byk C

15.3.20 Cantor CR. (1990) Orchestrating the human genome project. Science

Cantor CR. Orchestrating the human genome project. Science 1990.248(4951):49-51. PubMed PMID: 2181666

Type of reference	Article
Authors	Cantor CR

15.3.21 Caplan AL. (1997) The human genome project and the future of health care. The Journal of Legal Medicine

Caplan AL. The human genome project and the future of health care. The Journal of Legal Medicine 1997.18(4):547-51. doi: 10.1080/01947649709511050. PubMed PMID: 11645020

Type of reference	Article
Authors	Caplan AL

15.3.22 Carmichael B. (2003) The human genome project--threat or promise? Journal of Intellectual Disability Researc

Carmichael B. The human genome project--threat or promise? Journal of Intellectual Disability Research 2003.47(Pt 7):505-8. PubMed PMID: 12974882

Type of reference	Article
Authors	Carmichael B

15.3.23 Casalino L, Keller EF. (1991) Decoding the human genome project: An interview with Evelyn Fox Keller. Socialist Review

Casalino L, Keller EF. Decoding the human genome project: An interview with Evelyn Fox Keller. Socialist Review 1991.21(2):111-28. PubMed PMID: 11659474

Type of reference	Article
Authors	Casalino L, Keller EF

15.3.24 Cassel CK, Levinson D. (1995) The human genome project: Who's looking out for ELSI? Ethical, legal and social implications. Hospital Practice

Cassel CK, Levinson D. The human genome project: Who's looking out for ELSI? Ethical, legal and social implications. Hospital Practice 1995.30(4):11, 4. PubMed PMID: 7714015

Type of reference	Article
Authors	Cassel CK, Levinson D

15.3.25 Christodoulou J. (2003) The human genome project: Opportunities, challenges and consequences for population screening. The Southeast Asian Journal of Tropical Medicine and Public Health

Christodoulou J. The human genome project: Opportunities, challenges and consequences for population screening. The Southeast Asian Journal of Tropical Medicine and Public Health 2003.34 Suppl 3:234-8. PubMed PMID: 15906744

Type of reference	Article
Authors	Christodoulou J

15.3.26 Clayton B. (2005) The human genome project: An increasingly elusive ‘human nature’. Semiotica

Clayton B. The human genome project: An increasingly elusive ‘human nature’. Semiotica 2005.2005(155):249-58

Type of reference	Article
Authors	Clayton B

15.3.27 Collins, Francis S. (2004) What we do and don't know about 'race,' 'ethnicity,' genetics and health at the dawn of the genome era: Commentary. Nature Genetics

Collins, Francis S. What we do and don't know about 'race,' 'ethnicity,' genetics and health at the dawn of the genome era. Nature Genetics 36 (2004). PubMed PMID: 15507997

Type of reference	Article
Authors	Collins, Francis S.

15.3.28 Collins F, Galas D. (1993) A new five-year plan for the U.S. Human Genome Project. Science

Collins F, Galas D. A new five-year plan for the U.S. Human Genome Project. Science 1993.262(5130):43-6. PubMed PMID: 8211127

Type of reference	Article
Authors	Collins F, Galas D

15.3.29 Collins F. (2010) Has the revolution arrived? Nature

Collins F. Has the revolution arrived? Nature 2010.464(7289):674-5. doi: 10.1038/464674a. PubMed PMID: 20360716

Type of reference	Article
Authors	Collins F

15.3.30 Collins FS, Mansoura MK. (2001) The human genome project. Revealing the shared inheritance of all humankind. Cancer

Collins FS, Mansoura MK. The human genome project. Revealing the shared inheritance of all humankind. Cancer 2001.91(1 Suppl):221-5. PubMed PMID: 11148583

Type of reference	Article
Authors	Collins FS, Mansoura MK

15.3.31 Collins FS, Patrinos A, Jordan E, Chakravarti A, Gesteland R, Walters L. (1998) New goals for the U.S. Human genome project: 1998-2003. Science

Collins FS, Patrinos A, Jordan E, Chakravarti A, Gesteland R, Walters L. New goals for the U.S. Human genome project: 1998-2003. Science 1998.282(5389):682-9. Epub 1998/10/23. PubMed PMID: 9784121

Type of reference	Article
Authors	Collins FS, Patrinos A, Jordan E, Chakravarti A, Gesteland R, Walters L

15.3.32 Collins FS. (1991) Medical and ethical consequences of the human genome project. The Journal of Clinical Ethics

Collins FS. Medical and ethical consequences of the human genome project. The Journal of Clinical Ethics 1991.2(4):260-7. PubMed PMID: 1804396

Type of reference	Article
Authors	Collins FS

15.3.33 Collins FS. (1995) Evolution of a vision: Genome project origins, present and future challenges, and far-reaching benefits. Part 2. Human Genome News

Collins FS. Evolution of a vision: Genome project origins, present and future challenges, and far-reaching benefits. Part 2. Human Genome News 1995.7(3-4):3, Available from: http://web.ornl.gov/sci/techresources/Human_Genome/publicat/hgn/v7n3/03collin.shtml

Type of reference	Article
Authors	Collins FS

15.3.34 Collins FS. (1999) Shattuck Lecture--Medical and societal consequences of the human genome project. The New England Journal of Medicine

Collins FS. Shattuck Lecture--Medical and societal consequences of the human genome project. The New England Journal of Medicine 1999.341(1):28-37. doi: 10.1056/NEJM199907013410106. PubMed PMID: 10387940

Type of reference	Article
Authors	Collins FS

15.3.35 Creskoff K. (1998) Scientific imperialism or service to humanity? The complexities of the human genome diversity project. Princeton Journal of Bioethics

Creskoff K. Scientific imperialism or service to humanity? The complexities of the human genome diversity project. Princeton Journal of Bioethics 1998.1(1):6-22. PubMed PMID: 11657339

Type of reference	Article
Authors	Creskoff K

15.3.36 Cunningham BC. (1996) Impact of the human genome project at the interface between patent and FDA laws. Risk

Cunningham BC. Impact of the human genome project at the interface between patent and FDA laws. Risk 1996.7(3):253-66. PubMed PMID: 11655078

Type of reference	Article
Authors	Cunningham BC

15.3.37 Cunningham H. (1998) Colonial encounters in postcolonial contexts: Patenting indigenous DNA and the human genome diversity project. Critique of Anthropology

Cunningham H. Colonial encounters in postcolonial contexts: Patenting indigenous DNA and the human genome diversity project. Critique of Anthropology 1998.18(2):205-33. doi: 10.1177/0308275x9801800205, Available from: http://coa.sagepub.com/content/18/2/205.abstract.

Type of reference	Article
Authors	Cunningham H

15.3.38 Curley RA, Caperna LM. (2003) The brave new world is here: Privacy issues and the human genome project. Defense counsel journal / International Association of Defense Counsel

Curley RA, Caperna LM. The brave new world is here: Privacy issues and the human genome project. Defense counsel journal / International Association of Defense Counsel 2003.70(1):22-35. PubMed PMID: 17256217

Type of reference	Article
Authors	Curley RA, Caperna LM

15.3.39 Davis JJ. (2004) Ethical concerns of american evangelical christians relative to genetic interventions and the human genome project, 1974 to the present. Ethics & medicine : a Christian perspective on issues in bioethics

Davis JJ. Ethical concerns of american evangelical christians relative to genetic interventions and the human genome project, 1974 to the present. Ethics & medicine : a Christian perspective on issues in bioethics 2004.20(1):23-33. PubMed PMID: 15462045

Type of reference	Article
Authors	Davis JJ

15.3.40 Davis MH. (1993) Patents and the human genome project. Do sequence patents promote biotechnology as a public utility? Biotechnology

Davis MH. Patents and the human genome project. Do sequence patents promote biotechnology as a public utility? Biotechnology 1993.11(6):736-8. PubMed PMID: 7763677

Type of reference	Article
Authors	Davis MH

15.3.41 Delisi C. (1988) The human genome project. American Scientist

Delisi C. The human genome project. American Scientist 1988.76(5):488-93.

Type of reference	Article
Authors	Delisi C

15.3.42 Delisi C. (2001) Genomes: 15 years later. A perspective by Charles Delisi, HGP pioneer. Human Genome News

Delisi C. Genomes: 15 years later. A perspective by Charles Delisi, HGP pioneer. Human Genome News 2001.11(3-4):3, Available from: http://web.ornl.gov/sci/techresources/Human_Genome/publicat/hgn/v11n3/05delisi.shtml

Type of reference	Article
Authors	Delisi C

15.3.43 Dizikes GJ. (1995) Update on the human genome project. Clinics in Laboratory Medicine

Dizikes GJ. Update on the human genome project. Clinics in Laboratory Medicine 1995.15(4):973-88. PubMed PMID: 8838234

Type of reference	Article
Authors	Dizikes GJ

15.3.44 Dodson M, Williamson R. (1999) Indigenous peoples and the morality of the human genome diversity project. Journal of Medical Ethics

Dodson M, Williamson R. Indigenous peoples and the morality of the human genome diversity project. Journal of Medical Ethics 1999.25(2):204-8. PubMed PMID: 10226929; PMCID: PMC479208

Type of reference	Article

Authors	Dodson M, Williamson R

15.3.45 Doukas DJ. (1993) Primary care and the human genome project. Into the breach. Archives of Family Medicine

Doukas DJ. Primary care and the human genome project. Into the breach. Archives of Family Medicine 1993.2(11):1179-83. PubMed PMID: 8124493

Type of reference	Article
Authors	Doukas DJ

15.3.46 Dukepoo FC. (1999) It's more than the human genome diversity project. Politics and the Life Sciences

Dukepoo FC. It's more than the human genome diversity project. Politics and the Life Sciences 1999.18(2):293-7. PubMed PMID: 12557892

Type of reference	Article
Authors	Dukepoo FC

15.3.47 Durfy SJ. (1993) Ethics and the human genome project. Archives of Pathology & Laboratory Medicine

Durfy SJ. Ethics and the human genome project. Archives of Pathology & Laboratory Medicine 1993.117(5):466-9. PubMed PMID: 8489332

Type of reference	Article
Authors	Durfy SJ

15.3.48 Ellsworth DL, Hallman DM, Boerwinkle E. (1997) Impact of the human genome project on epidemiologic research. Epidemiologic Reviews

Ellsworth DL, Hallman DM, Boerwinkle E. Impact of the human genome project on epidemiologic research. Epidemiologic Reviews 1997.19(1):3-13. PubMed PMID: 9360897

Type of reference	Article
Authors	Ellsworth DL, Hallman DM, Boerwinkle E

15.3.49 Epstein CJ. (2002) Some ethical implications of the human genome project. Genetics in Medicine

Epstein CJ. Some ethical implications of the human genome project. Genetics in Medicine 2000.2(3):193-7. doi: 10.109700125817-200005000-00006. PubMed PMID: 11256665

Type of reference	Article
Authors	Epstein CJ

15.3.50 Eunpu DL, Weiss JO. (1993) The human genome project: A public forum -- report on a model conference for genetics professionals and consumers. Journal of Genetic Counseling

Eunpu DL, Weiss JO. The human genome project: A public forum -- report on a model conference for genetics professionals and consumers. Journal of Genetic Counseling 1993.2(2):93-113. PubMed PMID: 11652352

Type of reference	Article
Authors	Eunpu DL, Weiss JO

15.3.51 Evans GA. (1999) The human genome project and public policy. Public Understanding of Science

Evans GA. The human genome project and public policy. Public Understanding of Science 1999.8(3):161-8. doi: 10.1088/0963-6625/8/3/301, Available from: http://pus.sagepub.com/content/8/3/161.abstract.

Type of reference	Article
Authors	Evans GA

15.3.52 Fetters MD, Doukas DJ, Phan KL. (1999) Family physicians' perspectives on genetics and the human genome project. Clinical Genetics

Fetters MD, Doukas DJ, Phan KL. Family physicians' perspectives on genetics and the human genome project. Clinical Genetics 1999.56(1):28-34. PubMed PMID: 10466414

Type of reference	Article
Authors	Fetters MD, Doukas DJ, Phan KL

15.3.53 Fink L, Collins FS. (1997) The human genome project: View from the national institutes of health. Journal of the American Medical Women's Association

Fink L, Collins FS. The human genome project: View from the national institutes of health. Journal of the American Medical Women's Association 1997.52(1):4-7, 15. PubMed PMID: 9033164

Type of reference	Article
Authors	Fink L, Collins FS

15.3.54 Fitzgerald J. (1998) Geneticizing disability: The human genome project and the commodification of self. Issues in Law & Medicine

Fitzgerald J. Geneticizing disability: The human genome project and the commodification of self. Issues in law & medicine 1998.14(2):147-63. PubMed PMID: 9807243

Type of reference	Article
Authors	Fitzgerald J

15.3.55 Flower MJ, Heath D. (1993) Micro-anatomo politics: Mapping the human genome project. Culture, medicine and psychiatry

Flower MJ, Heath D. Micro-anatomo politics: Mapping the human genome project. Culture, medicine and psychiatry 1993.17(1):27-41. PubMed PMID: 8354070

Type of reference	Article
Authors	Flower MJ, Heath D

15.3.56 Francke U. (2001) The human genome project: Implications for the endocrinologist. Journal of Pediatric Endocrinology & Metabolism : JPEM

Francke U. The human genome project: Implications for the endocrinologist. Journal of Pediatric Endocrinology & Metabolism : JPEM 2001.14 Suppl 6:1395-408. PubMed PMID: 11837493

Type of reference	Article
Authors	Francke U

15.3.57 Gabard DL. (1999) Homosexuality and the human genome project: Private and public choices. Journal of Homosexuality

Gabard DL. Homosexuality and the human genome project: Private and public choices. Journal of Homosexuality 1999.37(1):25-51. doi: 10.1300/J082v37n01_03. PubMed PMID: 10203068

Type of reference	Article
Authors	Gabard DL

15.3.58 Galenzoski K, Chudley A. (2001) Genetic landmarks through philately: The human genome project and the new millennium. Clinical Genetics

Galenzoski K, Chudley A. Genetic landmarks through philately: The human genome project and the new millennium. Clinical Genetics 2001.59(6):393-6. PubMed PMID: 11453970

Type of reference	Article
Authors	Galenzoski K, Chudley A

15.3.59 Gannon P, Guthrie T, Laurie G. (1995) Patents, morality and DNA: Should there be intellectual property protection of the human genome project? Medical Law International

Gannon P, Guthrie T, Laurie G. Patents, morality and DNA: Should there be intellectual property protection of the human genome project? Medical Law International 1995.1(4):321-45. PubMed PMID: 11660020

Type of reference	Article
Authors	Gannon P, Guthrie T, Laurie G

15.3.60 Garver KL, Garver B. (1994) The human genome project and eugenic concerns. American Journal of Human Genetics

Garver KL, Garver B. The human genome project and eugenic concerns. American Journal of Human Genetics 1994.54(1):148-58. PubMed PMID: 8279465; PMCID: PMC1918077

Type of reference	Article
Authors	Garver KL, Garver B

15.3.61 Gauging the economic impact of the human genome project. (2011) Human Gene Therapy

Gauging the economic impact of the human genome project. Human Gene Therapy 2011.22(7):777-9. doi: 10.1089/hum.2011.2508. PubMed PMID: 21756073

Type of reference	Article

15.3.62 Gisler M, Sornette D, Woodard R. (2011) Innovation as a social bubble: The example of the human genome project. Research Policy

Gisler M, Sornette D, Woodard R. Innovation as a social bubble: The example of the human genome project. Research Policy 2011.40(10):1412-25

Type of reference	Article
Authors	Gisler M, Sornette D, Woodard R

15.3.63 Glasner P, Rothman H. (1999) Does familiarity breed concern? Bench scientists and the human genome mapping project. Science and Public Policy

Glasner P, Rothman H. Does familiarity breed concern? Bench scientists and the human genome mapping project. Science and Public Policy 1999.26(4):233-40. doi: 10.3152/147154399781782383, Available from: http://spp.oxfordjournals.org/content/26/4/233.abstract.

Type of reference	Article
Authors	Glasner P, Rothman H

15.3.64 Greely HT. (1999) The overlooked ethics of the human genome diversity project. Politics and the Life Sciences

Greely HT. The overlooked ethics of the human genome diversity project. Politics and the Life Sciences 1999.18(2):297-99. PubMed PMID: 12557893

Type of reference	Article
Authors	Greely HT

15.3.65 Greely HT. (2001) Human genome diversity: What about the other human genome project? Nature Reviews Genetics

Greely HT. Human genome diversity: What about the other human genome project? Nature Reviews Genetics 2001.2(3):222-7. doi: 10.1038/35056071. PubMed PMID: 11256074

Type of reference	Article
Authors	Greely HT

15.3.66 Green ED, Guyer MS. (2011) Charting a course for genomic medicine from base pairs to bedside.

Green ED, Guyer MS, National Human Genome Research I. Charting a course for genomic medicine from base pairs to bedside. Nature 2011.470(7333):204-13. doi: 10.1038/nature09764. PubMed PMID: 21307933

Type of reference	Article
Authors	Green ED, Guyer MS

15.3.67 Grisolia S. (1991) Ethical and social aspects of the human genome project. Impact of Science on Society

Grisolia S. Ethical and social aspects of the human genome project. Impact of Science on Society 1991.41[1(161)]):37-43. PubMed PMID: 11660526

Type of reference	Article
Authors	Grisolia S

15.3.68 Guyer MS, Collins FS. (1993) The human genome project and the future of medicine. American Journal of Diseases of Children

Guyer MS, Collins FS. The human genome project and the future of medicine. American Journal of Diseases of Children 1993.147(11):1145-52. PubMed PMID: 8237907

Type of reference	Article
Authors	Guyer MS, Collins FS

15.3.69 Harry D. (1996) The human genome diversity project and its implications for indigenous peoples. Genewatch : a bulletin of the Committee for Responsible Genetics

Harry D. The human genome diversity project and its implications for indigenous peoples. Genewatch : a bulletin of the Committee for Responsible Genetics 1996.10(2-3):8-9. PubMed PMID: 11660352

Type of reference	Article
Authors	Harry D

15.3.70 Henderson L, Kitzinger J. (2007) Orchestrating a science 'event': The case of the human genome project. New genetics and society

Henderson L, Kitzinger J. Orchestrating a science 'event': The case of the human genome project. New genetics and society 2007.26(1):65-83. doi: 10.1080/14636770701218175.

Type of reference	Article
Authors	Henderson L, Kitzinger J

15.3.71 Holland A, Clare IC. (2003) The human genome project: Considerations for people with intellectual disabilities. Journal of Intellectual Disability Research

Holland A, Clare IC. The human genome project: Considerations for people with intellectual disabilities. Journal of Intellectual Disability Research 2003.47(Pt 7):515-25. PubMed PMID: 12974884

Type of reference	Article
Authors	Holland A, Clare IC

15.3.72 Holmes EM. (1996) Solving the insurance/genetic fair/unfair discrimination dilemma in light of the human genome project. Kentucky Law Journal

Holmes EM. Solving the insurance/genetic fair/unfair discrimination dilemma in light of the human genome project. Kentucky Law Journal 1996.85(3):503-664. PubMed PMID: 11863023

Type of reference	Article
Authors	Holmes EM

15.3.73 Hubbard R. (2000) Eugenics and the human genome project. Genewatch

Hubbard R. Eugenics and the human genome project. Genewatch 2000.13(3):7-8. PubMed PMID: 12814102

Type of reference	Article
Authors	Hubbard R

15.3.74 Iles AT. (1996) The human genome project: A challenge to the human rights framework. Harvard Human Rights Journal

Iles AT. The human genome project: A challenge to the human rights framework. Harvard Human Rights Journal 1996.9:27-60. PubMed PMID: 11660498

Type of reference	Article
Authors	Iles AT

15.3.75 International Human Genome Sequencing Consortium. (2004) Finishing the euchromatic sequence of the human genome. Nature

International Human Genome Sequencing Consortium. Finishing the euchromatic sequence of the human genome. Nature 2004.431(7011):931-45. doi: 10.1038/nature03001. PubMed PMID: 15496913

Type of reference	Article

15.3.76 Jackson F. (1998) Scientific limitations and ethical ramifications of a non-representative human genome project: African american response. Science and Engineering Ethics

Jackson F. Scientific limitations and ethical ramifications of a non-representative human genome project: African american response. Science and Engineering Ethics 1998.4(2):155-70. PubMed PMID: 11657772

Type of reference	Article
Authors	Jackson F

15.3.77 Jin J. (2000) An evaluation of the ethical, legal and social implications program of the U.S. Human Genome Project. Princeton Journal of Bioethics

Jin J. An evaluation of the ethical, legal and social implications program of the U.S. Human Genome Project. Princeton Journal of Bioethics 2000.3(1):35-50. PubMed PMID: 11936136

Type of reference	Article
Authors	Jin J

15.3.78 Jordan E. (1992) The human genome project: Where did it come from, where is it going? American Journal of Human Genetics

Jordan E. The human genome project: Where did it come from, where is it going? American journal of human genetics 1992.51(1):1-6. Epub 1992/07/01. PubMed PMID: 1609788; PMCID: PMC1682896

Type of reference	Article
Authors	Jordan E

15.3.79 Juengst ET. (1991) The human genome project and bioethics. Kennedy Institute of Ethics journal

Juengst ET. The human genome project and bioethics. Kennedy Institute of Ethics journal 1991.1(1):71-4. PubMed PMID: 10113820

Type of reference	Article
Authors	Juengst ET

15.3.80 Juengst ET. (1996) Self-critical federal science? The ethics experiment within the U.S. Human genome project. Social Philosophy & Policy

Juengst ET. Self-critical federal science? The ethics experiment within the U.S. Human genome project. Social Philosophy & Policy 1996.13(2):63-95. PubMed PMID: 11653300

Type of reference	Article
Authors	Juengst ET

15.3.81 Kean S. (2011) Human genome 10th anniversary. The human genome (patent) project. Science

Kean S. Human genome 10th anniversary. The human genome (patent) project. Science 2011.331(6017):530-1. doi: 10.1126/science.331.6017.530. PubMed PMID: 21292952

Type of reference	Article
Authors	Kean S

15.3.82 Kennedy S, Shuman C. (2002) The impact of the human genome project clinical care and ethical challenges. Qatar Medical Journal

Kennedy S, Shuman C. The impact of the human genome project clinical care and ethical challenges. Qatar Medical Journal 2002.2002(1):8

Type of reference	Article
Authors	Kennedy S, Shuman C

15.3.83 Kimmelman J. (2006) The post-human genome project mindset: Race, reliability, and health care. Clinical Genetics

Kimmelman J. The post-human genome project mindset: Race, reliability, and health care. Clinical Genetics 2006.70(5):427-32. Epub 2006/10/10. doi: 10.1111/j.1399-0004.2006.00706.x. PubMed PMID: 17026628

Type of reference	Article
Authors	Kimmelman J

15.3.84 Kirby M. (1993) Legal problems: Human genome project. The Australian Law Journal

Kirby M. Legal problems: Human genome project. The Australian Law Journal 1993.67(12):894-903. PubMed PMID: 11659800

Type of reference	Article
Authors	Kirby M

15.3.85 Kirby M. (1994) The human genome project--promise and problems. The Journal of Contemporary Health Law and Policy

Kirby M. The human genome project--promise and problems. The Journal of Contemporary Health Law and Policy 1994.11(1):1-21. PubMed PMID: 10142389

Type of reference	Article
Authors	Kirby M

15.3.86 Klein E. (2010) To ELSI or not to ELSI neuroscience: Lessons for neuroethics from the human genome project. AJOB Neuroscience

Klein E. To ELSI or not to ELSI neuroscience: Lessons for neuroethics from the human genome project. AJOB Neuroscience 2010.1(4):3-8

Type of reference	Article
Authors	Klein E

15.3.87 Knoppers BM, Chadwick R. (1994) The human genome project: Under an international ethical microscope. Science

Knoppers BM, Chadwick R. The human genome project: Under an international ethical microscope. Science 1994.265(5181):2035-6. PubMed PMID: 8091225

Type of reference	Article
Authors	Knoppers BM, Chadwick R

15.3.88 Koski CA. (2005) The human genome project: An examination of its challenge to the technological imperative. New Genetics and Society

Koski CA. The human genome project: An examination of its challenge to the technological imperative. New Genetics and Society 2005.24(3):265-81. PubMed PMID: 16610129

Type of reference	Article
Authors	Koski CA

15.3.89 Lander ES. (1998) Scientific commentary: The scientific foundations and medical and social prospects of the human genome project. The Journal of Law, Medicine & Ethics

Lander ES. Scientific commentary: The scientific foundations and medical and social prospects of the human genome project. The Journal of Law, Medicine & Ethics 1998.26(3):184-8, 78. PubMed PMID: 11066875

Type of reference	Article
Authors	Lander ES

15.3.90 Laurie GT. (1996) The most personal information of all: An appraisal of genetic privacy in the shadow of the human genome project. International Journal of Law, Policy, and the Family

Laurie GT. The most personal information of all: An appraisal of genetic privacy in the shadow of the human genome project. International Journal of Law, Policy, and the Family 1996.10(1):74-101. PubMed PMID: 16883663

Type of reference	Article
Authors	Laurie GT

15.3.91 Lester LA, Lemke AMY, Levinson D, Mahowald MB. (1995) The human genome project and women cystic fibrosis: A case study. Journal of Women's Health

Lester LA, Lemke AMY, Levinson D, Mahowald MB. The human genome project and women cystic fibrosis: A case study. Journal of Women's Health 1995.4(6):623-35. doi: 10.1089/jwh.1995.4.623.

Type of reference	Article
Authors	Lester LA, Lemke AMY, Levinson D, Mahowald MB

15.3.92 Lewontin R. (1992) The dream of the human genome: Doubts about the human genome project. The New York Review of Books

Lewontin R. The dream of the human genome: Doubts about the human genome project. The New York Review of Books 1992.39(10):31-40. PubMed PMID: 11659413

Type of reference	Article
Authors	Lewontin R

15.3.93 Lock M. (1994) Interrogating the human diversity genome project. Social Science & Medicine

Lock M. Interrogating the human diversity genome project. Social Science & Medicine 1994.39(5):603-6. PubMed PMID: 7973860

Type of reference	Article
Authors	Lock M

15.3.94 Lone Dog L. (1999) Whose genes are they? The human genome diversity project. Journal of Health & Social Policy

Lone Dog L. Whose genes are they? The human genome diversity project. Journal of health & social policy 1999.10(4):51-66. doi: 10.1300/J045v10n04_04. PubMed PMID: 10538186

Type of reference	Article
Authors	Lone Dog L

15.3.95 Lunshof JE et al. (2010) Personal genomes in progress: From the human genome project to the personal genome project. Dialogues in Clinical Neuroscience

Lunshof JE, Bobe J, Aach J, Angrist M, Thakuria JV, Vorhaus DB, Hoehe MR, Church GM. Personal genomes in progress: From the human genome project to the personal genome project. Dialogues in Clinical Neuroscience 2010.12(1):47-60. PubMed PMID: 20373666; PMCID: PMC3181947

Type of reference	Article
Authors	Lunshof JE, Bobe J, Aach J, Angrist M, Thakuria JV, Vorhaus DB, Hoehe MR, Church GM

15.3.96 Lysaught MT. (1994) Map, myth, or medium of redemption: How do we interpret the human genome project? Second Opinion

Lysaught MT. Map, myth, or medium of redemption: How do we interpret the human genome project? Second Opinion 1994.19(4):76-84. PubMed PMID: 11645259

Type of reference	Article
Authors	Lysaught MT

15.3.97 Macer DR. (1999) Ethical opportunities offered by the human genome diversity project. Politics and the Life Sciences

Macer DR. Ethical opportunities offered by the human genome diversity project. Politics and the Life Sciences 1999.18(2):325-7. PubMed PMID: 12561791

Type of reference	Article
Authors	Macer DR

15.3.98 Mackler BF, Barach M. (1991) The human genome project in the united states: A perspective on the commercial, ethical, legislative and health care issues. International Journal of Bioethics

Mackler BF, Barach M. The human genome project in the united states: A perspective on the commercial, ethical, legislative and health care issues. International journal of bioethics 1991.2(3):149-57. PubMed PMID: 11654898

Type of reference	Article
Authors	Mackler BF, Barach M

15.3.99 Mahowald MB. (1997) The human genome project and women. Women's health issues

Mahowald MB. The human genome project and women. Women's health issues 1997.7(4):204-5. doi: 10.1016/S1049-3867(97)00010-8. PubMed PMID: 9283270

Type of reference	Article
Authors	Mahowald MB

15.3.100 Makowski DR. (1996) The human genome project and the clinician. The Journal of the Florida Medical Association

Makowski DR. The human genome project and the clinician. The Journal of the Florida Medical Association 1996.83(5):307-14. PubMed PMID: 8666966

Type of reference	Article
Authors	Makowski DR

15.3.101 McCain L. (2002) Informing technology policy decisions: The us human genome project's ethical, legal, and social implications programs as a critical case. Technology in Society

McCain L. Informing technology policy decisions: The us human genome project's ethical, legal, and social implications programs as a critical case. Technology in Society 2002.24(1–2):111-32. doi: 10.1016/S0160-791X(01)00048-3http://dx.doi.org/10.1016/S0160-791X(01)00048-3, Available from: http://www.sciencedirect.com/science/article/pii/S0160791X01000483.

Type of reference	Article
Authors	McCain L

15.3.102 McCann-Mortimer P, Augoustinos M, Lecouteur A. (2004) 'Race' and the human genome project: Constructions of scientific legitimacy. Discourse & Society

McCann-Mortimer P, Augoustinos M, Lecouteur A. 'Race' and the human genome project: Constructions of scientific legitimacy. Discourse & Society 2004.15(4):409-32. doi: 10.1177/0957926504043707.

Type of reference	Article
Authors	McCann-Mortimer P, Augoustinos M, Lecouteur A

15.3.103 McCloy L. (1996) The human genome project and social consequences of widespread genetic testing: What we have to learn from breast cancer. The Journal of the Oklahoma State Medical Association

McCloy L. The human genome project and social consequences of widespread genetic testing: What we have to learn from breast cancer. The Journal of the Oklahoma State Medical Association 1996.89(4):139-41. PubMed PMID: 8776166

Type of reference	Article
Authors	McCloy L

15.3.104 McConkey EH et al. (2000) Proposal for a human genome evolution project. Molecular Phylogenetics and Evolution

McConkey EH et al. Proposal for a human genome evolution project. Molecular Phylogenetics and Evolution 2000.15(1):1-4. doi: 10.1006/mpev.1999.0735. PubMed PMID: 10764529

Type of reference	Article
Authors	McConkey EH, Fouts R, Goodman M, Nelson D, Penny D, Ruvolo M, Sikela J, Stewart CB, Varki A, Wise S

15.3.105 McKusick VA. (1989) Hugo news. The human genome organisation: History, purposes, and membership. Genomics

McKusick VA. Hugo news. The human genome organisation: History, purposes, and membership. Genomics 1989.5(2):385-7. PubMed PMID: 2676842

Type of reference	Article
Authors	McKusick VA

15.3.106 McKusick VA. (1991) Current trends in mapping human genes. FASEB journal

McKusick VA. Current trends in mapping human genes. FASEB journal 1991.5(1):12-20. PubMed PMID: 1991580

Type of reference	Article
Authors	McKusick VA

15.3.107 McLean SA, Giesen D. (1994) Legal and ethical considerations of the human genome project. Medical Law International

McLean SA, Giesen D. Legal and ethical considerations of the human genome project. Medical Law International 1994.1(2):159-75. PubMed PMID: 11653112

Type of reference	Article
Authors	McLean SA, Giesen D

15.3.108 Mehlman MJ. (1999) The human genome project and the courts: Gene therapy and beyond. Judicature

Mehlman MJ. The human genome project and the courts: Gene therapy and beyond. Judicature 1999.83(3):124-30. PubMed PMID: 12737163

Type of reference	Article

Authors	Mehlman MJ

15.3.109 Morris LJ. (1994) Bioethical dilemmas: Decision-making and the human genome project. Science Teacher

Morris LJ. Bioethical dilemmas: Decision-making and the human genome project. Science Teacher 1994.61(2):38-41. PubMed PMID: 15584167

Type of reference	Article
Authors	Morris LJ

15.3.110 Mowat D. (2002) Ethical, legal and social issues surrounding the human genome project. Internal Medicine Journal

Mowat D. Ethical, legal and social issues surrounding the human genome project. Internal Medicine Journal 2002.32(3):89-90. PubMed PMID: 11885849

Type of reference	Article
Authors	Mowat D

15.3.111 Mundy C. (2001) The human genome project: A historical perspective. Pharmacogenomics

Mundy C. The human genome project: A historical perspective. Pharmacogenomics 2001.2(1):37-49. doi: 10.1517/14622416.2.1.37. PubMed PMID: 11258196

Type of reference	Article
Authors	Mundy C

15.3.112 Munger KM, Gill CJ, Ormond KE, Kirschner KL. (2007) The next exclusion debate: Assessing technology, ethics, and intellectual disability after the human genome project. Mental Retardation and Developmental Disabilities Research Reviews

Munger KM, Gill CJ, Ormond KE, Kirschner KL. The next exclusion debate: Assessing technology, ethics, and intellectual disability after the human genome project. Mental retardation and developmental disabilities research reviews 2007.13(2):121-8. doi: 10.1002/mrdd.20146. PubMed PMID: 17563891

Type of reference	Article
Authors	Munger KM, Gill CJ, Ormond KE, Kirschner KL

15.3.113 Murray TH, Livny E. (1995) The human genome project: Ethical and social implications. Bulletin of the Medical Library Association

Murray TH, Livny E. The human genome project: Ethical and social implications. Bulletin of the Medical Library Association 1995.83(1):14-21. PubMed PMID: 7703933; PMCID: PMC225990

Type of reference	Article
Authors	Murray TH, Livny E

15.3.114 Murray TH. (1991) Ethical issues in human genome research. FASEB journal

Murray TH. Ethical issues in human genome research. FASEB journal 1991.5(1):55-60. PubMed PMID: 1825074

Type of reference	Article
Authors	Murray TH

15.3.115 NHGRI Leadership. (2015) Understanding our genetic inheritance. The united states human genome project. The first five years: Fiscal years 1991-1995. NHGRI Executive Summary

NHGRI Leadership. Understanding our genetic inheritance. The united states human genome project. The first five years: Fiscal years 1991-1995. NHGRI Executive Summary 2015. Available from: https://www.genome.gov/10001477/human-genome-projects-fiveyear-plan-19911995/

Type of reference	Article

15.3.116 Niewöhner J. (2013) The material gene: Gender, race, and heredity after the human genome project. New genetics and society

Niewöhner J. The material gene: Gender, race, and heredity after the human genome project. New genetics and society 2013.32(4):459-61. doi: 10.1080/14636778.2013.852466.

Type of reference	Article
Authors	Niewöhner Jorg

15.3.117 Norman BJ, Miller SD. (2011) Human genome project and sickle cell disease. Social work in public health

Norman BJ, Miller SD. Human genome project and sickle cell disease. Social work in public health 2011.26(4):405-16. doi: 10.1080/19371918.2011.579488. PubMed PMID: 21707349

Type of reference	Article
Authors	Norman BJ, Miller SD

15.3.118 O'Connor NK. (1993) Human genome project. The Journal of family practice

O'Connor NK. Human genome project. The Journal of family practice 1993.36(1):14-5. PubMed PMID: 8419496

Type of reference	Article
Authors	O'Connor NK

15.3.119 O'Rourke KD. (2001) Genetics and ethics. Is the ministry prepared to answer ethical questions raised by the human genome project? Health progress

O'Rourke KD. Genetics and ethics. Is the ministry prepared to answer ethical questions raised by the human genome project? Health progress 2001.82(2):28-32. PubMed PMID: 11299877

Type of reference	Article
Authors	O'Rourke KD

15.3.120 Olson M, Hood L, Cantor C, Botstein D. (1989) A common language for physical mapping of the human genome. Science

Olson M, Hood L, Cantor C, Botstein D. A common language for physical mapping of the human genome. Science 1989.245(4925):1434-5. PubMed PMID: 2781285

Type of reference	Article
Authors	Olson M, Hood L, Cantor C, Botstein D

15.3.121 Patrinos A, Drell DW. (1997) The human genome project: View from the Department of Energy. Journal of the American Medical Women's Association

Patrinos A, Drell DW. The human genome project: View from the Department of Energy. Journal of the American Medical Women's Association 1997.52(1):8-10. PubMed PMID: 9033165

Type of reference	Article
Authors	Patrinos A, Drell DW

15.3.122 Patrinos AA. (2000) The human genome project: Interaction of the physical sciences with biology. The Journal of Law, Medicine & Ethics

Patrinos AA. The human genome project: Interaction of the physical sciences with biology. The Journal of Law, Medicine & Ethics 2000.28(4 Suppl):54-64. PubMed PMID: 11244845

Type of reference	Article
Authors	Patrinos AA

15.3.123 Pellegrino ED. (2001) The human genome project: The central ethical challenge. St Thomas Law Review

Pellegrino ED. The human genome project: The central ethical challenge. St Thomas Law Review 2001.13(4):815-25. PubMed PMID: 12661542

Type of reference	Article
Authors	Pellegrino ED

15.3.124 Pellerin C. (1994) Ethical, legal, and social issues of the human genome project: What to do with what we know. Environmental Health Perspectives

Pellerin C. Ethical, legal, and social issues of the human genome project: What to do with what we know. Environmental Health Perspectives 1994.102(1):58-9. PubMed PMID: 9719668; PMCID: PMC1567247

Type of reference	Article
Authors	Pellerin C

15.3.125 Peters TF, Russell RJ. (1992) The human genome project: What questions does it raise for theology and ethics? Midwest medical ethics : a publication of the Midwest Bioethics Center

Peters TF, Russell RJ. The human genome project: What questions does it raise for theology and ethics? Midwest medical ethics : a publication of the Midwest Bioethics Center 1992.8(1):12-7. Epub 1992/07/01. PubMed PMID: 16038081

Type of reference	Article
Authors	Peters TF, Russell RJ

15.3.126 Phan KL, Doukas DJ, Fetters MD. (1995) Religious leaders' attitudes and beliefs about genetics research and the human genome project. The Journal of Clinical Ethics

Phan KL, Doukas DJ, Fetters MD. Religious leaders' attitudes and beliefs about genetics research and the human genome project. The Journal of Clinical Ethics 1995.6(3):237-46. PubMed PMID: 8605386

Type of reference	Article
Authors	Phan KL, Doukas DJ, Fetters MD

15.3.127 Phoenix DD et al. (1995) Sickle cell screening policies as portent: How will the human genome project affect public sector genetic services? Journal of the National Medical Association

Phoenix DD et al. Sickle cell screening policies as portent: How will the human genome project affect public sector genetic services? Journal of the National Medical Association 1995.87(11):807-12. PubMed PMID: 8907815; PMCID: PMC2607960

Type of reference	Article
Authors	Phoenix DD, Lybrook SM, Trottier RW, Hodgin FC, Crandall LA

15.3.128 Phua K-L. (2004) The human genome project and genetic research: What are the implications for ethics and equity? Critical Public Health

Phua K-L. The human genome project and genetic research: What are the implications for ethics and equity? Critical Public Health 2004.14(2):191-200. doi: 10.1080/09581590410001725427.

Type of reference	Article
Authors	Phua K-L

15.3.129 Pohlhaus JR, Cook-Deegan RM. (2008) Genomics research: World survey of public funding. BMC genomics

Pohlhaus JR, Cook-Deegan RM. Genomics research: World survey of public funding. BMC genomics 2008.9:472. doi: 10.1186/1471-2164-9-472. PubMed PMID: 18847466; PMCID: PMC2576262

Type of reference	Article
Authors	Pohlhaus JR, Cook-Deegan RM

15.3.130 Polychronakos C. (2003) Impact of the human genome project on pediatric endocrinology. Hormone research

Polychronakos C. Impact of the human genome project on pediatric endocrinology. Hormone research 2003.59(2):55-65. Epub 2003/02/18. doi: 10.1159/000068574. PubMed PMID: 12589108

Type of reference	Article
Authors	Polychronakos C

15.3.131 Raskin S. (2000) And the monster is--us? Ethical, legal, and social issues of the human genome project. Maryland Medicine

Raskin S. And the monster is--us? Ethical, legal, and social issues of the human genome project. Maryland Medicine 2000.1(4):23-5. PubMed PMID: 11147453

Type of reference	Article
Authors	Raskin S

15.3.132 Reardon J. (2001) The human genome diversity project: A case study in coproduction. Social Studies of Science

Reardon J. The human genome diversity project: A case study in coproduction. Social Studies of Science 2001.31(3):357-88. doi: 10.1177/030631201031003002

Type of reference	Article
Authors	Reardon J

15.3.133 Reilly PR. (2001) The human genome project. Recent genetic advances will have far-reaching implications for catholic health care. Health progress

Reilly PR. The human genome project. Recent genetic advances will have far-reaching implications for catholic health care. Health progress 2001.82(2):24-7. PubMed PMID: 11299876

Type of reference	Article
Authors	Reilly PR

15.3.134 Resnik DB. (1999) The human genome diversity project: Ethical problems and solutions. Politics and the Life Sciences

Resnik DB. The human genome diversity project: Ethical problems and solutions. Politics and the Life Sciences 1999.18(1):15-23. PubMed PMID: 11660815

Type of reference	Article
Authors	Resnik DB

15.3.135 Rix BA. (1991) Should ethical concerns regulate science? The European experience with the human genome project: A report from Denmark. Bioethics

Rix BA. Should ethical concerns regulate science? The European experience with the human genome project: A report from Denmark. Bioethics 1991.5(3):250-6. PubMed PMID: 11659342

Type of reference	Article
Authors	Rix BA

15.3.136 Roberts L. (1988) Carving up the human genome. Science

Roberts L. Carving up the human genome. Science 1988.242(4883):1244-6. PubMed PMID: 2904174

Type of reference	Article
Authors	Roberts L

15.3.137 Roberts L. (1989) New game plan for genome mapping. Science

Roberts L. New game plan for genome mapping. Science 1989.245(4925):1438-40. PubMed PMID: 2781288

Type of reference	Article
Authors	Roberts L

15.3.138 Roberts L. (1990) The genetic map is back on track after delays. Science

Roberts L. The genetic map is back on track after delays. Science 1990.248(4957):805. PubMed PMID: 11659233

Type of reference	Article
Authors	Roberts L

15.3.139 Roberts L. (2001) The human genome. Controversial from the start. Science

Roberts L. The human genome. Controversial from the start. Science 2001.291(5507):1182-8. PubMed PMID: 11233424

Type of reference	Article
Authors	Roberts L

15.3.140 Rodriguez E. (1998) The human genome project and eugenics. The Linacre Quarterly

Rodriguez E. The human genome project and eugenics. The Linacre Quarterly 1998.65(2):73-82. PubMed PMID: 11655361

Type of reference	Article
Authors	Rodriguez E

15.3.141 Rodriguez E. (2000) Social attitudes and the human genome project: Ethical implications. The Linacre Quarterly

Rodriguez E. Social attitudes and the human genome project: Ethical implications. The Linacre Quarterly 2000.67(1):28-40. PubMed PMID: 12199283

Type of reference	Article
Authors	Rodriguez E

15.3.142 Rosner M, Johnson TR. (1995) Telling stories: Metaphors of the human genome project. Hypatia

Rosner M, Johnson TR. Telling stories: Metaphors of the human genome project. Hypatia 1995.10(4):104-29. PubMed PMID: 11660599

Type of reference	Article
Authors	Rosner M, Johnson TR

15.3.143 Sachs BP, Korf B. (1993) The human genome project: Implications for the practicing obstetrician. Obstetrics and gynecology

Sachs BP, Korf B. The human genome project: Implications for the practicing obstetrician. Obstetrics and gynecology 1993.81(3):458-62. PubMed PMID: 8437805

Type of reference	Article
Authors	Sachs BP, Korf B

15.3.144 Saunders M. (2011) The human genome project: An historical perspective for social workers. Social work in public health

Saunders M. The human genome project: An historical perspective for social workers. Social work in public health 2011.26(4):336-48. doi: 10.1080/19371918.2011.579041. PubMed PMID: 21707344

Type of reference	Article
Authors	Saunders M

15.3.145 Sawicki MP, Samara G, Hurwitz M, Passaro E, Jr. (1993) Human genome project. American journal of surgery

Sawicki MP, Samara G, Hurwitz M, Passaro E, Jr. Human genome project. American journal of surgery 1993.165(2):258-64. PubMed PMID: 8427408

Type of reference	Article
Authors	Sawicki MP, Samara G, Hurwitz M, Passaro E, Jr.

15.3.146 Schimpf MO, Domino SE. (2001) Implications of the human genome project for obstetrics and gynecology. Obstetrical & gynecological survey

Schimpf MO, Domino SE. Implications of the human genome project for obstetrics and gynecology. Obstetrical & gynecological survey 2001.56(7):437-43. PubMed PMID: 11435952

Type of reference	Article
Authors	Schimpf MO, Domino SE

15.3.147 Schuklenk U. (1999) The human genome diversity project: Ethical concerns. Politics and the Life Sciences

Schuklenk U. The human genome diversity project: Ethical concerns. Politics and the Life Sciences 1999.18(2):332-3. PubMed PMID: 12561794

Type of reference	Article
Authors	Schuklenk U

15.3.148 Schulz A, Caldwell C, Foster S. (2003) "What are they going to do with the information?" Latino/latina and african american perspectives on the human genome project. Health Education & Behavior

Schulz A, Caldwell C, Foster S. "What are they going to do with the information?" Latino/latina and african american perspectives on the human genome project. Health education & behavior 2003.30(2):151-69. PubMed PMID: 12693521

Type of reference	Article
Authors	Schulz A, Caldwell C, Foster S

15.3.149 Sinsheimer RL. The Santa Cruz workshop--May 1985. Genomics

Sinsheimer RL. The Santa Cruz workshop--May 1985. Genomics 1989.5(4):954-6. PubMed PMID: 2591974

Type of reference	Article
Authors	Sinsheimer RL

15.3.150 Smith D. (1995) Evolution of a vision: Genome project origins, present and future challenges, and far-reaching benefits. Part 1. Human Genome News

Smith D. Evolution of a vision: Genome project origins, present and future challenges, and far-reaching benefits. Part 1. Human Genome News 1995.7(3-4):2, Available from: http://web.ornl.gov/sci/techresources/Human_Genome/publicat/hgn/v7n3/02smithr.shtml

Type of reference	Article
Authors	Smith D

15.3.151 Smith GK, Kettelberger DM. (1994) Patents and the human genome project. AIPLA quarterly journal

Smith GK, Kettelberger DM. Patents and the human genome project. AIPLA quarterly journal 1994.22(1):27-64. PubMed PMID: 11660522

Type of reference	Article
Authors	Smith GK, Kettelberger DM

15.3.152 Smith JD. (1994) Reflections on mental retardation and eugenics, old and new: Mensa and the human genome project. Mental Retardation

Smith JD. Reflections on mental retardation and eugenics, old and new: Mensa and the human genome project. Mental Retardation 1994.32(3):234-8. PubMed PMID: 8084276

Type of reference	Article
Authors	Smith JD

15.3.153 Smith JE. (1993) Ethical issues raised by the human genome project. American Journal of Hospital Pharmacy

Smith JE. Ethical issues raised by the human genome project. American journal of hospital pharmacy 1993.50(9):1945-50. PubMed PMID: 8135246

Type of reference	Article
Authors	Smith JE

15.3.154 Sorenson JR, Cheuvront B. (1993) The human genome project and health behavior and health education research. Health Education Research

Sorenson JR, Cheuvront B. The human genome project and health behavior and health education research. Health education research 1993.8(4):589-93. PubMed PMID: 10146565

Type of reference	Article
Authors	Sorenson J, Cheuvront B

15.3.155 Spengler SJ. (1997) Emerging technologies from the human genome project for understanding susceptibility and risk. Environmental Toxicology and Pharmacology

Spengler SJ. Emerging technologies from the human genome project for understanding susceptibility and risk. Environmental toxicology and pharmacology 1997.4(3-4):235-8. PubMed PMID: 21781826

Type of reference	Article
Authors	Spengler SJ

15.3.156 Spier RE. (1998) The human genome project under the microscope. Science and Engineering Ethics

Spier RE. The human genome project under the microscope. Science and Engineering Ethics 1998.4(2):131-4. PubMed PMID: 11657768

Type of reference	Article
Authors	Spier RE

15.3.157 Tauer JE. (2001) International protection of genetic information: The progression of the human genome project and the current framework of human rights doctrines. Denver Journal of International Law and Policy

Tauer JE. International protection of genetic information: The progression of the human genome project and the current framework of human rights doctrines. Denver journal of international law and policy 2001.29(3-4):209-37. PubMed PMID: 12769121

Type of reference	Article
Authors	Tauer JE

15.3.158 van Ommen GJ. (1998) The human genome project and the role of genetics in health care. Clinical chemistry and laboratory medicine

van Ommen GJ. The human genome project and the role of genetics in health care. Clinical chemistry and laboratory medicine 1998.36(8):515-7. doi: 10.1515/CCLM.1998.087. PubMed PMID: 9806451

Type of reference	Article
Authors	van Ommen GJ

15.3.159 Vicedo M. (1992) The human genome project: Towards an analysis of the empirical, ethical, and conceptual issues involved. Biology and Philosophy

Vicedo M. The human genome project: Towards an analysis of the empirical, ethical, and conceptual issues involved. Biology and Philosophy 1992.7(3):255-78. doi: 10.1007/bf00129970.

Type of reference	Article
Authors	Vicedo M

15.3.160 Walker RL, Morrissey C. (2014) Bioethics methods in the ethical, legal, and social implications of the human genome project literature. Bioethics

Walker RL, Morrissey C. Bioethics methods in the ethical, legal, and social implications of the human genome project literature. Bioethics 2014.28(9):481-90. doi: 10.1111/bioe.12023. PubMed PMID: 23796275; PMCID: PMC3785570

Type of reference	Article
Authors	Walker RL, Morrissey C

15.3.161 Wallace RW. (1998) The human genome diversity project: Medical benefits versus ethical concerns. Molecular medicine today

Wallace RW. The human genome diversity project: Medical benefits versus ethical concerns. Molecular medicine today 1998.4(2):59-62. doi: 10.1016/S1357-4310(97)01206-9. PubMed PMID: 9547791

Type of reference	Article
Authors	Wallace RW

15.3.162 Walsh J. (1994) Reproductive rights and the human genome project. Southern California Review of Law and Women's studies

Walsh J. Reproductive rights and the human genome project. Southern California Review of Law and Women's studies 1994.4(1):145-81. PubMed PMID: 11660643

Type of reference	Article
Authors	Walsh J

15.3.163 Watson JD, Cook-Deegan RM. (1990) The human genome project and international health. JAMA

Watson JD, Cook-Deegan RM. The human genome project and international health. JAMA 1990.263(24):3322-4. PubMed PMID: 2348545

Type of reference	Article
Authors	Watson JD, Cook-Deegan RM

15.3.164 Watson JD, Cook-Deegan RM. (1991) Origins of the human genome project. FASEB journal

Watson JD, Cook-Deegan RM. Origins of the human genome project. FASEB journal 1991.5(1):8-11. PubMed PMID: 1991595

Type of reference	Article
Authors	Watson JD, Cook-Deegan RM

15.3.165 Watson JD, Jordan E. (1989) The human genome program at the National Institutes of Health. Genomics

Watson JD, Jordan E. The human genome program at the National Institutes of Health. Genomics 1989.5(3):654-6. PubMed PMID: 2613247

Type of reference	Article
Authors	Watson JD, Jordan E

15.3.166 Watson JD. (1990) The human genome project: Past, present, and future. Science

Watson JD. The human genome project: Past, present, and future. Science 1990.248(4951):44-9. PubMed PMID: 2181665

Type of reference	Article
Authors	Watson JD

15.3.167 Wattanapitayakul S, Schommer JC. (1999) The human genome project: Benefits and risks to society. Drug Information Journal

Wattanapitayakul S, Schommer JC. The human genome project: Benefits and risks to society. Drug Information Journal 1999.33(3):729-35

Type of reference	Article
Authors	Wattanapitayakul S, Schommer JC

15.3.168 Whittaker LA. (1992) The implications of the human genome project for family practice. The Journal of Family Practice

Whittaker LA. The implications of the human genome project for family practice. The Journal of family practice 1992.35(3):294-301. PubMed PMID: 1517727

Type of reference	Article

Authors	Whittaker LA

15.3.169 Wicks AC, Sever LE, Harty R, Gajewski SW, Marcus-Smith M. (1999) Screening workers for genetic hypersusceptibility: Potential ethical, legal, and social implications from the human genome project. Journal of Health and Human Services Administration

Wicks AC, Sever LE, Harty R, Gajewski SW, Marcus-Smith M. Screening workers for genetic hypersusceptibility: Potential ethical, legal, and social implications from the human genome project. Journal of health and human services administration 1999.22(1):116-32. PubMed PMID: 10848187

Type of reference	Article
Authors	Wicks AC, Sever LE, Harty R, Gajewski SW, Marcus-Smith M

15.3.170 Wiechers IR, Perin NC, Cook-Deegan R. (2013) The emergence of commercial genomics: Analysis of the rise of a biotechnology subsector during the human genome project, 1990 to 2004. Genome medicine

Wiechers IR, Perin NC, Cook-Deegan R. The emergence of commercial genomics: Analysis of the rise of a biotechnology subsector during the human genome project, 1990 to 2004. Genome medicine 2013.5(9):83. doi: 10.1186/gm487. PubMed PMID: 24050173; PMCID: PMC3971346

Type of reference	Article
Authors	Wiechers IR, Perin NC, Cook-Deegan R

15.3.171 Wiesenthal DL, Wiener NI. (1996) Privacy and the human genome project. Ethics & Behavior

Wiesenthal DL, Wiener NI. Privacy and the human genome project. Ethics & Behavior 1996.6(3):189-202. doi: 10.1207/s15327019eb0603_2. PubMed PMID: 11654975

Type of reference	Article
Authors	Wiesenthal DL, Wiener NI

15.3.172 Williams SJ, Hayward NK. (2001) The impact of the human genome project on medical genetics. Trends in molecular medicine

Williams SJ, Hayward NK. The impact of the human genome project on medical genetics. Trends in molecular medicine 2001.7(5):229-31. PubMed PMID: 11325635

Type of reference	Article
Authors	Williams SJ, Hayward NK

15.3.173 Wolfsberg TG et al. (2002) A user's guide to the human genome. Nature Genetics

Wolfsberg TG et al. A user's guide to the human genome. Nature Genetics 2002.32 Suppl:1-79. doi: 10.1038/ng961. PubMed PMID: 12236228

Type of reference	Article
Authors	Wolfsberg TG, Wetterstrand KA, Guyer MS, Collins FS, Baxevanis AD

15.3.174 Yaes RJ. (1990) Funding the human genome project. JAMA

Yaes RJ. Funding the human genome project. JAMA 1990.264(22):2866-7. PubMed PMID: 2288595

Type of reference	Article
Authors	Yaes RJ

15.3.175 Yesley MS. (2008) What's ELSI got to do with it? Bioethics and the human genome project. New genetics and society

Yesley MS. What's ELSI got to do with it? Bioethics and the human genome project. New genetics and society 2008.27(1):1-6

Type of reference	Article
Authors	Yesley MS

15.3.176 Zneimer SM. (2002) The human genome project: Exploring its progress and successes and the ethical, legal, and social implications. Clinical leadership & management review : the journal of CLMA

Zneimer SM. The human genome project: Exploring its progress and successes and the ethical, legal, and social implications. Clinical leadership & management review : the journal of CLMA 2002.16(3):151-7. PubMed PMID: 12046269

Type of reference	Article
Authors	Zneimer SM

15.4 Books

15.4.1 Abraham lincoln's DNA and other adventures in genetics

Type of reference	Book
Authors	Reilly PR
Year	2002
Publisher	Cold Spring Harbor Laboratory Press
ISBN	9780879696498
Link	https://books.google.com/books?id=1mvLjlJUV_IC

15.4.2 A Century of Eugenics in America: From the Indiana Experiment to the Human Genome Era

Type of reference	Book
Year	2010
Link	http://www.iupress.indiana.edu/product_info.php?products_id=464617
Review	"Paul Lombardo is a noted author on the sterilization laws that emerged out of the early 20th - century eugenics movement. He has edited a volume of ten essays that trace the change in view of eugenics over the past century. The essays attempt to "describe and analyze the many ways the term [eugenics] was used to justify cultural shifts, social programs, and laws in the United States" (p. 2). The eugenics movement was fostered by the middle class, in particular, health and social welfare professionals. They considered that both good, and bad, mental and physical health, intelligence, social economic status were inherited. Reformers advocated both positive and negative eugenic reforms to eliminate disease, crime, and poverty, which in turn could lower the tax burden." -Ruth Clifford Engs, *The Quarterly Review of Biology*, December 2011 http://www.jstor.org/stable/10.1086/662511

15.4.3 A troublesome inheritance: Genes, race and human history

Wade N

Type of reference	Book
Year	2014
Publisher	Penguin Publishing Group
ISBN	9780698163799
Link	https://books.google.com/books?id=hPp4AgAAQBAJ

15.4.4 Biology, Computing, and the History of Molecular Sequencing: from Proteins to DNA, 1945-2000

Type of reference	Book
Year	2012
Link	http://www.palgrave.com/products/title.aspx?pid=407773
Review	"…Miguel Garcia-Sancho's history of molecular sequencing is both timely and relevant for making sense of contemporary biomedical practices that rely so deeply on sequencing. The narrative cuts a narrow slice through the varied and complex terrains of physics, biochemistry, molecular biology, computing, instrumentation and business in which sequencing practices emerged and developed. In doing so, it reveals how the second half of the twentieth century has seen biology develop into a highly interdisciplinary set of practices, not merely dominated by the tools and concepts of molecular biology but interwoven and overlaid with techniques from a variety of fields." -Hallam Stevens, *Social History of Medicine*, 2014 http://shm.oxfordjournals.org/content/27/2/397.extract#

15.4.5 Biotechnology and the Human Genome: Innovations and Impact

Type of reference	Book
Editors	Woodhead, Avril D.; Barnhart, Benjamin J.; Vivirito, Katherine
Year	1988
Publisher	Basic Life Sciences
ISBN	978-1-4684-5549-6 (Print) 978-1-4684-5547-2 (Online)
External Link	https://books.google.com/books?id=V3vdBwAAQBAJ&pg=PR2&lpg=PR2&dq=Biotechnology+and+the+Human+Genome+and%20Impact&f=false

15.4.6 Blood of the isles

Type of reference	Book
Authors	Sykes B
Year	2011
Publisher	Transworld
ISBN	9781446438800
Link	https://books.google.com/books?id=3ccq6DZgmLEC

15.4.7 Bones, brains and DNA: The human genome and human evolution

Type of reference	Book
Authors	Tattersall I DeSalle R Wynne PJ
Year	2007
Publisher	Bunker Hill Pub
ISBN	9781593730567
Link	https://books.google.com/books?id=E80VNEsU694C

15.4.8 Brave New World?: Theology, Ethics and the Human Genome

Type of reference	Book
Authors	Celia Deane-Drummond
Year	2003
Link	http://books.google.com/books/about/Brave_New_World.html?id=3wKvOLPORHwC

15.4.9 Controlling Our Destinies: Historical, Philosophical, Ethical, Theological Perspectives on the Human Genome Project

Type of reference	Book

Year	2000
Link	http://undpress.nd.edu/book/P00522
Review	"Building on a conference at Notre Dame in 1995, this anthology explores some of the philosophic and theological questions stirred by The Human Genome Project (HGP). So, while there is mention of issues like confidentiality, screening and the like, the book is addressed to more basic themes: reductionism, materialism, determinism, causality, eugenics, the import of molecular biology for ideas about human nature. A fruitful text, the reader is bound to find several essays that meet his or her needs and interests...." -Howard Radest http://metapsychology.mentalhelp.net/poc/view_doc.php?type=book&id=277

15.4.10 Cracking the Genome: Inside the Race to Unlock Human DNA - first popular science book on the Human Genome Project

Type of reference	Book
Authors	Davies, Kevin
Year	2001
Publisher	Free Press
ISBN	978-0743204798
Link	http://books.google.com/books/about/Cracking_the_Genome.html?id=EnqT-HvWdKMC
Review	“Davies provides a compelling overview of [the human genome] project... If you want a sense of both the excitement of the human genome project, and of its promise, or if you simply want the story of the most important scientific development of the past half century, this book is essential reading.” — Kenan Malik, *Daily Telegraph*http://www.telegraph.co.uk/culture/4721849/Private-genes-public-genes.html

15.4.11 Dangerous diagnostics: The social power of biological information

Type of reference	Book
Authors	Nelkin D Tancredi LR
Year	1994
Publisher	University of Chicago Press
ISBN	9780226571294
Link	https://books.google.com/books?id=Q_ftRP3l4n8C

15.4.12 Decoding Our DNA: Craig Venter vs the Human Genome Project

Type of reference	Book
Authors	Karen Ballen
Year	2012
Link	http://www.amazon.com/Decoding-Our-DNA-Scientific-Rivalries/dp/0761354891

15.4.13 DNA USA: A genetic portrait of america

Type of reference	Book
Authors	Sykes B
Year	2012
Publisher	Liveright
ISBN	9780871404763
Link	https://books.google.com/books?id=5oyhspzVy6cC

15.4.14 Drawing the Map of Life: Inside the Human Genome Project

Type of reference	Book
Authors	McElheny, Victor
Year	2010
Link	http://www.pbgtoolkit.com/book.php?isbn=9780465028955
Review	"Since the 1970s Victor McElheny has chronicled the maturation of molecular biology from the thrilling vanguard of laboratory science into an economic powerhouse and the core discipline of biomedicine. His 2003 life of James Watson is the first biography of the celebrated co-solver of the structure of DNA. In his latest book McElheny draws on firsthand experience, news reports and press releases, interviews, the scientific literature, and some scholarly books in recounting the origins of the Human Genome Project and bringing its story up-to-date. He chooses to emphasize the genome as technology, an approach that, without some sophistication, easily leads to a triumphalist narrative—a seduction that McElheny makes no visible effort to resist." -Nathaniel Comfort, *Technology and Culture*, January 2012 https://muse.jhu.edu/login?auth=0&type=summary&url=/journals/technology_and_culture/v053/53.1.comfort.html

15.4.15 Gene Mapping: Using Law and Ethics as Guides

Type of reference	Book
Year	1992
Link	https://books.google.com/books/about/Gene_Mapping.html?id=LnRrAAAAMAAJ
Review	“This volume takes the reader through all the main ethical aspects of the project to map the human genome: the question of the moral distinction between somatic and germline gene therapy (here regarded as difficult to uphold); privacy and control of genetic information, including the possible consequences of genetic testing for insurance and employment, and the danger of the reinforcement of racial prejudice.” –Ruth Chadwick, *Journal of Medical Ethics*, 1994 http://jme.bmj.com/content/20/2/118.1.full.pdf+html

15.4.16 Genes and Human Self-Knowledge: Reflections on Modern Genetics

Type of reference	Book

Authors	Robert F. Weir, Susan C. Lawrence, Evan Fales
Year	1994
Link	http://books.google.com/books/about/Genes_And_Human_Self_Knowledge.html?id=rd54VprASbAC
Review	“Scientists may have an insufficient knowledge or interest in ethics, philosophy or psychosocial issues, and vice versa…. Genes and Human Self Knowledge is the publication of the proceedings of a four-day symposium held at the University of Iowa in 1992, which attempts to provide this interdisciplinary approach. The symposium gathered together experts from several different areas; philosophers, historians, biomedical ethicists, molecular genetic scientists, clinical geneticists and members of the general public to address various aspects of human genetics with special reference to the impact of the Human Genome Project (HGP) on these aspects.” –Anneke Lucassen, *Journal of Medical Ethics*, 1995 http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1376726/?page=1

15.4.17 Genetic Analysis: Genes, Genomes, and Networks in Eukaryotes (2nd Edition)

Meneely, Philip. Genetic Analysis: Genes, Genomes, and Networks in Eukaryotes 2nd Edition, Oxford University Press, Oxford, UK, 2014, p. 107

Type of reference	Book
Authors	Meneely, Philip
Year	2014

15.4.18 Gene Wars: Science, Politics, and the Human Genome

Type of reference	Book
Authors	Robert Cook-Deegan
Year	1994
Link	http://books.google.com/books/about/The_Gene_Wars.html?id=5B0k-LUDjVEC
Review	"In 1986-88, Cook-Deegan directed a team at the Office of Technology Assessment advising Congress on the human genome project, and later he headed a bioethics committee concerned with its policy implications. From this vantage point he relates how what began as a technological vision has been shaped by powerful political forces. Initially, he describes the scientific ideas and the technology that gave the project its impetus, moving on to track the bureaucratic involvement that began in 1985 when the Department of Energy, interested in genetic effects of exposure to the atomic bomb, proposed sequencing the human genome." - *Kirkus Reviews*, January 1994 https://www.kirkusreviews.com/book-reviews/robert-cook-deegan/the-gene-wars/

15.4.19 Genome: The Autobiography of a Species in 23 Chapters

Type of reference	Book
Authors	Ridley, Matt
Year	1999
Publisher	Harper
ISBN	978-0060194970
Link	http://books.google.com/books/about/Genome.html?id=h2zcDWshkEkC
Review	"It is not about the Human Genome Project or the way research is carried out. Ridley, a British journalist with a doctoral degree in zoology, does touch on the incredible potential of genetics for alleviating human misery, and he can't help releasing regular salvos at the antigenetics crowd. But much of his remarkable book is focused on a higher plane of pure intellectual discovery. It is a nearly jargon-free expedition that hops from one human chromosome to the next (23 in all) in search of the most delightful stories. Even practicing geneticists -- apt to view the genome as a boring research tool -- will come away with a greater sense of wonder at the hidden secrets in the text." -Lee Silver, *New York Times*, 27 February 2000 https://www.nytimes.com/books/00/02/27/reviews/000227.27silvert.html

15.4.20 Genomics: The Science and Technology Behind the Human Genome Project

Type of reference	Book
Year	1999
Link	http://onlinelibrary.wiley.com/book/10.1002/0471220566
Review	“This book is an outgrowth of a series of lectures given by one of the former heads (CRC) of the Human Genome Initiative. The book is designed to reach a wide audience, from biologists with little chemical or physical science background through engineers, computer scientists, and physicists with little current exposure to the chemical or biological principles of genetics.” – Martin Serra, *Journal of Chemical Education*, January 2000 http://pubs.acs.org/doi/pdf/10.1021/ed077p33

15.4.21 Guide to the Human Genome Project: Technologies, People, and Information

Type of reference	Book
Year	1993
Link	http://books.google.com/books/about/A_Guide_to_the_Human_Genome_Project.html?id=IWr15gWQED4C

15.4.22 Human natures: Genes, cultures, and the human prospect

Type of reference	Book

Authors	Ehrlich PR
Year	2000
Publisher	Island Press
ISBN	9781559637794
Link	https://books.google.com/books?id=mHFsScY8ewMC

15.4.23 Human origins: What bones and genomes tell us about ourselves

Type of reference	Book
Authors	DeSalle R Tattersall I
Year	2008
Publisher	Texas A & M University Press
ISBN	9781603446761
Link	https://books.google.com/books?id=Bf4Sitw7YaIC

15.4.24 Jacob's Ladder: The History of the Human Genome Project

Type of reference	Book
Authors	Henry Gee
Year	2004
Link	http://books.google.com/books/about/Jacob_s_Ladder.html?id=cUWlYdEPY7IC
Review	"*Nature* science writer Gee begins with a description of how a fertilized human egg develops into a person. As everyone has observed, that person will resemble both parents in various ways, but how are those traits inherited? Aristotle thought that the fetus was made largely out of menstrual blood; others thought that semen carried the entire reproductive package. The details of reproduction weren't sorted out until the 17th century, when the newly invented microscope revealed the nature of sperm. Even two centuries later, a serious obstacle to the acceptance of Darwin's theories was scientists' incomplete understanding of just how heredity worked. Mendel's work, which sorted out of the fundamentals of genetics, provided the missing link, and Thomas Hunt Morgan's meticulous study of fruit flies proved that genes were more than just a metaphor." -*Kirkus Reviews* https://www.kirkusreviews.com/book-reviews/henry-gee/jacobs-ladder-2/

15.4.25 Life out of Sequence: A Data-Driven History of Bioinformatics

Type of reference	Book
Year	2013
Link	http://press.uchicago.edu/ucp/books/book/chicago/L/bo16744390.html
Review	"No one ever spoke of 'phys-informatics' when computers entered physics after World War II, Hallam Stevens notes toward the end of *Life Out of Sequence*, yet 'bioinformatics' quickly came to slip naturally from tongues and keyboards to designate the seemingly novel domain created when computers later colonized biology. How bioinformatics emerged as a distinct domain of biological knowledge and practice and how it may eventually disappear, coming to be completely incorporated into its host, are the subjects of this sharp and lucid work of history and anthropology of science." -Michael Fortun, *Science*, 7 February 2014 http://www.sciencemag.org/content/343/6171/613.full

15.4.26 Life script: How the human genome discoveries will transform medicine and enhance your health

Type of reference	Book
Authors	Wade N
Year	2002
Publisher	Simon & Schuster
ISBN	9780743217392
Link	https://books.google.com/books?id=j6NPNz-YKCMC

15.4.27 Living with the Genome: Ethical and Social Aspects of Human Genetics

Type of reference	Book
Editors	A. Clarke, F. Ticehurst
Year	2006
Link	http://www.palgrave.com/page/detail/living-with-the-genome-angus-clarke/?isb=9781403936202
Review	"*Living with the Genome* has its origins in the Encyclopaedia of the Human Genome, and comprises an edited collection of the 'ethical and social' (but not legal) contributions to the latter text. It is therefore a far more economical alternative for the non-scientist. The book is sensibly divided into six sections, each with a well-written introduction by the editors. These sections consist of 5-8 short chapters of around six pages each. Such short chapters cannot give a full account of the ideas or research the authors seek to present; however, they serve as a useful introduction to prominent projects or concepts." -Martyn Pickersgill, *Medical Sociology Online*, November 2007 http://www.medicalsociologyonline.org/resources/MSo-&-MSN-Archive/MSo_v.2/MSoVol02Issue2.pdf

15.4.28 Mapping and Sequencing the Human Genome

Type of reference	Book
Authors	Committee on Mapping and Sequencing the Human Genome, Board on Basic Biology, Commission on Life Sciences, National Research Council (NRC)
Year	1988
Publisher	National Academy Press, Washington D.C.
ISBN	978-0-309-07462-9
Link	http://www.nap.edu/read/1097/chapter/1

15.4.29 Mapping the Code: The Human Genome Project and the Choices of Modern Science

Type of reference	Book
Author	Joel Davis
Year	1992
Link	https://books.google.com/books/about/Mapping_the_Code.html?id=a1TwAAAAMAAJ
Review	"Joel Davis's book is one of several that address the complex issues raised by the human genome project. Like its fellows it starts by explaining recombinant DNA technology in terms which are comprehensible to the non-specialist. It goes on to outline the background to the project and its political aspects, describes some of the science behind it and ends by raising some of the ethical issues which may follow from its exploitation." –David Weatherall, *Journal of Medical Ethics*, June 1992 http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1376129/

15.4.30 Orphan: The quest to save children with rare genetic disorders

Type of reference	Book
Authors	Reilly PR
Year	2015
Publisher	Cold Spring Harbor Laboratory Press
ISBN	9781621821373
Link	https://books.google.com/books?id=HHIgrgEACAAJ

15.4.31 Perilous Knowledge: The Human Genome Project and Its Implications

Type of reference	Book
Authors	Tom Wilkie
Year	1993
Link	http://books.google.com/books/about/Perilous_Knowledge.html?id=ZZZ9QgAACAAJ
Review	"At the end of the Eighties, the new tools of molecular genetics were recognised as sufficiently powerful for a major enterprise to be mounted that would locate and identify all the one hundred thousand or so genes that comprise our genetic essence. The Human Genome Project has support from a number of governments, including those of Britain and the United States. It is advancing rapidly on the scientific front – and raising a variety of social spectres, including the 'fear', as Tom Wilkie writes in *Perilous Knowledge*, 'that the project may open the door to a world peopled by Frankenstein's monsters and disfigured by a new eugenics.'" - Daniel Kevles, *London Review of Books*, 19 August 1993 http://www.lrb.co.uk/v15/n16/daniel-kevles/flavr-of-the-month

15.4.32 Perspectives on Properties of the Human Genome Project

Type of reference	Book
Authors	F. Scott Kieff
Year	2003
Link	http://books.google.com/books/about/Perspectives_on_properties_of_the_human.html?id=f5NpAAAAMAAJ
Review	"Kieff's timely and masterful book establishes a modern truth: to translate a scientific discovery into tangible patient benefits requires an intellectual property lawyer. [It] should be read not only by legal scholars but also scientists and the general public." – Dr. Mark Siegler, University of Chicago Pritzker School of Medicine http://www.elsevier.com/books/perspectives-on-properties-of-the-human-genome-project/kieff/978-0-12-017650-2

15.4.33 Proceed with caution: Predicting genetic risks in the recombinant DNA era

Type of reference	Book
Authors	Holtzman NA
Year	1989
Publisher	Johns Hopkins University Press
ISBN	9780801837302
Link	https://books.google.com/books?id=HO0gAQAAIAAJ

15.4.34 Race to the Finish: Identity and Governance in an Age of Genomics

Type of reference	Book
Year	2004
Link	http://press.princeton.edu/titles/7891.html
Review	"Reardon's book is a work of oral history and cultural analysis, which is fairly new to issues in science. She presents the co due largely to the myopia of its organizers in not appreciating the interdisciplinary nature of the endeavor. They situated the rather than as collaborators; they could not operationalize 'voluntary informed consent' in a cross genetics." –Jonathan Marks, *The Quarterly Review of Biology*, December 2005 http://www.jstor.org/stable/10.1086/501319?Search=yes&resultItemClick=true&searchText=rt:&searchText=%22Race%20t Finish%2522%2520AND%2520rt%3A%2522Identity%2520and%2520Governance%2520in%2520an%2520Age%2520of%

15.4.35 Scientific Feuds: From Galileo to the Human Genome Project

Type of reference	Book
Authors	Joel Levy

Year	2010
Link	https://books.google.com/books/about/Scientific_Feuds.html?id=tFrYkQEACAAJ
Review	"From epic conflicts to petty quarrels, *Scientific Feuds* unmasks the true nature of scientific progress, proving that in their quest to extend the boundaries of knowledge, scientists all too often create enemies. When it comes to the human stories behind the ideas, the world of science is rich in drama and emotion." –John Anderson, *Education in Chemistry*, November 2010 http://www.rsc.org/education/eic/issues/2010November/ScientificFuedsFromGalileoHumanGenomeProject.asp

15.4.36 The $1,000 Genome: The Revolution in DNA Sequencing and the New Era of Personalized Medicine

Type of reference	Book
Authors	Kevin Davies
Year	2010
Publisher	Simon & Schuster
Link	http://books.simonandschuster.com/The-$1-000-Genome/Kevin-Davies/9781416569619
Review	"Davies injects himself rather minimally into the story, adopting the detachment of a seasoned science journalist. By focusing on the field rather than the players, he communicates more information about the trajectory and methodological details of sequencing technology…. while also capturing more of the controversy within mainstream medicine about personal genomics. In response to this sobriety, I suppose I judged *The $1,000 Genome* against a more conventional standard… This standard was fulfilled, as during an interview with American College of Medical Genetics President Bruce Korf, who emphasized that "the size of the relative risks is very modest" for nearly all direct-to-consumer genetic tests and expressed doubts "that many people could appreciate just how subtle the changes hovering around the baseline risk are." – Maynard Olson, *Nature*

15.4.37 The Biotech Century: Harnessing the Gene and Remaking the World

Type of reference	Book
Authors	Jeremy Rifkin
Year	1999
Publisher	Jeremy P. Tarcher/Putnam
ISBN	0874779537, 9780874779530
Link	https://books.google.com/books/about/The_Biotech_Century.html?id=Q5ZKAAAAYAAJ

15.4.38 The Book of Man: The Human Genome Project and the Quest to Discover Our Genetic Heritage

Type of reference	Book
Authors	Walter Bodmer, Robvin McKie
Year	1998

Link	https://global.oup.com/academic/product/the-book-of-man-9780195114874?cc=us&lang=en&
Review	"The authors recount the history and describe the biology underlying 'one of mankind's greatest odysseys' in a digestible form for a wide audience. The scope is broad, with chapters on genetic engineering and the birth of pharmacogenomics, gene mapping and positional cloning, cancer and behavioural genetics, forensic and evolutionary applications, and genetic diagnosis and therapy. The narrative style in inviting and the reader rapidly becomes attuned to the distinctive voice of Walter Bodmer who seldom flinches from hyperbole. Anecdotes, scattered throughout the text, add human interest to the science." –Martin Farrall, *Journal of Medical Genetics*, August 1998 http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1051413/

15.4.39 The Code of Codes: Scientific and Social Issues in the Human Genome Project

Type of reference	Book
Authors	Daniel J. Kevles, Leroy Hood
Year	1992
Link	http://www.hup.harvard.edu/catalog.php?isbn=9780674136465
Review	"This book reflects the interdisciplinary approach of the HGP, presenting both scientific perspectives and commentary on social and ethical issues. It is notable that the content of this book is more heavily weighted toward consideration of the latter than is the HGP itself; fully two-thirds of the books consists of essays with historical and ethical themes. The diverse collection affords an opportunity to compare and contrast the thoughts of individuals who are considering the implications of this genetic research from very different disciplines and perspectives." –Sharon Durfy, *American Journal of Human Genetics*, May 1993 http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1682037/

15.4.40 The Common Thread: A Story of Science, Politics, Ethics, and the Human Genome - John Sulston's inside account of the Human Genome Project

Type of reference	Book
Authors	Sulston, John and Ferry, Georgina
Year	2002
Link	http://www.nap.edu/catalog.php?record_id=10373
Review	"This is a gripping insider's story of the Human Genome Project, revealing both the exciting science leading to it and the battle to keep the results, 'the heritage of humanity,' secure from control by private interests. As the authors state in the preface, 'Today any scientist anywhere can access the sequence freely at no cost. . . . We wrote this book so that people might understand how close the world came to losing that freedom.'" -Isaac Rabino, *The New England Journal of Medicine*, May 2003 http://www.nejm.org/doi/full/10.1056/NEJM200305013481824

15.4.41 The Delphic Boat: What Genomes Tell Us

Type of reference	Book
Authors	Antoine Danchin
Year	2002
Link	http://www.hup.harvard.edu/catalog.php?isbn=9780674009301
Review	"*The Delphic Boat* is both a scientific and a philosophical exploration of the meaning of the human genome. The title is taken from a question posed to the Oracle of Delphi regarding the structure and function of a wooden boat. If, over time, the wooden planks that make up the boat rot and are all replaced, then is the boat still the same boat? Yes, because the important defining characteristic of the boat is the *relationship* between the planks and not the actual original planks. Danchin extends this lesson into the realm of genetics, specifically, the wealth of data derived from the Human Genome Project. Knowing the DNA sequences is but a start in our efforts to understand genetics and life; what matters is the relationship and organization of the genetic material. According to Danchin, simply knowing the sequence of genes does not answer many of the questions we have. We also need to know about the sequential arrangement of genes, gene expression within the cell, and other aspects that influence gene function." -John Relethford, *Human Biology*, June 2004 http://muse.jhu.edu/journals/hub/summary/v076/76.3relethford.html

15.4.42 The DNA mystique: The gene as a cultural icon

Type of reference	Book
Authors	Nelkin D Lindee MS
Year	2004
Publisher	University of Michigan
ISBN	9780472030040
Link	https://books.google.com/books?id=_wNg_2drUKcC

15.4.43 The eighth day of creation: Makers of the revolution in biology

Type of reference	Book
Authors	Judson HF
Year	2004
Publisher	Cold Spring Harbor Laboratory Press
ISBN	9788796947853
Link	https://books.google.com/books?id=5cRPPgAACAAJ

15.4.44 The Genetic Revolution: Scientific Prospects and Public Perceptions

Type of reference	Book
Editor	Bernard D. Davis
Link	https://books.google.com/books/about/The_Genetic_revolution.html?id=g4lqAAAAMAAJ http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2589517/

15.4.45 The Genome War: How Craig Venter Tried to Capture the Code of Life and Save the World

Type of reference	Book
Authors	Shreeve, James
Year	2004
Link	http://books.google.com/books/about/The_Genome_War.html?id=GERcyqzOP9MC
Review	"The title of this book, *The Genome War,* is only partly exaggerated. No casualties were reported, but all the psychological ingredients of a war were present and are documented in the book. The subtitle is a joke, I hope. *The Genome War* has something in common with *Les Liaisons Dangereuses*. In Laclos's novel, the apparent goal of the characters — to seduce a human being — is little more than a pretext for a cruel game of power. Two centuries later the pretext has become grander — the goal no longer centers on a single person, but on the DNA of the species — but the game is no less cruel. Through 26 dense chapters, Shreeve displays for us the intricate game of personalities and ambitions that ultimately led to the completion of the Human Genome Project." -Guido Barbujani, *The New England Journal of Medicine*, July 2004 http://www.nejm.org/doi/full/10.1056/NEJM200407153510324

15.4.46 The Genomic Revolution: Unveiling the Unity of Life

Type of reference	Book
Authors	Rob DeSalle, Michael Yudell
Year	2002
Link	http://www.nap.edu/catalog.php?record_id=10125
Review	"*The Genomic Revolution: Unveiling the Unity of Life* is an attempt by a diverse group of experts to engage the public, mainly non-scientific readers, in the multi-faceted aspects of what has come to be called the 'genomic revolution.' Although books on this subject have lately proliferated, the niche that this book fills is in weaving scientific fact with stories of discovery from some of the scientists who helped make history, to create in one text a guided 'insider's view' of a mosaic of topics for the general public. This book is the outcome of a two-day conference, 'Sequencing the Human Genome: New Frontiers in Science and Technology,' held in September 2000 at the American Museum of Natural History (AMNH). Like the conference and the AMNH's subsequent exhibit, 'The Genomic Revolution,' the book is primarily aimed at a general readership and assumes no prior knowledge of the field." -Amalia Issa, *Nature Medicine*, 2003 http://www.nature.com/nm/journal/v9/n1/full/nm0103-11b.html

15.4.47 The Human Blueprint: The Race to Unlock the Secrets of Our Genetic Script

Type of reference	Book

Author	Robert Shapiro
Year	1991
Link	https://books.google.com/books/about/The_Human_Blueprint.html?id=ixjbAAAAMAAJ

15.4.48 The Human Genome

Type of reference	Book
Editors	Carina Dennis, Richard B. Gallagher
Year	2001
Link	http://books.google.as/books?id=0ilvQgAACAAJ&dq=related:ISBN159373056X
Review	"The book is aimed at both non-specialists and students in the field, and presents the goals, history and consequences of obtaining the genome sequence. With a foreword by James Watson, the book describes early achievements in DNA structure and human genome mapping, followed by a detailed account of the dramatic course of events that led to the sequencing the human genome ahead of schedule.The style is very clear and the authors present not only the facts, but also the spirit of this dramatic race." -Daniel Cohen, *Nature*, March 2002 http://www.nature.com/nature/journal/v416/n6878/full/416265a.html

15.4.49 The Human Genome: Book of Essential Knowledge

Type of reference	Book
Author	John Quackenbush
Year	2011
Publisher	Penquin
Link	https://books.google.com/books/about/Curiosity_Guides_The_Human_Genome.html?id=gqeo5CvBOa8C

15.4.50 The Human Genome Project

Type of reference	Book
Authors	Sharon J. Durfy, Amy E. Grotevant
Year	1991
Link	https://books.google.com/books/about/The_Human_Genome_Project.html?id=mMljnQEACAAJ

15.4.51 The Human Genome Project: The Formation of Federal Policies in the United States

Type of reference	Book chapter
Year	1991
Link	http://www.ncbi.nlm.nih.gov/books/NBK234203/

15.4.52 The Human Genome Project in College Curriculum: Ethical Issues and Practical Strategies

Type of reference	Book
Year	2008
Link	http://www.upne.com/1584656956.html
Review	"*The Human Genome Project in College Curriculum: Ethical Issues and Practical Strategies* is a collection of 13 interdisciplinary essays that address the range of ELSI implications of the HGP. The authors do a good job of keeping essays grounded in the practical and at a level to which students can relate. The essay Gene Therapy, *Gattaca*, and Sara Goering describes the paired use of a popular film and an academic publication to teach about bioethics, and the essay Best Interests and *My Sister's Keeper* similarly anchors the topic of patient rights in a bestselling novel." -Phyllis Frosst, *The Quarterly Review of Biology*, September 2009 http://www.jstor.org/stable/10.1086/644723

15.4.53 The Language of Life: DNA and the Revolution in Personalized Medicine

Type of reference	Book
Authors	Frances S. Collins
Year	2010
Link	http://books.google.com/books/about/The_Language_of_Life.html?id=hSbNxPTwL7wC
Review	"In his new book, he is here to tell us that the era of personalised genetic testing is nigh. No one could be a more authoritative messenger than Collins. He directed the Human Genome Project – a 15-year international collaborative programme to sequence the entire 3.1 billion-letter code of human DNA – from 1993 to its completion in 2003. Since then, genome sequencing has followed the trail blazed by computing power. A new major animal genome is sequenced every few months (recent acquisitions include the platypus, the zebra fish and the domestic cow) and there are now more than 1,000 bacterial genome sequences. There is an international race for human genomes to be sequenced at a cost of less than $1,000, and Collins believes this will be achieved within five to seven years. He is unlikely to be wrong." -Peter Forbes, *The Guardian*, 19 March 2010 http://www.theguardian.com/books/2010/mar/20/language-life-dna-peter-forbes

15.4.54 The Lives to Come: The Genetic Revolution and Human Possibilities

Type of reference	Book
Authors	Philip Kitcher
Year	1996
Link	http://books.google.com/books/about/The_Lives_to_Come.html?id=TUpM7FsD8YIC
Review	"Kitcher has written a searching, valuable guide to the immediate practical consequences and long-range implications of the new molecular genetics. The next decade, he predicts, will make possible hundreds, even thousands, of genetic tests to determine whether people carry genes that predispose them to various diseases or disabilities. He argues that the potential benefits of genetic testing must be carefully weighed against whether effective treatment exists. Stressing that gene replacement therapy is only one among many possible interventions, he foresees a patchwork of therapies, including dietary and environmental changes, to bring relief from hereditary disorders" -*Publishers Weekly* http://www.publishersweekly.com/978-0-684-80055-4

15.4.55 The Molecular Vision of Life: Caltech, the Rockefeller Foundation, and the Rise of the New Biology

Type of reference	Book
Authors	Lily E. Kay
Link	https://books.google.com/books?id=vEHeNI2a8OEC&lr=

15.4.56 The New Genetics: Challenges for Science, Faith, and Politics

Type of reference	Book
Authors	Roger Lincoln Shinn
Year	1996
Link	http://books.google.com/books/about/The_new_genetics.html?id=a5ruAAAAMAAJ

15.4.57 The Science of Human Perfection: How Genes Became the Heart of American Medicine

Type of reference	Book
Authors	Nathaniel Comfort
Year	2012
Link	http://yalepress.yale.edu/book.asp?isbn=9780300169911
Review	“Comfort … reveals the origins of the eugenics movement, beginning with the population studies begun by Darwin's cousin Francis Galton. These were picked up by British and

	American progressives who campaigned for 'race hygiene' as a way of improving the human race. In the post–World War II era, ethical issues came to the fore as medical professionals and scientists tried to avoid 'throwing out the eugenic baby with the Nazi bathwater.' As concerns about the effects of nuclear radiation mounted, researchers focused their attention on the role of mutations in causing cancer and degenerative diseases. Crick and Watson's discovery of the structure of DNA led to the unraveling of the genetic code and the mapping of the human genome, and the door opened for the development of new pharmaceuticals and the possibility of direct intervention to correct genetic diseases." –*Kirkus Reviews*, 1 August 2012 https://www.kirkusreviews.com/book-reviews/nathaniel-comfort/science-human-perfection/

15.4.58 The seven daughters of eve

Type of reference	Book
Authors	Sykes B
Year	2002
Publisher	Corgi
ISBN	9780552148764
Link	https://books.google.com/books?id=UH47PgAACAAJ

15.4.59 The sports gene: Inside the science of extraordinary athletic performance

Type of reference	Book
Authors	Epstein D
Year	2013
Publisher	Penguin Publishing Group
ISBN	9781101622636
Link	https://books.google.com/books?id=656SnRCgu3sC

15.4.60 The story of the most astonishing scientific adventure of our time- the attempt to map all the genes in the human body

Type of reference	Book
Authors	Bishop JE Waldholz M
Year	1990
Publisher	Simon and Schuster
ISBN	9780671670948
Link	https://books.google.com/books?id=DcfwAAAAMAAJ

15.4.61 The Violinist's Thumb: And Other Lost Tales of Love, War, and Genius, as Written by Our Genetic Code

Type of reference	Book
Authors	Sam Kean
Year	2012
Link	https://books.google.com/books/about/The_Violinist_s_Thumb.html?id=E0b2SUbPIo0C
Review	"Here's an astonishing story: On Aug. 6, 1945, a man named Tsutomu Yamaguchi was running late to his job at the Mitsubishi headquarters in Hiroshima. When the bomb hit, he was far enough away to survive the blast but not far enough to escape immediate radiation burns. Somehow he found his way on board a train that would get him out of town and back to his family in Nagasaki. He made it home the morning of Aug. 8, just in time — well, you guessed it. He survived both bombings. Remarkably, he recovered, returned to work and went on to father two children. He lived to the age of 93. Science writer Sam Kean uses Yamaguchi's story to illustrate the complicated interplay between radiation and DNA. His new book, "The Violinist's Thumb," takes the same approach to our genetic code that his previous one, "The Disappearing Spoon," took to the periodic table of elements. In both books, Kean finds a way to frame complex and terribly important fields of science on a human scale, making them relatable and meaningful." –Amy Stewart, *Washington Post*, 10 August 2012 https://www.washingtonpost.com/opinions/the-violinists-thumb--and-other-lost-tales-of-love-war-and-genius-as-written-by-our-genetic-code-by-sam-kean/2012/08/10/e68a026a-cf8d-11e1-8e56-dffbfbe1bd20_story.html

15.4.62 Transducing the Genome

Type of reference	Book
Authors	Zweiger, Gary
Year	2001
Link	http://books.google.com.au/books/about/Transducing_the_Genome.html?id=Q8nqqIaFKH4C&redir_esc=y
Review	"In *Transducing the Genome* … Gary Zweiger, a scientist-executive at Incyte Genomics, provides a bracing insider's account of why gene structure matters to science and commerce. His focus is on transducing the information content of DNA into useful form. He teases out a powerful theme of genomics: its focus on methods of creating massive databases quickly. This contrasts with and augments the tradition of hypothesis-driven experiment in molecular biology. The gods in Zweiger's pantheon are mathematicians, computer scientists, technology developers and database mavens. Molecular biologists enter the story, but mainly those with an avidity for technology and an appetite for large scale. Zweiger weds his enthusiasm for large-scale genomics to an anarchist theory of innovation that entails substantial contributions by private firms. No one is in charge, and that is a Good Thing." –Robert Cook-Deegan, *American Scientist*, January-February 2001 http://www.americanscientist.org/bookshelf/pub/hype-and-hope

15.4.63 Travelling around the human genome: An in situ investigation

Type of reference	Book
Authors	Jordan B

Year	1993
Publisher	Editions INSERM
ISBN	9782855985725
Link	https://books.google.com/books?id=1RbSt1LGClsC

15.4.64 Understanding the Human Genome Project

Type of reference	Book
Authors	Michael Palladino
Year	2002
Link	http://books.google.com/books/about/Understanding_the_human_genome_project.html?id=zMoTAQAAMAAJ

15.4.65 What remains to be discovered: Mapping the secrets of the universe, the origins of life, and the future of the human race

Type of reference	Book
Authors	Maddox J
Year	1998
Publisher	Macmillan
ISBN	9780333650080
Link	https://books.google.com/books?id=OO51jwEACAAJ

15.4.66 Won for All: How the Drosophila Genome Was Sequenced

Ashburner, Michael. Won for All: How the Drosophila Genome Was Sequenced, Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY, 2006

Type of reference	Book
Authors	Michael Ashburner
Year	2006
Publisher	Cold Spring Harbor Press

15.5 Videos

15.5.1 Capitol Hill Briefing on Gene Patents, 15 Sept 2011

Type of reference	Video
Title	Capitol Hill Briefing on Gene Patents, 15 Sept 2011
Link	https://youtu.be/UqwzLz32Lc82

15.5.2 Celebrating a 'decade of discovery' since the Human Genome Project, A film by the Wellcome Trust

Type of reference	Video
Title	Celebrating a 'decade of discovery' since the Human Genome Project, A film by the Wellcome Trust
Year	2010
Link	https://youtu.be/lY2oua8wpDc

15.5.3 Cracking the Code of Life, PBS documentary

Type of reference	Video
Uploaded by	PBS
Title	Cracking the Code of Life
Link	http://www.pbs.org/wgbh/nova/body/cracking-the-code-of-life.html

15.5.4 DNA Interactive

Type of reference	Video
Uploaded by	Dolan DNA Learning Center
Title	DNA Interactive (DNAi)
Link	http://www.dnai.org/

15.5.5 DNA - The Next Generation (NHGRI video hosted by Robert Krulwich)

Type of reference	Video
Title	DNA - The Next Generation
Year	2010
Link	https://youtu.be/TYRrXO_22No

15.5.6 Gene Patenting: The Economic Legal and Health Dilemma

Type of reference	Video

Title	Gene Patenting: The Economic Legal and Health Dilemma
Year	2011
Link	https://youtu.be/UdOdthMV_zE

15.5.7 Genetics 101 Part 1: What are genes?

Type of reference	Video
Title	Genetics 101 Part 1: What are genes?
Link	https://youtu.be/ubq4eu_TDFc

15.5.8 Genetics 101 Part 2: What are SNPs?

Type of reference	Video
Title	Genetics 101 Part 2: What are SNPs?
Link	https://youtu.be/tJjXpiWKMyA

15.5.9 Genetics 101 Part 3: Where do your genes come from?

Type of reference	Video
Title	Genetics 101 Part 3: Where do your genes come from?
Link	https://youtu.be/-Yg89GY61DE

15.5.10 Genetics 101 Part 4: What are phenotypes?

Type of reference	Video
Title	Genetics 101 Part 4: What are phenotypes?
Link	https://youtu.be/kLpr6t4-eLI

15.5.11 Genetics 101 Part 5: Why no Y?

Type of reference	Video
Title	Genetics 101 Part 5: Why no Y?
Link	https://youtu.be/QCm2x9OABI8

15.5.12 HGP10: Conceptualization of the Human Genome Project & Development of Data Release Principles

Type of reference	Video
Title	HGP10: Conceptualization of the Human Genome Project & Development of Data Release Principles
Year	2013
Link	https://youtu.be/NF2Ew1E1kZE

15.5.13 Human Genome First Draft Announcement at the White House (June 26, 2000)

Type of reference
Link

15.5.14 NHGRI Video Archive (GenomeTV)

Videos featuring the science, research, programs and staff of the National Human Genome Research Institute, as well as researchers and scientists from around the world. Many of these videos were created and produced by *Genome Productions*, a part of the Communications and Public Liaison Branch of the National Human Genome Research Institute.

Type of reference	Video
Uploaded by	National Human Genome Research Institute (NHGRI)
Year	2000-2016
Link	http://www.genome.gov/GenomeTV/ https://www.genome.gov/10001292/nhgri-video-archive/
Notes	All U.S. government-produced video and audio clips are in the public domain and may be freely distributed and copied.

15.5.15 The $1,000 Genome... The $1,000,000 Interpretation

Type of reference	Video
Authors	Kevin Davies
Year	2013

15.5.16 The Genetic Information Nondiscrimination Act in Action

Type of reference	Video
Title	The Genetic Information Nondiscrimination Act in Action
Year	2011
Link	https://youtu.be/-KcWAMo5T_o

15.5.17 The Human Genome: A Decade of Discovery, Creating a Healthy Future (AM Session - Part 1)

Type of reference	Video
Title	The Human Genome: A Decade of Discovery, Creating a Healthy Future (AM Session - Part 1)
Year	2010
Link	https://youtu.be/RvNXPC7qOxY

15.5.18 The Human Genome at 10: An Overview, Eric Lander

Type of reference	Video
Title	The Human Genome at 10: An Overview, Eric Lander
Year	2011
Link	https://youtu.be/bUq_YVzYZAs

15.5.19 Transformational Impact of Human Genome Project

Leroy Hood speaking at CSHL.

Type of reference	Video
Authors	CSHL Library & Archives
Title	Transformational Impact of Human Genome Project
Year	2010
Link	https://youtu.be/PnpEqHDczNk
Summary	On the 10th anniversary of the release of the draft human genome sequence, Leroy Hood, inventor, biologist, and key player of the Human Genome Project (HGP), enumerates the major transformational impacts of the HGP on science, medicine, and society. Interview conducted at Cold Spring Harbor Laboratory in 2010.

15.5.20 What is Genomics - Full Length

Type of reference	Video
Title	What is Genomics - Full Length
Year	2010
Link	https://youtu.be/mmgICIg0Y1k

15.6 Websites

15.6.1 1000 Genomes: A Deep Catalog of Human Genetic Variation

Type of reference	Website
Creators	1000 Genomes Project
Title	1000 Genomes: A Deep Catalog of Human Genetic Variation
Link	http://www.1000genomes.org/

15.6.2 ACLU Challenges Patents On Breast Cancer Genes

Type of reference	Website
Creators	ACLU
Title	ACLU Challenges Patents On Breast Cancer Genes

Link	https://www.aclu.org/news/aclu-challenges-patents-breast-cancer-genes

15.6.3 An Overview of the Human Genome Project

Type of reference	Website
Creators	NHGRI
Title	An Overview of the Human Genome Project
Link	http://www.genome.gov/12011238

15.6.4 Association for Molecular Pathology v. Myriad Genetics, Inc.

Type of reference	Website
Creators	SCOTUSblog, Supreme Court of the United States
Title	Association for Molecular Pathology v. Myriad Genetics, Inc.
Link	http://www.scotusblog.com/case-files/cases/association-for-molecular-pathology-v-myriad-genetics-inc/

15.6.5 Association for Molecular Pathology v. Myriad Genetics, No. 11-725

Type of reference	Website
Creators	U.S. Supreme Court
Title	Association for Molecular Pathology v. Myriad Genetics, No. 11-725
Link	http://www.supremecourt.gov/Search.aspx?FileName=/docketfiles/11-725.htm

15.6.6 Bioethics

Type of reference	Journal Website
Creators	John Wiley & Sons
Link	http://onlinelibrary.wiley.com/journal/10.1111/%28ISSN%291467-8519

15.6.7 Biology and Computing

Type of reference	Website
Creators	University of California, Berkeley
Title	Biology and Computing
Link	https://www.ocf.berkeley.edu/~edy/

15.6.8 BRCA1 and BRCA2: Cancer Risk and Genetic Testing

Type of reference	Website
Authors	National Cancer Institute (NCI)
Title	BRCA1 and BRCA2: Cancer Risk and Genetic Testing

Link	http://www.cancer.gov/about-cancer/causes-prevention/genetics/brca-fact-sheet
Date	April 1, 2015

15.6.9 BRCA - Brief For Amicus Curiae James D. Watson In Support Of Neither Party

Type of reference	Website
Creators	James D. Watson
Title	BRCA - Brief For Amicus Curiae James D. Watson In Support Of Neither Party
Link	https://www.aclu.org/legal-document/brca-brief-amicus-curiae-james-d-watson-support-neither-party

15.6.10 Cancer Genome Atlas

Type of reference	Website
Creators	National Cancer Institute (NCI), National Human Genome Research Institute (NHGRI)
Title	Cancer Genome Atlas
Link	http://cancergenome.nih.gov/

15.6.11 Cancer Genome Project

Type of reference	Website
Creators	Wellcome Trust Sanger Institute
Title	Cancer Genome Project
Link	https://www.sanger.ac.uk/research/projects/cancergenome/

15.6.12 Conversations in Genetics

Type of reference
Link

15.6.13 DOE Science Showcase - Genomics

Type of reference	Website
Creators	U.S. Department of Energy
Title	DOE Science Showcase - Genomics
Link	http://www.osti.gov/home/doe-science-showcase-genomics

15.6.14 ELSI2.0

Type of reference	Website
Creators	ELSI2.0
Title	ELSI2.0: An International Collaboratory for Genomics and Society Research

Link	https://elsi2workspace.tghn.org/

15.6.15 ELSI Genetics Resource Directory

Type of reference	Website
Creators	WHO
Title	ELSI Genetics Resource Directory
Link	http://www.who.int/genomics/elsi/regulatory_data/en/

15.6.16 ELSI on the L: Law Students in Chicago Blogging about Ethical Dilemmas in Scientific Research and Healthcare

Type of reference
Title
Link

15.6.17 ELSI Personal Genomics Seminar Series

Type of reference	Website
Authors	University of Michigan
Title	ELSI Personal Genomics Seminar Series
Link	http://elsi.umich.edu/

15.6.18 ENCODE Project: Encyclopedia Of DNA Elements

Type of reference	Website
Creators	ENCODE Consortium
Title	ENCODE Project: Encyclopedia Of DNA Elements
Link	http://www.genome.gov/encode/

15.6.19 ESRC Genomics Policy and Research Forum

Type of reference	Website
Creators	Genomics Network
Title	ESRC Genomics Policy and Research Forum
Link	http://www.genomicsnetwork.ac.uk/forum/

15.6.20 Ethical, Legal, Social Implications & Issues of Human Genome Project (ELSI)

Type of reference	Website
Creators	Genetics Education Center, University of Kansas Medical Center
Title	Ethical, Legal, Social Implications & Issues of Human Genome Project (ELSI)

Link	https://www.kumc.edu/gec/prof/geneelsi.html

15.6.21 Ethical, Legal and Social Implications (ELSI) of Genetic Knowledge

Type of reference	Website
Creators	National Human Genome Research Institute (NHGRI)
Title	Ethical, Legal and Social Implications (ELSI) of Genetic Knowledge
Link	http://www.genome.gov/25019880

15.6.22 Ethical, Legal and Social Implications (ELSI) Research Program Abstracts and Activities Database

Type of reference
Title
Link

15.6.23 European Society of Human Genetics (ESHG): ESHG or ESHG endorsed Documents

Type of reference	Website
Creators	European Society of Human Genetics (ESHG)
Title	European Society of Human Genetics (ESHG): ESHG or ESHG endorsed Documents
Link	https://www.eshg.org/eshgdocs.0.html

15.6.24 For Your Information: Australian Privacy Law and Practice (ALRC Report 108)

Type of reference	Website
Creators	Australian Law Reform Commission (ALRC)
Title	For Your Information: Australian Privacy Law and Practice (ALRC Report 108)
Link	http://www.alrc.gov.au/publications/report-108

15.6.25 Geneethics.ca

Type of reference	Website
Creators	Genethics
Title	Geneethics.ca
Link	http://genethics.ca/

15.6.26 Genentech Legal Counsel and Vice President, 1976-1988, and Entrepreneur, Thomas Kiley

Type of reference	Website
Creators	Regional Oral History Office (ROHO), University of California
Title	Genentech Legal Counsel and Vice President, 1976-1988, and Entrepreneur, Thomas Kiley
Link	http://content.cdlib.org/view?docId=kt9g5015sn&brand=calisphere&doc.view=entire_text

15.6.27 Gene Patenting

Type of reference	Website
Creators	ACLU
Title	Gene Patenting
Link	https://www.aclu.org/issues/privacy-technology/medical-and-genetic-privacy/gene-patenting

15.6.28 Genes in Life

Genes in Life is a place for the general public to learn about all the ways genetics is a part of your life. On their site, you will learn how genetics affects you and your family, why you should talk to your healthcare providers about genetics, how to get involved in genetics research, and much more.

Type of reference	Website
Creators	Genetic Alliance
Title	Genes in Life
Link	http://www.genesinlife.org/

15.6.29 GeneTests

Type of reference	Website
Creators	BioReference Laboratories
Title	GeneTests
Link	https://www.genetests.org/

15.6.30 GenETHX Blog Bioethics Research Library

Type of reference	Website
Creators	Bioethics Research Library, Kennedy Institute of Ethics, Georgetown University
Title	GenETHX Blog Bioethics Research Library
Link	http://blog.genethx.org/

15.6.31 Genetic Nondiscrimination Act of 2008 (GINA) - from EEOC

Type of reference	Website
Creators	U.S. Equal Employment Opportunity Commission (EEOC)
Title	Genetic Nondiscrimination Act of 2008 (GINA) - from EEOC
Link	http://www.eeoc.gov/laws/statutes/gina.cfm

15.6.32 Genetic Nondiscrimination Act of 2008 (GINA) - from HHS

Type of reference	Website
Creators	U.S. Department of Health & Human Services (HHS)
Title	Genetic Nondiscrimination Act of 2008 (GINA) - from HHS
Link	http://www.hhs.gov/ocr/privacy/hipaa/understanding/special/genetic/

15.6.33 Genetics and Cancer

Type of reference	Website
Creators	American Cancer Society (ACS)
Title	Genetics and Cancer
Link	http://www.cancer.org/cancer/cancercauses/geneticsandcancer/genetics-and-cancer-landing

15.6.34 Genetics and Genomics Timeline

Type of reference	Website
Creators	Genome News Network
Title	Genetics and Genomics Timeline
Link	http://www.genomenewsnetwork.org/resources/timeline/

15.6.35 Genetics Home Reference - Policy and Ethics Resources

Type of reference	Website
Creators	NIH NLM
Title	Genetics Home Reference - Policy and Ethics Resources
Link	http://ghr.nlm.nih.gov/Resources/ethics

15.6.36 Genetic Testing Registry

Type of reference	Website
Creators	NIH, NCBI
Title	Genetic Testing Registry
Link	http://www.ncbi.nlm.nih.gov/gtr/

15.6.37 GeneWatch

Type of reference	Website
Creators	GeneWatch UK
Title	GeneWatch
Link	http://www.genewatch.org/ http://www.genewatch.org/uploads/f03c6d66a9b354535738483c1c3d49e4/HGPhistory_1.pdf

15.6.38 Genographic Project

Type of reference	Website
Creators	National Geographic
Title	Genographic Project
Link	https://genographic.nationalgeographic.com/

15.6.39 Genome: Unlocking Life's Code

Type of reference	Website
Creators	Smithsonian National Museum of Natural History, National Human Genome Research Institute (NHGRI)
Title	Genome: Unlocking Life's Code
Link	https://unlockinglifescode.org/

15.6.40 GenomeCanada - Policy Directions Briefs

Type of reference	Website
Creators	GenomeCanada
Title	GenomeCanada Policy Directions Briefs
Link	http://www.genomecanada.ca/en/ge3ls/policy-portal/directions.aspx

15.6.41 GenomeEthics

Type of reference	Website
Creators	Wellcome Trust Sanger Institute
Title	GenomeEthics
Link	http://www.genomethics.org/

15.6.42 Genome Statute and Legislation Database

Type of reference	Website
Creators	NHGRI
Title	Genome Statute and Legislation Database
Link	https://www.genome.gov/PolicyEthics/LegDatabase/pubsearch.cfm

15.6.43 Genomes Unzipped

Type of reference	Website
Creators	Daniel MacArthur et al. (hosted at ScienceBlogs)
Title	Genomes Unzipped
Link	http://scienceblogs.com/geneticfuture/category/genomes_unzipped/

15.6.44 Genome-Wide Association Studies

Type of reference	Website
Authors	NIH
Title	Genome-Wide Association Studies
Link	https://www.genome.gov/20019523

15.6.45 Genomics: What potential does understanding our genetic playbook hold?

Type of reference	Website
Creators	actionbioscience
Title	Genomics: What potential does understanding our genetic playbook hold?
Link	http://www.actionbioscience.org/genomics/

15.6.46 Human Genome News

Type of reference	Website
Creators	U.S. Department of Energy Office of Biological and Environmental Research
Title	Human Genome News
Link	http://web.ornl.gov/sci/techresources/Human_Genome/publicat/hgn/

15.6.47 Human Genome Project (HGP) History (a personal account)

Type of reference	Website
Creators	George M. Church
Title	Human Genome Project (HGP) History (a personal account)
Link	http://arep.med.harvard.edu/gmc/HGP.html

15.6.48 Human Genome Research and Society

Type of reference	Website
Creators	Eubios Ethics Institute
Title	Human Genome Research and Society
Link	http://www.eubios.info/HGR.htm

15.6.49 Human Microbiome Project (HMP)

Type of reference	Website
Creators	NIH Office of Strategic Coordination - The Common Fund
Title	Human Microbiome Project (HMP)
Link	https://commonfund.nih.gov/hmp/index

15.6.50 Intellectual Property Rights and Innovation: Evidence from the Human Genome

Type of reference	Website
Creators	Heidi L. Williams/National Bureau for Economic Research (NBER) (NBER Working Paper No. 16213)
Title	Intellectual Property Rights and Innovation: Evidence from the Human Genome
Link	http://www.nber.org/papers/w16213

15.6.51 International Genomics Consortium

Type of reference	Website
Creators	International Genomics Consortium (IGC)
Title	International Genomics Consortium
Link	http://www.intgen.org/

15.6.52 Is Cancer Genetic?

Type of reference	Website
Creators	Coriell Personalized Medicine Collaborative
Title	Is Cancer Genetic?
Link	https://cpmc.coriell.org/Sections/Education/CancerRisk.aspx?PgId=63

15.6.53 Le programme génome et la médecine

Type of reference	Website
Creators	Histrecmed, IRH CNRS
Title	Le programme génome et la médecine
Link	http://www.histrecmed.fr/index.php?option=com_content&view=article&id=7&Itemid=123

15.6.54 Nature Milestones - DNA Technology

Type of reference	Website
Creators	Nature Publishing Group
Title	Nature Milestones - DNA Technology
Link	http://www.nature.com/milestones/miledna/index.html

15.6.55 NHGRI History of Genomics Program

Type of reference	Website
Creators	National Human Genome Research Institute (NHGRI)
Title	NHGRI History of Genomics Program
Link	http://www.genome.gov/27557501

15.6.56 Nobel Week Dialogue: The Genetic Revolution and Its Impact on Society

Type of reference	Website
Creators	Nobel Media AB
Title	Nobel Week Dialogue: The Genetic Revolution and Its Impact on Society
Link	http://www.nobelweekdialogue.org/the-genetic-revolution-and-its-impact-on-society/

15.6.57 Nursing World, Personalized Medicine

Type of reference	Website
Creators	American Nurses Association
Title	Nursing World, Personalized Medicine
Link	http://nursingworld.org/genetics

15.6.58 Online Education Kit: Understanding the Human Genome Project

Type of reference	Website
Creators	National Human Genome Research Institute (NHGRI)
Title	Online Education Kit: Understanding the Human Genome Project
Link	http://www.genome.gov/25019879

15.6.59 Oral History of Human Genetics Project

Type of reference
Authors
Title
Link

15.6.60 Personal Genome Project

Type of reference	Website
Title	Personal Genome Project
Link	http://www.personalgenomes.org/

15.6.61 Policy and ethics issues

Type of reference	Website
Creators	NHGRI
Title	Policy and ethics issues
Link	https://www.genome.gov/27527631

15.6.62 Public Health Genomics

Type of reference	Journal Website
Creators	Genomic Medicine Alliance, Karger Medical and Scientific Publishers
Title	Public Health Genomics
Link	https://www.karger.com/Journal/Home/224224

15.6.63 Sharing Clinical Reports Project (SCRP)

Type of reference	Website
Creators	NIH ClinGen
Title	Sharing Clinical Reports Project (SCRP)
Link	https://www.clinicalgenome.org/data-sharing/sharing-clinical-reports-project-scrp/

15.6.64 Stanford Center for Integration of Research on Genetics and Ethics (CIRGE)

Type of reference	Website
Creators	Stanford Center for Biomedical Ethics
Title	Stanford Center for Integration of Research on Genetics and Ethics (CIRGE)
Link	http://med.stanford.edu/cirge.html

15.6.65 The American Journal of Bioethics

Type of reference	Journal Website
Creators	Taylor & Francis
Title	The American Journal of Bioethics
Link	http://www.tandfonline.com/loi/uajb20#.ViaOPCvDEV4

15.6.66 The Genome: Controversy for All Times

Type of reference	Website
Creators	Jimmy-Lee Moore, Yale-New Haven Teachers Institute
Title	The Genome: Controversy for All Times
Link	http://www.yale.edu/ynhti/curriculum/units/2001/1/01.01.02.x.html

15.6.67 The Genomics Landscape a Decade after the Human Genome Project

Type of reference	Website
Creators	National Human Genome Research Institute (NHGRI)
Title	The Genomics Landscape a Decade after the Human Genome Project
Link	http://www.genome.gov/27552238

15.6.68 The HUGO Journal

Type of reference	Journal Website
Creators	The Human Genome Organisation, Springer
Title	The HUGO Journal
Link	http://www.springer.com/biomed/journal/11568

15.6.69 The Human Genome: A Decade of Discovery, Creating a Healthy Future

Type of reference	Website
Creators	National Human Genome Research Institute (NHGRI)
Title	The Human Genome: A Decade of Discovery, Creating a Healthy Future
Link	http://www.genome.gov/27539538

15.6.70 The Human Genome Project - Scitable

Type of reference	Website
Creators	Nature Education
Title	The Human Genome Project - Scitable
Link	http://www.nature.com/scitable/ebooks/the-human-genome-project-16553838

15.6.71 The Human Genome Project - Wellcome Trust Sanger Institute

Type of reference	Website
Creators	Wellcome Trust Sanger Institute
Title	The Human Genome Project - Wellcome Trust Sanger Institute
Link	Human Genome Project and Sanger Institute

15.6.72 U.S. SACGHS Documents, Reports and Correspondence

Type of reference	Website
Creators	NIH, Office of Science Policy
Title	U.S. SACGHS Documents, Reports and Correspondence
Link	http://osp.od.nih.gov/sacghs-document-archive/genetics-education-and-training-report-secretarys-advisory-committee-genetics-health-and-society

15.6.73 UCLA Institute for Society and Genetics

Type of reference	Website
Creators	UCLA Institute for Society and Genetics
Title	UCLA Institute for Society and Genetics
Link	http://socgen.ucla.edu/

15.6.74 What ELSI is New?

Type of reference	Website
Creators	Genomics Law Report, Robinson Bradshaw & Hinson (law firm)
Title	What ELSI is New?
Link	http://www.genomicslawreport.com/index.php/category/badges/what-elsi-is-new/

15.6.75 WHO Human Genetics Programme

Type of reference	Website
Creators	WHO Human Genetics Programme
Title	WHO Human Genetics Programme
Link	http://www.who.int/genomics/en/

15.6.76 Who Owns Your Body?

Type of reference	Website
Creators	Institute for Science, Law & Technology (ISLAT), Illinois Institute of Technology
Title	Who Owns Your Body?
Link	http://www.whoownsyourbody.org/

15.6.77 YourGenome.org

Type of reference	Website
Creators	Public Engagement Team, Wellcome Genome Campus
Title	YourGenome.org
Link	http://www.yourgenome.org/

15.7 Reports

15.7.1 ASHG Human Genome Committee Report, 1991

ASHG Human Genome Committee Report
The Human Genome Project: Implications for Human Genetics.

Type of reference	Report
Authors	C. Thomas Caskey
Year	1991
Publisher	Am. J. Hum. Genet.
Link	http://www.ashg.org/pdf/policy/ashg_ps_september1991.pdf

15.7.2 Lawrence Livermore National Laboratory- Completing the Human Genome Project and Triggering Nearly $1 Trillion in U.S. Economic Activity

Type of reference	Report
Authors	J. S. Stewart
Year	2015, July 28
Publisher	Lawrence Livermore National Laboratory
Link	https://e-reports-ext.llnl.gov/pdf/798174.pdf

15.7.3 The Belmont Report

The Belmont Report was the result of the work of the National Commission for the Protection of Human Subjects of Biomedical and Behaviorial Research. This body existed from 1974 to 1978 and was the first bioethics commission the U.S. government ever convened. The commission was charged with forming guidelines for research involving human volunteers. The Belmont Report, published in 1979, was immensely influential and had an effect on all later work on bioethics regulation in the United States.

Type of reference	Report
Authors	National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research
Year	1979
Publisher	U.S. federal government
Link	http://www.hhs.gov/ohrp/regulations-and-policy/belmont-report/

16 ARCHIVAL COLLECTIONS

16.1 Government (Federal and State) Archives

Please be aware that there is very little released material available on the Human Genome Project at this time. However, researchers are welcome to use the Freedom of Information Act (FOIA) to place a request for information release. A FOIA request needs to be in writing, and it must state that it is a FOIA request. It needs to be as specific as possible (names, dates, places). Finally, you must provide all your contact information, including your name, phone number, mailing address and email address. Please see: http://www.foia.gov/how-to.html

16.1.1 Argonne National Laboratory/Archives

Laboratory does not have an archives. Unable to find any information related to Mirzabekov.

Type of resource	Laboratory Archives/ National Archives
Collections	**Record Group 326 Records of the Atomic Energy Commission** **Administrative History** The Atomic Energy Commission (AEC) was established in 1946 to control the development and use of atomic energy, including the encouragement of private participation in research and practical uses of atomic energy. The AEC had responsibility to regulate the use of nuclear materials in order to protect the health and safety of the public. It was concerned with fissionable material supply, development of reactors, development and testing of nuclear weapons, basic and applied research, dissemination of information relating to atomic energy, and development and administration of international cooperation for peaceful uses of atomic energy. The AEC was discontinued on October 11, 1974, and was replaced by two new agencies: the Energy Research and Development Administration (ERDA, see RG 430) and the Nuclear Regulatory Commission (NRC, see RG 431). The functions of ERDA were later incorporated into the Department of Energy when that Department was created in 1977 (see also RG 434). **Records Description** **Dates**: 1942-1988 **Volume**: 396 cubic feet Records of the Argonne National Laboratory (ANL), Lemont, Illinois. The records document scientific research and development conducted at its relationship with University of Chicago administrators and faculty members and with scientists in the United States and Europe. They relate to the exchange of technical data and studies, personnel placement, and the role of the ANL as an experimental laboratory and a training ground for teachers and scientists. Included are case files, correspondence, narrative and statistical reports, and publications. **Nontextual records** include engineering drawings, photographs, and sound recordings (oral histories). **Related Microfilm Publications** **M1108**, *Harrison-Bundy Files Relating to the Development of the Atomic Bomb*, 1942-1946; **M1109,** *Correspondence ("Top Secret") of the Manhattan Engineer District*, 1942-1946, **A1218,** *Manhattan Engineer District History.***Record Group 434 General Records of the Department of Energy**

	Administrative History The Department of Energy was established October 1, 1977 by the DOE Organization Act (91 Stat. 569), August 4, 1977 and EO 12009, September 13, 1977, consolidating functions formerly vested in the Energy Research and Development Administration, the Federal Energy Administration, the Federal Power Commission, and other agencies. DOE administers and coordinates federal energy programs, including the nuclear weapons program. The department engages in energy technology research and development. It also markets power generated by federal hydroelectric projects. DOE promotes energy conservation. **Records Description** **Dates:** ca.1892-1993 **Volume:** 1,914 cubic feet Records of the Center for Human Radiobiology, Argonne National Laboratory, Argonne, Illinois. The records document the medical tracking of the health of individuals exposed to radioactive substances as a result of their occupations. The project, Records of Health Effects of Exposure to Internally Deposited Radioactivity, commonly referred to as the Internal Emitter Project, comprise three studies brought together at Argonne National Laboratory. The studies are: • New Jersey Radium Research Project; • Argonne National Laboratory and Argonne Cancer Research Hospital; • Radioactivity Center at the Massachusetts Institute of Technology. Included are administrative files, case files, reports and studies. **Nontextual records** include microfiche, photographs, and X-rays.
Connections	http://www.anl.gov/about-argonne/history http://www.archives.gov/chicago/holdings/rg-300-donated-materials.html http://www.archives.gov/research/guide-fed-records/groups/326.html

16.1.2 Atomic Energy Commission (AEC)/Archives

Type of resource	Independent Agency
Dates	1942-1975
Connections	Records of the Atomic Energy Commission are held at NARA: http://www.archives.gov/research/guide-fed-records/groups/326.html

16.1.3 Biomedical Ethics Advisory Committee (BEAC)/Archives

Type of resource	Commission
Dates	1974-2009
Collections	**[2001-2009] President's Council on Bioethics (PCBE)** **Archived PCBE website** *Created by President George W. Bush in 2001, the Council was charged with advising the President on bioethical issues that may emerge as a consequence of advances in biomedical science and technology. It expired in 2009.* • Human Cloning and Human Dignity: An Ethical Inquiry (July 2002) • Beyond Therapy: Biotechnology and the Pursuit of Happiness (October 2003) • Being Human: Readings from the President's Council on Bioethics (December 2003) • Monitoring Stem Cell Research (January 2004) • Reproduction and Responsibility: The Regulation of New Biotechnologies (March 2004) • White Paper: Alternative Sources of Pluripotent Cells (May 2005) • Taking Care: Ethical Caregiving in Our Aging Society (September 2005)

- Human Dignity and Bioethics:Essays Commissioned by the President's Council on Bioethics (March 2008)
- The Changing Moral Focus of Newborn Screening: An Ethical Analysis by the President's Council on Bioethics (December 2008)
- Controversies in the Determination of Death: A White Paper by the President's Council on Bioethics (December 2008)

[1996-2001] National Bioethics Advisory Commission (NBAC)

Archived NBAC website

> *This commission met for the first time in 1996, a year after it was created by Executive Order. It expired in 2001.*

- Cloning Human Beings
  - Volume 1: Report and Recommendations (June 1997)
  - Volume 2: Commissioned Papers
- Research Involving Persons with Mental Disorders That May Affect Decisionmaking Capacity
  - Volume 1: Final Report (December 1998)
  - Volume 2: Commissioned Papers (March 1999)
- Research Involving Human Biological Materials: Ethical Issues and Policy Guidance
  - Volume 1: Report and Recommendations of the NBAC (August 1999)
  - Volume 2: Commissioned Papers (January 2000)
- Ethical Issues in Human Stem Cell Research
  - Volume 1: Report and Recommendations of the NBAC (September 1999)http://bioethics.georgetown.edu/pcbe/reports/past_commissions/nbac_stemcell1.pdf
  - Volume 2: Commissioned Papers (January 2000)
  - Volume 3: Religious Perspectives (June 2000)
- 1998-1999 Biennial Report
- Ethical and Policy Issues in International Research: Clinical Trials in Developing Countries (April 2001)
- Ethical and Policy Issues in Research Involving Human Participants • Volume I (August 2001)
- Ethical and Policy Issues in Research Involving Human Participants • Volume II (August 2001)

[1994-1995] Advisory Committee on Human Radiation Experiments

> *Created in January 1994 and dissolved in October 1995, the 14-member Committee was charged with investigating and reporting on the use of human beings as subjects of federally funded research using ionizing radiation. To maximize public access as required under the Federal Advisory Committee Act, the Committee created for the first time a gopher site on the World Wide Web, which is now under the National Security Agency Archives at http://www.gwu.edu/~nsarchiv/radiation/ . For additional information, see http://www.hss.energy.gov/HealthSafety/ohre/roadmap/index.html*

- Interim Report (1994)
- Final Report (1995)

[1994] Human Embryo Research Panel (National Institutes of Health)

> *This panel was formed by the National Institutes of Health in January 1994. The group classified human embryo research into three categories: acceptable, needing additional review, and unacceptable. It also drafted guidelines for the review and conduct of acceptable research. The Advisory Committee to the Director of NIH unanimously approved the report, but President Clinton issued a statement saying, "I do not believe that federal funds should be used to support the creation of human embryos for research purposes, and I have directed that NIH not allocate any resources for such research."*

- Volume 1 (September 1994)
- Volume 2 (September 1994)

[1989-ongoing as of 2010] NIH-DOE Joint Working Group on Ethical, Legal and Social Implications (ELSI) of Human Genome Research

ELSI is the largest bioethics initiative funded by the government, where a percentage of the research budgets within the U.S. Dept. of Energy and the U.S. Dept. of Health and Human Services is set aside to study the ethical, legal and social implications of research on the human genome. Begun in 1989, a joint working group between the two departments analyzes critical issues and provides guidance. Currently ELSI focuses on four priority areas: (1) the use and interpretation of genetic information; (2) clinical integration of genetic technologies; (3) issues surrounding genetics research; and (4) public and professional education and training on those issues.

[1988-1990] Biomedical Ethical Advisory Committee

The 14 initial members of this Committee were selected by the Biomedical Ethics Board, which was made up of six senators and six members of Congress. The group functioned only briefly from late 1988 to early 1989 and had two meetings before its parent group became politically deadlocked due to abortion politics, its appropriations were frozen, and finally its term expired in 1990.

[1988] Human Fetal Tissue Transplantation Research Panel

The National Institutes of Health created this 21 member advisory panel, composed of medical researchers, clergy, ethicists, lawyers, and politicians, to deliberate over federal support of therapeutic transplantation research using human tissue obtained from aborted fetuses. The group existed from the spring to the fall of 1988. In its December report, the panel in a majority vote of 19 to 2 recommended continuing the funding for such research if guidelines were established to keep abortion separate from the research. Despite the recommendation, the moratorium on such research that went into place as this topic was debated was extended from a temporary one to an indefinite one.

- Report of the Human Fetal Tissue Transplantation Research Panel (1988)

[1984] Great Britain: The Warnock Report on Human Fertilisation and Embryology

Chaired by Dame Mary Warnock, the 15-member committee examined the social, ethical, and legal implications of developments in assisted reproduction.

- Warnock Report

[1978-1983] President's Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research

This Congressionally mandated group was formed in 1978, succeeding the National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research. It worked independently from January 1980 to March 1983.

- Defining Death (1981)
- Protecting Human Subjects (1981)
- Whistleblowing in Biomedical Research (1981)
- IRB Guidebook (1981)
- Compensating for Research Injuries (1982)
- Splicing Life: The Social and Ethical Issues of Genetic Engineering with Human Beings (1982)
- Making Health Care Decisions (1982)
- Deciding to Forego Life-Sustaining Treatment (1983)
- Implementing Human Research Regulations (1983)
- Screening and Counseling for Genetic Conditions: The Ethical, Social, and Legal Implications of Genetic Screening, Counseling, and Education Programs (1983)

	• Securing Access to Health Care (1983) • Summing Up (1983) **[1978-1979] Ethics Advisory Board (EAB)** *This group began in 1978 under the auspices of the Department of Health, Education and Welfare. Its pronouncement on human embryo research in 1979 followed by the EAB dissolution began a 15-year moratorium on such research.* • HEW Support of Research Involving Human In Vitro Fertilization and Embryo Transfer: Report and Conclusions (1979) **[1974-1978] National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research** *The first public national body to shape bioethics policy in the U.S., this commission was created by Congress in 1974 and was under the Dept. of Health, Education and Welfare (now known as the Dept. of Health and Human Services) until 1978.* • Research on the Fetus (1975) http://bioethics.georgetown.edu/pcbe/reports/past_commissions/research_fetus.pdf • Research Involving Prisoners (1976)http://bioethics.georgetown.edu/pcbe/reports/past_commissions/Research_involving_prisoners.pdf • Research Involving Children (1977)http://bioethics.georgetown.edu/pcbe/reports/past_commissions/Research_involving_children.pdf • Psychosurgery: Report and Recommendations (March 1977)http://bioethics.georgetown.edu/pcbe/reports/past_commissions/psychosurgery.pdf • Disclosure of Research Information Under the Freedom of Information Act (April 1977) • Research Involving Those Institutionalized as Mentally Infirm (1978) • Ethical Guidelines for the Delivery of Health Services by DHEW (1978) http://bioethics.georgetown.edu/pcbe/reports/past_commissions/ethical_guidelines_health_services_min.pdf • Appendix to Ethical Guidelines for the Delivery of Health Services by DHEW (1978)http://bioethics.georgetown.edu/pcbe/reports/past_commissions/Appendix_ethical_guidelines.pdf • Institutional Review Boards (1978) • Implications of Advances in Biomedical and Behavioral Research (1978) • The Belmont Report: Ethical Principles and Guidelines for Protection of Human Subjects of Biomedical and Behavioral Research (1979) • The Belmont Report: History, 25th Anniversary, Oral Archives *Information on bioethics commissions taken from: Poland, Susan Cartier,Bioethics Commissions: Town Meetings with a Blue, Blue Ribbon , [Scope Note 34], Kennedy Institute of Ethics Journal 1998 March; 8(1): 91-109, Available as a monograph from National Reference Center for Bioethics Literature, Kennedy Institute, Georgetown University, Washington, DC 20057-1212; 888-BIOETHX. This article can be accessed at: http://bioethics.georgetown.edu/publications/scopenotes/sn34.pdf
Connections	Archives is held by Georgetown University: https://bioethicsarchive.georgetown.edu/pcbe/reports/past_commissions/

16.1.4 Brookhaven National Laboratory/Archives

Type of resource	Government Laboratory
Collections	BNL has a small informal collection of a few scientist's personal papers. However they do not have a formal archive. Nor have they sent archival material to outside facilities to maintain. All documentation that BNL possesses about the Human Genome project are considered records owned by the Department of Energy. Anyone looking for specific information on this project would have to submit a Freedom of Information Act request. All published material that came

	from BNL on this subject would be found at the Office of Scientific and Technical Information (OSTI), which is searchable by the public.
Connections	https://www.bnl.gov/about/history/ http://www.osti.gov/home/2014-catalogue-collections http://www.osti.gov/scitech/search/semantic:%22Human%20genome%22/filter-results:F

16.1.5 California State Archives/Archives

Type of resource	Government
Dates	1985-1990
Collections	Legislature -- Joint Committee on Science and Technology Hearing Files Hearing transcripts, tapes, agendas, testimony, and background information relating to science and technology issues. I Note: Restricted due to physical condition or format - See Reference Archivist.
Connections	http://www.sos.ca.gov/archives/about-archives/ http://www.sos.ca.gov/webcat/request/DoMenuRequest?SystemName=California+State+Archives&UserName=csa+pub prompt%20search&eloquentref=csa_public

16.1.6 Centers for Disease Control/Archives

Type of resource	Government Organization
Dates	1968-2004
Collections	**442.2.6 Machine-Readable Records (General)** **1968-2002** National survey of family growth files, containing social survey information on pregnant women and aspects of pregnancy, maternal and child care, 1976-95 (7 data sets), with supporting documentation. National immunization survey files, 2002 (2 data sets), with supporting documentation. Tuberculosis surveillance public use files, 1985-99 (86 data sets), with supporting documentation. National hospital discharge survey files, 1979-99 (108 data sets), with supporting documentation. Multiple cause of death files, 1974-93 (6 data sets), with supporting documentation. Marriage detail files, 1968-88 (21 data sets), with supporting documentation. Divorce detail files, 1968-88 (21 data sets), with supporting documentation. National health interview survey on disability files, 1994-95 (51 data sets), with supporting documentation. Sudden unexplained death syndrome among Southeast Asian refugees files, 1985-94 (3 data sets), with supporting documentation. Adult use of tobacco survey, 1986 (1 data set), with supporting documentation. Behavioral risk factor surveillance survey, 1984-98 (130 data sets), with supporting documentation. **442.2.7 Still Pictures (General)** **ca. 1993-2004** **Posters:** Aimed at increasing awareness of various health threats, and promoting the use of antibiotics, vaccinations, and other practices used to lessen or eliminate these threats, ca. 1993-2004 (63 images).
Connections	http://www.archives.gov/research/guide-fed-records/groups/442.html

16.1.7 Connecticut State Archives/Archives

Type of resource	State Archives
Collections	Edward A. Khairallah Papers. Date:undated, 1958-1996Creator:Khairallah, Edward A.Abstract:The collection contains the professional papers of Edward A. Khairallah, Professor of Molecular and Cell Biology, at the University of Connecticut.Publisher:Archives & Special Collections at the Thomas J. Dodd Research Center.Show Details | Show Relevant Containers

	Richard Erdoes papers Date:1920-2008Creator:Erdoes, Richard, 1912-Abstract:Correspondence, writings, audio and moving image recordings, photographic materials, subject files, printed ephemera, art work, and other materials created or collected by Richard Erdoes (1912-2008), author of more than a dozen books about American Indian life. The collection primarily documents Erdoes's activities between 1968 and 1999, and is useful for the study of his writing process and research interests, specifically his work with American Indian individuals and communities. His papers also serve as a resource for the study of the peoples, areas, and subjects that he chose to research and record, and are particularly useful for research about the American Indian civil rights movement, twentieth century American Indian spirituality and religious practices, especially among the Lakota, and American Indian cultural revitilization efforts during the latter half of the twentieth century.Publisher:Beinecke Rare Book and Manuscript Library P.O. Box 208240 New Haven, CT 06520 Email: beinecke.library@yale.edu Phone: (203) 432-2972 Fax: (203) 432-4047Show Details | Show Relevant Containers
Connections	http://ctstatelibrary.org/state-archives/

16.1.8 Equal Employment Opportunity Commission (EEOC)/Archives

Type of resource	Commission
Collections	**403.7 Still Pictures (General)** **1965-97** **Photographs:** Meetings, conferences, presentations, and head-and-shoulder views of prominent agency personnel, including official portraits (CC, 2,800 images). Included are photographs of EEOC Chairman Clarence Thomas, Anita Hill, actor Whitman Mayo, and Senator Strom Thurmond of South Carolina.**Posters:** EEOC poster collection (P), consisting of EEOC 25th Anniversary, 1989 (1 image); equal employment opportunity laws (English- and Spanish-language versions), 1990 (2 images); and publicizing the 1964 Civil Rights Act and the 1990 Americans with Disabilities Act, 1991 (1 image)
Connections	Records are held at NARA: http://www.archives.gov/research/guide-fed-records/groups/403.html

16.1.9 FCC/Archives

Type of resource	Government Agency
Collections	**173.1 ADMINISTRATIVE HISTORY** **Established:** As an independent agency by the Communications Act, June 19, 1934 (48 Stat. 1064). **Predecessor Agencies:** • Interstate Commerce Commission (regulation of telephone, telegraph, and cable companies, 1910-34) • Radio Service, Bureau of Navigation, Department of Commerce and Labor (1911-13) • Radio Service, Department of Commerce (1913-27) • Radio Division, Department of Commerce (1927-32, to Federal Radio Commission) • Department of State (licensing of submarine cable operations, 1921-34) • Federal Radio Commission (1927-34) **Functions:** Regulates the charges and operating practices of common carriers engaged in interstate or foreign communications. Issues broadcasting licenses. Assigns broadcast frequencies. Classifies radio and television stations and prescribes the nature of their services. Enforces radio requirements for some classes of vessels. **Finding Aids:** Albert W. Winthrop, comp., Preliminary Inventory of the Records of the Federal Communications Commission, PI 93 (1956); Forrest R. Holdcamper, comp., "Preliminary

Inventory of the Records of the Federal Communications Commission: A Supplement to Preliminary Inventory No. 93," NC 131 (Sept. 1965); supplement in National Archives microfiche edition of preliminary inventories.
Related Records: Record copies of publications of the Federal Communications Commission and its predecessors in RG 287, Publications of the U.S. Government.

173.2 RECORDS OF THE RADIO SERVICE AND THE RADIO DIVISION
1910-34

History: Radio Service, Bureau of Navigation, established in the Department of Commerce and Labor, July 1, 1911, by order of the Secretary, to implement the act of June 24, 1910 (36 Stat. 629) requiring radio equipment on passenger steamships. Transferred with the Bureau of Navigation to the Department of Commerce by the Department of Commerce Act (37 Stat. 736), March 4, 1913. Separated from the Bureau of Navigation, 1927, and became the Radio Division, Department of Commerce, with enhanced power to license radio operators, inspect stations, and monitor broadcast frequencies. Absorbed by the Federal Radio Commission pursuant to EO 5892, July 20, 1932.
Textual Records: Combined general correspondence files of the Radio Service, Radio Division, and Federal Radio Commission, on early radio regulation, 1910-34, with indexes, 1910-30. Correspondence of the Radio Division relating to complaints, station operations, administrative and technical matters, and the radio industry, 1929-32, with indexes, 1929-30. Correspondence of the Federal Radio Commission relating to applications for broadcast station licenses, 1928-32.
Motion Pictures (1 reel): Promotional film, Radio Station WIBO, Chicago, 1930. SEE ALSO 173.14.

173.3 RECORDS OF THE INTERSTATE COMMERCE COMMISSION (ICC)
1907-34

History: Regulatory responsibility for telegraph, telephone, and cable companies engaged in interstate operations vested in the ICC by the Mann-Elkins (Interstate Commerce) Act, June 18, 1910 (36 Stat. 544), subsequently modified by EO 3513, July 9, 1921, which transferred to the Department of State the responsibility for advising the President on the granting of licenses to submarine cable operators. ICC functions transferred to FCC by the Communications Act of 1934. State Department responsibilities transferred by EO 6779, June 30, 1934.
Textual Records: Regulations, 1912-32. "Formal docketed," 1912- 32, "finance," 1921-34, and "valuation," 1918-27, case files. Records relating to depreciation of telephone, telegraph, and cable properties, 1921-34. Minutes of meetings of the Engineering Board of the Bureau of Valuation, 1919-20. Records relating to the Western Union Telegraph Company, 1907-31; and to the Mackay Companies Land Line System, 1919-28. Records of the Chief Examiner of Accounts relating to corporate acquisitions by American Telephone and Telegraph, 1913-29.

173.4 RECORDS OF THE FEDERAL RADIO COMMISSION
1927-34

History: Established as an independent agency by act of February 23, 1927 (44 Stat. 1162) to regulate the broadcast industry, with authority to license stations, allocate frequencies, and control power usage. Absorbed, pursuant to EO 5892, July 20, 1932, functions, records, and personnel of the Radio Division, Department of Commerce. Abolished, 1934. SEE 173.1.
Textual Records: Microfilm copy of minutes, 1927-34 (8 rolls). Docketed case files, 1927-34.General orders, 1927-31. Decisions concerning construction permits for new stations and modifications of broadcast licenses, 1929-34.

173.5 GENERAL RECORDS OF THE FCC
1934-79

History: Commission members initially organized into three subcommissions, styled divisions (Radio, Telephone, and Telegraph Divisions). Divisional structure of commission abolished November 15, 1937, with FCC thereafter functioning as a single unit.
Textual Records: Minutes of Federal Radio Commission and FCC meetings and hearings, 1928-70. Microfilm copy of minutes of FCC meetings, 1934-71 (395 rolls). Docketed case files of the FCC, 1934-79 (4,281 ft.) Orders, 1934-39. Histories of World War II and Korean War activities of the FCC, 1948-52. Records of a special investigation of companies engaged in interstate telephone communications conducted under a joint resolution of the Congress, 1936. Exhibits presented by the National Association of Broadcasters in a hearing on the Communications Act, October 1934. Records of the Network Study Staff, Network Study Committee, consisting of correspondence, questionnaires, and program logs of the Broadcast

	Network Survey, 1956-57. Deleted auxiliary broadcast station history cards, 1959-63. Technical information conference files, 1946-50. Records relating to the International Telecommunications Union (ITU), United Nations, including administrative council files, 1957-61, 1972-74; circular letters, 1969-70; International Frequency Registration Board (IFRB) circulars, 1971-74; and treaty and conference files, 1972-75. Records relating to the International Radio Consultative Committee (CCIR), 1963-67. Correspondence relating to U.S. directional antenna pattern interference problems with Canada, Mexico, and Cuba, 1956-70. Annual reports by telephone companies on FCC Form M, 1970-79. Annual reports by wire telegraph, ocean cable, and radio-telegraph carriers on FCC Form O&R, 1971-79. Records relating to a survey of radio use in the United States (1940-47), 1950-52. Records relating to the Airspace Panel, Air Coordinating Committee, 1947-57. **Specific Restrictions:** As specified by the FCC, no one may examine the microfilm copies of the formal official minutes of the FCC bearing security or other classification mark or be given information from them or copies of them except by permission of the FCC. **Motion Pictures (4 items):** Exhibits submitted in evidence relating to cases heard and decided by the FCC, concerning petitions, complaints, or FCC motions, chiefly involving broadcasting stations and pertaining to such matters as rates, facilities, the quality of services, corporate organizations, and ownership transfers, 1953-68. SEE ALSO 173.14. **Video Recordings (10 items):** Exhibit submitted in evidence and relating to a case involving Danville Community Antenna Systems, Inc. (docket number 16865), 1968. **Sound Recordings (415 items):** Exhibits submitted in evidence relating to cases heard and decided by the FCC, concerning petitions, complaints, or FCC motions, chiefly involving telephone, telegraph, cable, and radio broadcasting companies and pertaining to such matters as rates, facilities, the quality of services, corporate organizations, assignments of radio frequencies, and ownership transfers, 1936-65. SEE ALSO 173.16. **Photographs (995 images):** Collected as part of a survey of radio use in the United States and illustrating radio use, the impact of radio technology on the transportation industry, and radio celebrities (1908-47), 1950-52. SEE ALSO 173.17. **173.6 RECORDS OF THE OFFICE OF THE EXECUTIVE DIRECTOR** **1927-71** **Textual Records:** General correspondence, 1927-71. Correspondence of the FCC Chairman, 1941-71. Public reactions to Chairman Newton R. Minnow's criticisms of network television, 1961. **Sound Recordings (131 items):** False claims for medical products and cures, from the general correspondence of the Executive Director, 1933-45. SEE ALSO 173.16. **173.7 RECORDS OF THE OFFICE OF THE CHIEF ACCOUNTANT** **1900-49** **History:** Established as the Accounting, Statistical, and Tariff Department in October 1934. Acquired the fiscal records of predecessor agencies, relating to wire and wireless communications. Name changed to Accounting Department in 1944, to Bureau of Accounts, May 12, 1948, and to Office of the Chief Accountant, March 3, 1950. Abolished October 31, 1955, and accounting functions integrated into the operating bureaus. Accounting Systems Division assigned to the Common Carrier Bureau and Economics Division to the Broadcast Bureau. **Textual Records:** Completed questionnaires (statistical circulars) from communications common carriers that relate to company histories, corporate relationships, fiscal matters, and operations, 1934-49. Financial summary data for telephone and telegraph carriers, 1920-48. Correspondence relating to the acquisition of physical plant by telephone companies, 1921-34. Records relating to the acquisition and disposal of physical plant by the Chesapeake and Potomac Telephone Company, 1900-37. Records relating to an original cost basis accounting study of American Telephone and Telegraph, 1937-44. **173.8 RECORDS OF THE OFFICE OF CHIEF ENGINEER** **1875-1967** **History:** Initial organization of the FCC in 1934 included Engineering Department, with responsibility for engineering phases of broadcast licensing, common carrier regulation, regulation of special services, supervision of field staff, and technical information engineering and research, including frequency allocation and treaty negotiation. Department redesignated Bureau of Engineering, May 12, 1948. Redesignated Office of Chief Engineer, April 3, 1950, concurrently with separation of common carrier functions as Common Carrier Bureau.

	Broadcast licensing functions separated from Office of Chief Engineer as Broadcast Bureau, July 31, 1950. Amateur radio, marine radio and safety, and public safety and special services functions consolidated as the Safety and Special Radio Services Bureau, June 4, 1951. Field Engineering and Monitoring Division made a separate bureau, March 2, 1952. Office of Chief Engineer redesignated Office of Science and Technology, May 1, 1979, and Office of Engineering and Technology, 1988. Functions include research, testing and approval of experimental radio equipment, frequency allocation, and treaty negotiation. **Textual Records:** North American Regional Broadcast Agreement (NARBA) file, 1939-65. FCC frequency allocation records, 1928-50. Treaty and conference records, 1875-1967. **173.9 RECORDS OF THE COMMON CARRIER BUREAU** **1914-70** **History:** Common carrier regulation initially assigned to Engineer Department, 1934. Separately denominated Common Carrier Branch under Engineering Department by 1947. Engineering Department became Bureau of Engineering, May 12, 1948, with former Common Carrier Branch redesignated Common Carrier Division. Common Carrier Division separated from Bureau of Engineering (which became Office of Chief Engineer) and designated Common Carrier Bureau, April 3, 1950, with regulatory responsibility for interstate and international common carrier communications (initially telephone, telegraph, and radio, with subsequent addition of satellite communications). **Textual Records:** Annual financial reports of communications common carriers, 1914-70, with an index, 1914-45. **173.10 RECORDS OF THE BROADCAST BUREAU** **1937-73** **History:** Responsibility for engineering phases of broadcast licensing initially assigned to Engineer Department, 1934. Separately denominated Broadcast Branch under Engineering Department by 1947. Engineering Department became Bureau of Engineering, May 12, 1948, with former Broadcast Branch divided into FM (Frequency Modulation) Broadcast Division, Television Broadcast Division, and Standard Broadcast Division. Bureau of Engineering redesignated Office of Chief Engineer, April 3, 1950. Broadcast divisions separated from Office of Chief Engineer and reconstituted as Broadcast Bureau, June 4, 1951, with responsibility for regulation of broadcasting activity. Acquired licensing function from Bureau of the Secretary, 1952. Consolidated with Cable Television Bureau (which had been established in January 1970) to form Mass Media Bureau, November 30, 1982. **173.10.1 General records** **Textual Records:** Correspondence and other records relating to the administration, finances, and operations of broadcasting stations and networks, 1939-50. Annual financial reports of broadcasting stations, 1937-71. **Specific Restrictions:** As specified by the FCC, the annual financial reports filed by licensees and permittees of standard, FM, television, and international broadcast stations with the FCC in accordance with section 0.417 of the FCC Rules and Regulations are not open to public inspection unless special permission is granted by the FCC upon written request describing in detail the documents to be inspected and the reasons therefor. **173.10.2 Records of the Technical and Allocations Branch, Broadcast Facilities Division** **Textual Records:** Interference case files, 1954-60. Reports and correspondence relating to field measurement data for FM and television stations, 1941-59. Reports pertaining to stratovision flight tests, 1946-69. Records relating to the development of FM multiplex (stereo) broadcast stations, 1957-59; development of educational television, 1959-60; and development of Community Antenna Television (CATV), translators, and Ultra High Frequency (UHF) boosters, 1950-64. Records relating to synchronous booster transmitter operation of broadcast stations WINX, Washington, DC, and WBAL, Baltimore, MD, 1940-51; to compatible single-sideband broadcast transmission experimental stations, 1958-61; to experimental subscription television stations, 1949-57; and to closed experimental and developmental broadcast stations, 1938- 65; Records relating to the history of color television, 1941-51; history of the development of television, 1938-65; and history of theater television, 1948-49. **173.10.3 Records of the Research Branch, Research and Education Division** **Textual Records:** Questionnaires for the 1966 political broadcasting survey, 1966-67. Correspondence and reports concerning the 1972 political broadcasting survey, 1964-73.

	173.11 RECORDS OF THE RADIO INTELLIGENCE DIVISION **1940-47** **History:** Established July 1, 1940, as the National Defense Operations Section of the Field Division to investigate and monitor clandestine wireless operations in the United States and its possessions and to train military personnel and intelligence agents in monitoring techniques. Discontinued in 1946. **Textual Records:** Subject-classified general file, 1942-45. Reports, correspondence, and other records relating to congressional investigations of the FCC and the attack on Pearl Harbor and to the security classification of records, 1942-46. Files of George E. Sterling, Chief of the Division, 1940-47. Records relating to clandestine stations, intercepted radio transmissions, and cooperation with British and Canadian security organizations, 1940-45. **Maps (52 items):** Hydrographic Office tracking charts annotated with dots to show locations of SOS reports and submarine attack sites along the U.S. coasts and in the Caribbean, 1942 (5 items). Diagrams showing the Japanese Navy communications net (28 items) and the German communications net in Europe (8 items), 1942-43. Charts showing German clandestine circuits monitored at North Scituate, RI, 1943 (3 items). World chart and papers relating to American Telephone and Telegraph circuits and censorship instructions, 1942 (3 items). Master call list diagrams, 1943 (4 items). Unidentified chart showing signals converging on a site north of the Spanish coast, 1943 (1 item). SEE ALSO 173.12. **173.12 RECORDS OF FIELD OFFICES** **1950-52** **Textual Records (in San Francisco):** Records of the San Francisco Field Office including affidavits, clippings, letters, memorandums, pleadings, and telegrams, 1950-52. **173.13 CARTOGRAPHIC RECORDS (GENERAL)** **1932-42** Maps of the United States, 1932 and 1937, and of Cuba, 1942, showing commercial aviation radio stations, aeronautical stations, and call letters. SEE Maps UNDER 173.11. **173.14 MOTION PICTURES (GENERAL)** SEE UNDER 173.2 and 173.5. **173.15 VIDEO RECORDINGS (GENERAL)** SEE UNDER 173.5. **173.16 SOUND RECORDINGS (GENERAL)** SEE UNDER 173.5 and 173.6. **173.17 STILL PICTURES (GENERAL)** **1974-88** **Photographs:** FCC commissioners and officials, 1974-87 (CM, 776 images). FCC events and activities, 1981-88 (EV, 355 images). FCC facilities, 1987-88 (FC, 98 images). **Photographic Prints:** Documenting renovations of FCC facilities, 1985-87 (RP, 118 images).
Connections	Records of the FCC are held by NARA: http://www.archives.gov/research/guide-fed-records/groups/173.html

16.1.10 Federal Bureau of Investigation (FBI)/Archives

Type of resource	Government Archives
Connections	https://vault.fbi.gov/

16.1.11 Food and Drug Administration (FDA) Archives

Type of resource	Government Agency
Dates	1877-1978

Collections	**88.1 Administrative History** **Established:** In the Department of Agriculture, effective July 1, 1930, by the Agricultural Appropriation Act (46 Stat. 422), May 27, 1930. **Predecessor Agencies:** **In the Department of Agriculture:** • Division of Chemistry (1862-1901) • Bureau of Chemistry (1901-27) Insecticide and Fungicide Board (IFB, 1910-27) Food, Drug, and Insecticide Administration (FDIA, 1927-30) **Transfers:** To Federal Security Agency by Reorganization Plan No. IV of 1940, effective June 30, 1940; to Department of Health, Education, and Welfare (HEW) by Reorganization Plan No. 1 of 1953, effective April 11, 1953; to Public Health Service (PHS), HEW, by HEW reorganization order, April 1, 1968; to newly established Consumer Protection and Environmental Health Service, PHS, HEW, by HEW reorganization plan, effective July 1, 1968; to operating health agency status within PHS, effective July 1, 1970, by HEW reorganization plan, January 16, 1970; with PHS to Department of Health and Human Services by Department of Education Organization Act (93 Stat. 695), October 17, 1979. **Functions:** Enforces statutes and regulations promoting the purity, standard potency, and accurate labeling of foods, cosmetics, medicines, and other consumer products.**Related Records:** Record copies of publications of the Food and Drug Administration and its predecessors in RG 287, Publications of the U.S. Government. Records of the Public Health Service, 1912-1968, RG 90. Records of the Bureau of Agricultural and Industrial Chemistry, RG 97. Records of the Consumer Product Safety Commission, RG 424. **88.2 General Records of the FDA and its Predecessors** **1880-1942** **History:** Division of Chemistry established in the Department of Agriculture pursuant to provisions of its establishing act (12 Stat. 387), May 15, 1862. Began analysis of foods, drugs, and insecticides, 1883. Redesignated Bureau of Chemistry, effective July 1, 1901. Enforced an act of June 30, 1906 (34 Stat. 768), called the Food and Drugs Act for appropriations purposes. Insecticide and Fungicide Board established by General Order 143, Department of Agriculture, December 22, 1910, to administer the Insecticide and Fungicide Act (36 Stat. 331), April 26, 1910, with associated analytical work vested in Bureau of Chemistry. IFB superseded, July 1, 1927, by the Food, Drug, and Insecticide Administration, established on that date pursuant to the Agricultural Appropriation Act (44 Stat. 1002), January 18, 1927, absorbing also the regulatory functions of the Bureau of Chemistry, which was merged by the same act with the Bureau of Soils to form the Bureau of Chemistry and Soils. FDIA redesignated FDA, 1930. See 88.1. **Textual Records:** Project schedules and reports on enforcement of the Food and Drugs Act, 1916-38. Index of articles seized because of violations of the Food and Drugs Act, 1908-39. Records relating to the Food and Drugs Act, including correspondence, 1919-37, with index; charge and status cards, showing product status and charges against products, dealers, and manufacturers, 1907-38; and an index to manufacturers charged with violations, 1909-40. Records of the Food Standards Committee relating to investigations into the manufacture of food products, 1897-1938. Records relating to foreign food and drug legislation, 1910-40, with card index. Records concerning Consumers' Research, Inc., 1922-40. Summary information cards about seizure recommendations, 1907-38, and food product sample analyses, 1905-33. Import detention notices, 1908-38, and card index to import detention correspondence, 1906-42. Records relating to the proposed importation of medicinal and food substances, 1922-38. Records relating to an importer of chemicals used in fruit and vegetable sprays and pharmaceuticals, 1925-38. Allotment and disbursement ledgers, 1914-40. Reports, circulars, bulletins, and other records of committees engaged in the publication of the *United States Pharmacopoeia*, 1880-1940.

88.3 Records of the Bureau of Chemistry
1877-1943 (bulk 1877-1920)

Textual Records: Transcripts of hearings to determine the legal definition of whiskey, 1906-9. Records relating to a court case involving the seizure of a shipment of phenacetin (or acetphenetidin), 1906-14. Minutes of the Committee on Business Methods, 1907-13. Reports and correspondence relating to enforcement of the Food and Drugs Act ("Special File"), 1907-20. Letters sent to inspection districts, 1916-17. World War I project files on problems of conservation, preservation, and development of new food sources, 1917-19. Card index to publications and manuscripts of former staff members, 1900-43. Miscellaneous records, 1877-1910.

88.4 Records of the Board of Food and Drug Inspection
1904-13

History: Established by order of the Secretary of Agriculture, April 25, 1907, to act on all questions arising from enforcement of the Food and Drugs Act of 1906. Interpreted the act and conducted hearings on alleged violations. Abolished, February 1, 1914, with functions divided between Bureau of Chemistry and Office of the Solicitor, Department of Agriculture.
Textual Records: Minutes of executive sessions, 1907-13. Index to hearings, 1907-13. Correspondence of the Chairman, 1908-10. Food inspection decisions, 1904-13. Transcripts of hearings on bleached flour, November 18-23, 1908. Notices of judgment obtained by the board, 1908-10. Reports by the Bureau of Chemistry, Solicitor of the Department of Agriculture, U.S. consuls abroad, and others, 1908-12. Records relating to recommendations on the seizure and condemnation of food and drug shipments on grounds of adulteration or mislabeling, 1908-12.

88.5 Records of the Referee Board of Consulting Scientific Experts
1911-13

History: Established by the Secretary of Agriculture, February 20, 1908, to report on the wholesome or deleterious character of foods and drugs. Discontinued after June 30, 1915.
Textual Records: Reports, food charts, blood analyses, and correspondence relating to the use of sulphur dioxide as a food preservative and to the use of alum in certain foods, 1911-13.

88.6 Records of the Supervising Tea Examiner and Successors
1912-37

History: Established in the Department of the Treasury as head of the tea inspection service, to enforce the Tea Act (29 Stat. 604), March 2, 1897, and to provide expert assistance to the Secretary of the Treasury in setting standards of purity and quality for imported teas. Responsibility for administering the act transferred to the Bureau of Chemistry, July 1, 1920. Returned to FDIA by the Agriculture Appropriations Act of 1927 (44 Stat. 1003), January 15, 1927.
Textual Records: Periodic and special statistical reports, 1912- 37. Correspondence, 1913-29.

88.7 Records of the Food, Drug, and Insecticide Administration and the Food and Drug Administration
1907-77

Textual Records: Records of FDIA and FDA Commissioners relating to proposed food and drug legislation, 1927-40. FDA general correspondence, 1930-37, with index. Transcript of a hearing before the Senate Committee on Agriculture and Forestry concerning the administration of the Food and Drugs Act, June 3- 30, 1930. Reports, correspondence, and memorandums relating to a survey of orange beverages and the effects of shellac on animal organisms, 1935-36. Records of the Food Division, 1929-41, and of its Beverage Branch, 1907-45, concerning tests and analyses of foods. Import milk permit case files, 1927-41, with index, 1927- 45. Minutes, reports, correspondence, and memorandums relating to the work of the Division of Medicine with the National Research Council committees on medical research and on drugs and medical supplies, 1941-46. Advertising material for patent medicines and health devices, used to demonstrate the need for regulation of food and drug advertising,

	1933-37. Printed notices of judgment in cases under section 4 of the Food and Drugs Act, 1908-43, and related partial index, 1922-37; and in cases under section 705 of the Federal Food, Drug, and Cosmetic Act of June 25, 1938 (52 Stat. 1040), 1940-54. Record set of FDA forms, 1950-77. **88.8 Records of the Philadelphia Field Station** **1906-46** **Textual Records (in Philadelphia):** Reports, correspondence, and memorandums relating to manufacturers and distributors of foods, drugs, and insecticides within its jurisdiction, 1906-46. **88.9 Textual Records (General)** **1903-78** Subject files, 1903-74. Drug reports, 1967-69. Hearing clerk records, 1961. Articles and speeches, 1916-64. Publications, 1917-68. Office of Public Information files, 1960-64. Food Standards Advisory Committee records, 1941-42. Records of the Federal Committee on Pest Control, 1946-64. Proceedings of conferences and National Food and Drug Council records, 1963-68. Citizens Advisory Committee files and other records, 1950-69. Radiation Registry of Physicians questionnaires and related records, 1960-78. Classified general subject files, 1945. Operational plans, 1966-74. **88.10 Motion Pictures (General)** **1957-68** *Operation Plumbob*, depicting FDA tests to determine effects of residual radiation (fallout) on commodities, 1957 (1 reel). FDA public service announcements on health and consumer fraud, 1966- 68 (3 reels). **88.11 Still Pictures (General)** **1885-1977** **Photographs:** FDA personnel, 1968-77 (P, 480 images). **Photographs and Color Slides:** FDA activities, including administration, laboratory analysis, and investigation, 1962-77 (A, 26,020 images). **Photographs and Lantern Slides:** Regulatory and analytical functions of the FDA and its predecessors, including chemical analysis of drugs, investigations of fraudulent labeling of drugs, inspections of food products, and seizure and destruction of contaminated foods; and manufacture of candy, liquor, and other commodities, 1885-1944 (GP, GB, GS, GN, 4,000 images).
Connections	Records of the FDA are held by NARA: http://www.archives.gov/research/guide-fed-records/groups/088.html

16.1.12 George Bush Presidential Library and Museum/Archives

Type of resource	Government/Library Archives
Connections	https://www.georgewbushlibrary.smu.edu/Home.aspx Bush, George
Collections	Finding Aids are organized into three categories: records processed under the Freedom of Information Act (FOIA), Staff Member Office Files (SMOF), and White House Office of Records Management (ORM) files. These listings will be updated as records are opened. Frozen White House website link is http://georgewbush-whitehouse.archives.gov. It is also possible to search the Public Papers of the Presidents online at the American Presidency Project at http://www.presidency.ucsb.edu/. There is very little released material available on Human Genome Project at this time (as of February 2016). However, researchers are welcome to use the Freedom of Information Act (FOIA) to place a request for information release. FOIA request needs to be in writing, and it must state that it is a FOIA request. It needs to be as specific as possible (names, dates,

	places). Finally, researchers must provide all of contact information including name, phone number, mailing address and email address. More information about the FOIA is available at: http://www.georgewbushlibrary.smu.edu/Research/FOIA%20and%20PRA.aspx You may send in your FOIA request by mail, fax, or e-mail to the following: Mail: George W. Bush Presidential Library c/o FOIA Coordinator 2943 SMU BLVD Dallas, Texas 75205 Fax: 214-346-1558 (please include cover sheet if possible) E-mail: gwbush.library@nara.gov (please include your name in the subject line)

16.1.13 Lawrence Berkeley National Laboratory/Archives

Type of resource	Laboratory/Government Archives
Collections	Lawrence Berkeley National Laboratory Archives does not maintain an onsite archives (nor a records center). Their records are considered to be federal records and are stored at the Federal Records Center in San Bruno. Permanent records are transferred to the Archives at San Bruno when they reach 25 years of age and then research access is managed by the National Archives. Research access to non-permanent federal records stored at the Federal Records Center may require a Freedom of information Act (FOIA) request or a California Public Records Act request.
Links	https://commons.lbl.gov/display/aro/Archives+and+Records

16.1.14 LOC Rare Book and Special Collections/Archives

Type of resource	Government Library
Dates	1990-2004
Content (type of)	Over 250 books, websites, archives, films/videos, photos
Connections	https://www.loc.gov/search/?q=human+genome+project

16.1.15 Los Alamos National Laboratory (LANL)/Archives

Type of resource	Government Laboratory/Library
Content (type of)	Reports, books, patents
Connections	Bitensky, Mark Deaven, Larry L DeLisi, Charles Goad, Walter Ulam, StanislawYesley, Michael
Collections	There are patents, books, and interviews, as well as other items related to the names of the above within the LANL catalog.
Links	http://catalog.lanl.gov/F/

16.1.16 NARA/Archives

Type of resource	National Archives
Connections	http://www.archives.gov/
Collections	NARA is the primary agency responsible for maintaining federal records. Therefore, the majority of records from national laboratories, presidents, and government agencies are held here. Please visit their website to search for relevant collections.

16.1.17 National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research/Archives

Type of resource	Government
Collections	Reports of the National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1974-78
Connections	http://www.hhs.gov/ohrp/archive/nationalcommission.html

16.1.18 National Human Genome Research Institute (NHGRI)/Archives

Christopher Donohue attended 2014 meeting at CSHL.

Type of resource
Connections

16.1.19 National Institute of General Medical Sciences (NIGMS)/Archives

Type of resource	Government Agency
Collections	Annual reports, reports
Date(s)	1971-1997
Connections	https://archive.org/search.php?query=creator%3A%22National+Institute+of+General+Medical+Sciences+%28U.S.%29

16.1.20 National Institute of Neurological and Communicative Disorders and Stroke (NINCDS)/Archives

Type of resource	Government Agency
Date	1972-1995
Collections	Annual reports
Connections	https://archive.org/search.php?query=creator%3A%22National+Institute+of+Neurological+Disorders+and+Stroke+%28U

16.1.21 National Institute of Neurological Disorders and Stroke (NINDS)/Archives

Type of resource	Government Agency

Date	1975-1995
Collections	Annual Reports
Connections	https://archive.org/search.php?query=creator%3A%22National+Institute+of+Neurological+Disorders+and+Stroke+%28U

16.1.22 National Institutes of Health (NIH)/Archives

Type of resource	Government Archives
Connections	NIH's collections are held at NARA: http://www.archives.gov/research/guide-fed-records/groups/443.html Adams, Mark Collins, Francis S. DeLisi, Charles Frederickson, Donald Gottesman, Michael Healy, Bernadine Kornberg, Arthur Moskowitz, Jay Nirenberg, Marshall Raub, William Tilghman, Shirley Varmus, HaroldWyngaarden, James

16.1.23 National Institutes of Health (NIH) Office of History/Archives

Type of resource	Government Archives
Content (type of)	photos and objects
Connections	http://nih.pastperfect-online.com/37870cgi/mweb.exe?request=keyword;keyword=human%20genome;dtype=d Anderson, William French Collins, Francis Frederickson, Donald Healy, Bernadine Kirschstein, Ruth Kornberg, Arthur Nathans, Daniel Nirenberg, Marshall Raub, William Singer, Maxine

16.1.24 National Library of Medicine (NLM)/ National Library of Medicine, Profiles in Science series/Archives

Type of resource	Government Archives
Collections	This site celebrates twentieth-century leaders in biomedical research and public health. It makes the archival collections of prominent scientists, physicians, and others who have advanced the scientific enterprise available to the public through modern digital technology.
Connections	https://profiles.nlm.nih.gov/ Avery, Oswald T.Lindberg, Donald A.B.

16.1.25 National Science Foundation (NSF)/Archives

Type of resource	Government Archives
Date	1907-87 (bulk 1948-87)
Collections	**History:** NSF responsibility under NSF Act of 1950 for development of a national science policy and coordination of federal government scientific research transferred to newly established Office of Science and Technology (OST) by Reorganization Plan No. 2 of 1962, effective June 8, 1962. OST abolished, with functions of Science Advisor to the President transferred from OST Director to NSF Director, by Reorganization Plan No. 1 of 1973, effective July 1, 1973. Office of Science and Technology Policy (OSTP) established, and functions of Science Advisor to the President transferred from NSF Director to OSTP Director, by the Presidential Science and Technology Advisory Organization Act of 1976 (90 Stat. 459), May 11, 1976. **Textual Records:** Central correspondence, 1949-63. Subject correspondence of the NSF Director, H. Guyford Stever, in his capacity as Science Advisor to the President, 1973-76. Subject correspondence of the Associate Director for Educational and International Activities, Harry C. Kelly, including correspondence created when he was Assistant Director for Scientific Personnel and Education (1951-59), 1951-62. Legislative files of the general counsel, 1956-70. Contract case files, 1966-87. **Related Records:** Records of the Office of the Special Assistant to the President for Science and Technology, in RG 359, Records of the Office of Science and Technology. Oral history interview of Wilson Harwood, NSF Assistant Director (1951-57), **in Eisenhower Library**. **307.3 Records of the Division of Science Resources Studies, Office of the Assistant Director for Scientific Personnel and Education** **1954-70** **Machine-Readable Records:** National Register of Scientific and Technical Personnel, 1954-70 (8 data sets), with supporting documentation. Science and Engineers Employment Surveys, 1971 (1 data set), with supporting documentation. National Engineers Register, 1964-69 (3 data sets), with supporting documentation. See also 307.14. **307.4 Records of the Office of the Director, Government and Public Programs** **1953-81** **307.4.1 General records** **Textual Records:** Selected subject files, 1953-75. **Motion Pictures:** *On the Ice*, concerning Antarctic research, 1969 (1 reel). *That Very Special Ship*, about the research ship *Glomar Challenger*, 1973 (1 reel). *TV Testing for the Future*, documenting the communications uses of television, 1979 (1 reel). See also 307.11. **Video Recordings:** *Science in the Seventies*, dealing with scientific research in the 1970's, 1974 (1 item). See also 307.12. **307.4.2 Records of the Office of the Assistant Director for Science Education relating to the Public Understanding of Science (PUS) Program** **Motion Pictures:** Produced under the PUS Program, and consisting of *Well of Life*, documenting oceanic exploration, 1976 (1 reel); *Exploding Universe*, explaining universe expansion theory, 1977 (1 reel); *Earth Space*, covering the magnetosphere and the Van Allen radiation belts, 1977 (1 reel); and *When Rivers Run Dry*, dealing with water allocation in the southwestern United States, 1978 (1 reel). See also 307.11. **Video Recordings:** Produced under the PUS Program for broadcast on commercial and public television, dealing with a variety of scientific and technological topics, 1976-81 (17 items). See also 307.12. **Sound Recordings:** Produced under the PUS Program for broadcast on commercial and public radio, dealing with a variety of scientific and technological topics, 1977-81 (17 items). See also 307.13. **Color Slides:** "The Universe of Dr. Einstein," a slide presentation produced under the PUS Program, 1979 (199 items). **307.5 Records of the Division of Polar Programs and its Predecessors** **1907-87 (bulk 1955-87)**

History: Office of the International Geophysical Year (IGY), responsible for funding U.S. participation in international exploration of Antarctic during IGY (July 1, 1956-December 31, 1957), established in Office of NSF Director, April 1955. Transferred to Office of Associate Director for Research, 1957. Redesignated Office of Special International Programs, and made responsible for U.S. Antarctic Research Program (USARP), August 4, 1958. USARP functions transferred to newly established Office of Antarctic Programs (OAP), May 26, 1961. OAP transferred to newly established Office of Associate Director (International Activities), November 1, 1962. Transferred to Office of Associate Director (Research), effective September 1, 1963, by Staff Memorandum O/D 9, August 16, 1963. Transferred to newly established Division of Environmental Sciences in Office of Associate Director (Research) by Staff Memorandum O/D 65-23, November 19, 1965. Transferred to newly established Office of Assistant Director for National and International Programs, effective October 27, 1969, by Staff Memorandum O/D 69-26, October 24, 1969. Redesignated Office of Polar Programs (OPP), and made responsible for direction of both arctic and antarctic research programs, December 19, 1969. Transferred to newly established Directorate for Astronomical, Atmospheric, Earth, and Ocean Sciences (AAEOS), effective September 30, 1975, by Staff Memorandum O/D 75-37, August 25, 1975. Redesignated Division of Polar Programs (DPP) by Staff Memorandum O/D 76-22, April 19, 1976. Directorate for AAEOS redesignated Directorate for Geosciences, May 1, 1986.

307.5.1 Records of the Office of the International Geophysical Year and the Office of Special International Programs

Textual Records: Distribution copies of minutes, program plans, budget estimates, and other records of the U.S. National Committee for the International Geophysical Year, 1955-59. Logs, memorandums, and other records of Little America Station, Antarctica, 1957-58. Numbered antarctic status reports issued by Office of USARP, 1959-61.

307.5.2 Records of the Office of Antarctic Programs, Office of Polar Programs, and Division of Polar Programs

Textual Records: Central decimal and alphanumeric correspondence, 1957-87. Messages, mainly between Washington, DC, headquarters and antarctic field stations, 1961-87. Grant and contract case files, 1959-87. Antarctic field station reports, 1961-69. Records relating to the antarctic research vessel, USNS *Eltanin*, 1962-73. Correspondence, program files, and project files of individual staff members and subordinate offices, 1961-83. Records retained by the central office representative ("USARP Representative") in Antarctica, 1966-70; in New Zealand, 1976-79; and on board USNS *Eltanin*, 1962-72. NSF-published translations of Soviet polar studies, 1955-70.

Maps: British Antarctic Expedition, 1907-9 (3 items). Australasian Antarctic Expedition, 1911-14 (3 items). Antarctic Traverse II, Plateau Station to Queen Maud's Land, 1964 (2 items). Beardmore Glacier traverse, n.d. (1 item). Antarctic International Communications Network, n.d. (1 item). Antarctic air navigation charts, 1958-63 (5 items). USARP activities, 1960- 61 (2 items). Antarctica, produced by the American Geographic Society, in conjunction with the IGY, 1957-58 (5 items), and for the USARP, 1962 (1 item) and 1970 (3 items). See also 307.10.

Aerial Photographs: Satellite views of antarctic region, 1970-73 (1,459 items). USARP aerial reconnaissance of Beardmore Glacier, December 29, 1958 (141 items). Aerial reconnaissances, Antarctica, December 24, 1958 (63 items), and January 8, 1968 (12 items). Aerial reconnaissance, Bush Mountains, Antarctica, 1959 (17 items). Aerial views, nuclear reactor site, McMurdo Sound, Antarctica, December 1, 1968 (8 items). See also 307.10.

Motion Pictures: Films collected or maintained by the Polar Information Service documenting the escort of Thomas B. Owens, NSF Assistant Director for National and International Programs, January 1971 (1 reel); an equipment test, September 25, 1971 (1 reel); and AIDJEX (Arctic Ice Dynamics Joint Experiment) Project, 1972 (1 reel). Office of Antarctic Programs films relating to activities of USNS *Eltanin*, 1963 (4 reels). OAP International Cooperation and Information Program films *Power for Continent Seven*, n.d. (1 reel); *NBC News Presents: Chet Huntley-- Through Drake Passage with USNS Eltanin*, n.d. (1 reel); *On the Ice*, n.d. (1 reel); *Soviet Drift Station*, 1968 (1 reel); and documenting tests of an under-ice observation chamber, n.d. (1 reel). Polar research activities, 1961-68 (10 reels), 1971-72. See also 307.11.

Video Recordings: The Antarctic, n.d.(2 items).

Sound Recordings: Ceremonies at South Pole Station honoring the fiftieth anniversary of the Scott-Amundsen Expeditions, October 30, 1961 (2 reels). OAP International Cooperation and Information Program recordings, consisting of Stanford University VLF (Very Low Frequency)

demonstration tape of nose whistlers, swishy whistlers, and similar VLF phenomena, 1958-63 (1 reel); interviews conducted by U.S. Navy journalist Craig Duncan at McMurdo Sound Station, Antarctica, of Russian exchange scientists Peter Astakov (upper atmosphere physicist) and B.G. Lupatin (geologist), November-December 1967 (1 reel); Operation Deep Freeze 66 postseason interview of USARP Director Tom O. Jones, 1965-66 (1 reel); lectures by Louis Quam, OAP chief scientist, December 27, 1968 (2 reels); and interview of William A. Briesmeister, cartographer with the American Geographical Society, relating the society's globe and Antarctic map projects, n.d. (1 reel). Polar Information Service recording of a lecture at McMurdo Sound Station, Antarctica, by Laurence M. Gould, chief scientist with the First Byrd Antarctic Expedition (1928-30), chairman of the Committee on Polar Research (National Academy of Sciences), and member (1952-62) of the NSF, January 10, 1977 (2 reels, 1 cassette). *Bicentennial from Antarctica*, 1976 (1 reel). Polar research activities, 1958-68 (6 reels) . See also 307.13.

Photographs: USARP activities, equipment, and facilities, 1957-70 (996 images). See also 307.15.

307.6 Records of the Office of the Assistant Director for Biological, Behavioral, and Social Sciences

1976-81

Machine-Readable Records: Public use sample of demographic information from the 1900 U.S. Census, produced by University of Washington Center for Studies in Demography and Ecology on an NSF grant, 1976-81, with supporting documentation (2 data sets). See also 307.14.

307.7 Records of the Office of the Assistant Director for Scientific, Technological, and International Affairs

1974-83

Textual Records: Records of the Women in Science Program, consisting of administrative records, 1974-82; computer printouts of grant awards, 1976-83; project reports, 1976-82; papers resulting from NSF grants, 1974-82; NSF-funded studies on women and the sciences in the 1970's, 1974-82; and reference materials, 1974-82.

Color Slides: "Opportunities in Science and Engineering," produced on an NSF grant by Scientific Manpower Commission; with supporting sound track and pamphlet, 1980 (80 images). See also 307.15.

307.8 Records of Committees, Commissions, and Boards

1956-75

307.8.1 Records of the President's Committee on Scientists and Engineers

History: Established as the National Committee for the Development of Scientists and Engineers, to encourage private sector efforts to increase quality and quantity of scientists and engineers, by announcement of President Dwight D. Eisenhower, April 3, 1956. Funded and given administrative assistance by NSF. Redesignated President's Committee on Scientists and Engineers by a memorandum from Assistant to the President Sherman Adams to Committee Chairman Howard L. Bevis, May 7, 1957. Terminated December 31, 1958, with operational functions transferred to Office of Civil and Defense Mobilization, and research and publicity functions transferred to NSF.

Textual Records: Summaries of meetings, 1956-57. Interim reports and final report, 1956-58. Press releases, 1956-58. Pamphlets on training and use of scientific personnel, 1956-58.

Finding Aids: Forrest R. Holdcamper, comp., "Preliminary Inventory of the Records of the National Science Foundation: Records of the President's Committee on Scientists and Engineers," NC 39 (1963).

Related Records: Committee operating records **in Eisenhower Library**.

307.8.2 Records of the Advisory Committee for Planning and Institutional Affairs

History: Established by charter, November 30, 1972, pursuant to the Federal Advisory Committee Act (86 Stat. 770), October 6, 1972. Terminated November 30, 1974.

Textual Records: Minutes, reports, correspondence, and other records of the committee and of its predecessors, the Advisory Committee for Planning and the Advisory Committee for Institutional Relations, 1968-75.

	307.8.3 Records of the U.S.-U.S.S.R. Joint Commission on Scientific and Technical Cooperation **History:** Established by Article 7 of the Agreement between the Government of the United States of America and the Government of the Union of Soviet Socialist Republics on Cooperation in the Fields of Science and Technology, effective May 24, 1972, and continuing for five years. Continued as part of extension of Agreement on an interim basis by exchange of notes between U.S. Secretary of State and U.S.S.R. Charge d'Affaires, May 24, 1977. Continued as part of Agreement renewal for another five years, effective July 8, 1977. Dissolved upon termination of Agreement according to its own terms, July 8, 1982. **Textual Records:** Records accumulated by NSF Director H. Guyford Stever while serving as chairman of the U.S. representatives on the Joint Commission (1973-75), consisting of correspondence, minutes, and records of working groups, 1972-75. **307.9 Records Relating to Project Mohole** **1962-68** **History:** Initiated 1958, on an NSF grant, by American Miscellaneous Society, a committee of the National Academy of Sciences-National Research Council, with the aim of drilling through Earth's crust to obtain a sample of its mantle. C. Don Woodward named as Project Coordinator, and Mohole Committee established, by NSF Director Alan T. Waterman, May 4, 1962. Project terminated October 1, 1966, by failure of appropriation. Project operations brought to conclusion, 1966-68, through regular NSF annual appropriation. **Textual Records:** Administrative records, including correspondence, project reports, and summaries of meetings, 1962- 68. Records relating to project subcontractors, 1963-67. Public relations records, 1962-66. **Photographs:** Project Mohole drill site selection; drilling equipment, platform design, development, and erection; and deep drilling technology, 1962-66 (230 images). See also 307.15. **307.10 Textual Records (General)** **1952-55** Minutes and related records of the National Science Board, 1952-55. **307.11 Cartographic Records (General)** See Maps under 307.5.2. See Aerial Photographs under 307.5.2. **307.12 Motion Pictures (General)** See under 307.4.1, 307.4.2, and 307.5.2. **307.13 Video Recordings (General)** See under 307.4.1 and 307.4.2. **307.14 Sound Recordings (General)** See under 307.4.2 and 307.5.2. **307.15 Machine-Readable Records (General)** See under 307.3 and 307.6. **307.16 Still Pictures (General)** See Photographs under 307.5.2 and 307.9. See Color Slides under 307.7.
Connections	Archives are held at NARA: http://www.archives.gov/research/guide-fed-records/groups/307.html

16.1.26 New Hampshire State Archives/Archives

Type of resource	State Archives
Content (type of)	Correspondence, audiocassettes, schedules, subject files, videocassettes
Abstract	Records related to Senator Humphrey Gordon: See Guide in "Personal Papers" Notebook, (FA#24).....RA Audiocassettes.....MV Correspondence Name Index.....M#363.01-363.14..... 953012/595034 Correspondence on Cartridge Microfilm 595031

	Correspondence on Open Reel Film, 148 Rolls.....MV Correspondence with Gov. Lane Dwinell.....Bx034021 Petitions to place name on ballot, 1990 .....M#354.02 .....943011 Photograph Negatives .....V25 Schedules 1986-1990.....M#360.00 .....MV Subject Files.....Hall Town/County Project Files .....Hall Videocassettes.....MV
Connections	http://sos.nh.gov/Arch_Rec_Mgmt.aspx Humphrey, Gordon

16.1.27 Nixon Presidential Library and Museum/Archives

Type of resource	Presidential Library/Archives
Collections	The major types ofPresidential materials are as follows:White House Central Files, the main filing system used by White House staff members andoffices to maintain non-sensitive recordso Staff Member and Office Files, when materials were sent in bulk by staff members andofficeso Subject Files, with 60 basic subject file categories arranged alphabeticallyo Alphabetical Name Files, where materials were filed alphabetically and cross-referencedby an individual or organization nameWhite House Special Files, created in September 1972 to provide a central storage location formaterials considered sensitive for either personal or political reasons. A select group of WhiteHouse staff reviewed andremoved documents from the Central Files to be placed in the SpecialFiles. The subject files of the Special Files and of the Central Files follow the same arrangementscheme. After 1972, material was filed directly into the Special Files.o Staff Member and Office Fileso Subject Fileso Alphabetical Name FilesNational Security Files, including National Security Council Files and Henry A. Kissinger'sOffice Files
Connections	https://www.nixonlibrary.gov/index.php https://www.nixonlibrary.gov/forresearchers/find/guide.pdf Nixon, Richard

16.1.28 Oak Ridge National Laboratory (ORNL)/Archives

Type of resource	National Laboratory Library/Archives
Content (type of)	Books, reports
Connections	https://libcat.ornl.gov/F/1M5ELV9XXT9R5F9X2CF4U21GU3MV3GB34RSSPDHQQBQTJFMPKA-06771?func=find-b-0 Trivelpiece, Alvin Uberbacher, Edward

16.1.29 Office of Management and Budget (OMB)/Archives

Type of resource	Government Archives
Date	1905-1980
Collections	**51.9 RECORDS OF THE OFFICE OF MANAGEMENT AND BUDGET** **1965-80** **922 lin. ft.** **51.9.1 Records of the Director's Office** **Textual Records:** Subject files of the Director, 1969-74. Program records, 1972-76, and administrative records, 1973-74, of the Special Assistant to the Deputy Director for Federal Drug Management. Subject files of the Assistant to the Director for Administration, 1968-76. Files of Executive orders and Presidential proclamations maintained by the General Counsel,

	1968-76. Program records of the Office of Federal Procurement Policy, 1975-76, including program records of the Assistant Administrators for Contract Administration, Logistics, and Regulations. **Sound Recordings (13 items):** Press conferences, speeches, and briefings by OMB Directors George Shultz, Roy Ash, Bert Lance, and James Lynn, and by other OMB officials, 1970-80. SEE ALSO 51.13.
Connections	Archives are held by NARA: http://www.archives.gov/research/guide-fed-records/groups/051.html

16.1.30 Orrin Hatch website/Archives

Type of resource	Websites
Current Repository	Brigham Young University/ Archive-It
Collections	Websites and webpages featuring Senator Orrin Hatch of Utah
Connections	Hatch, Orrin https://archive-it.org/collections/3725

16.1.31 Patent and Trademark Office (PTO)/Archives

Type of resource	Government Archives
Date	1836-1973
Collections	**241.2 RECORDS OF THE PATENT OFFICE (RECONSTRUCTED RECORDS) RELATING TO "NAME AND DATE" PATENTS** **1837-87** **12 lin. ft.** **History:** Granting of patents for inventions made a function of the Federal Government by Article I, section 8, of the Constitution. Patent Board, consisting of Secretary of State, Secretary of War, and Attorney General, established by the Patent Act of 1790 (1 Stat. 109), April 10, 1790. Abolished by the Patent Act of 1793 (1 Stat. 318), February 21, 1793, with responsibility for issuing patents given to Secretary of State. Superintendent of Patents appointed by Secretary of State, 1802. Superintendent of Patents and staff, collectively called the Patent Office, functioned in immediate office of the Secretary of State, 1802-36. By the Patent Act of 1836 (5 Stat. 117), July 4, 1836, Patent Office established as a separate organization within the Department of State, with a Commissioner of Patents at its head. SEE 241.3. **Note:** Patent records predating 1836 were unnumbered and could be accessed only by name of patentee and date of patent. After 1836, unique numbers assigned by the Patent Office distinguished each new patent. Most original patent records were destroyed by fire, December 15, 1836. Reconstruction of the records was authorized by the Patent Act of 1837 (5 Stat. 191), March 3, 1837, which permitted inventors who had letters patent either to submit the originals, or certified copies of the originals, to the Patent Office; or, in the absence of documentation, to create a new patent document furnished under oath as conforming to original drawings and specifications. Arbitrary numbers suffixed with "X" were assigned by the Patent Office to the restored drawings and specifications. **Textual Records:** Copies, made 1839-87, of certificates describing patents ("Patent Heads") granted between 1794 and 1835. Specifications, copied 1837-83, relating to original and reissued patents granted before 1837. Copies, made 1837-47, relating to patents granted before 1837. **Engineering Plans (3,000 items):** Drawings, made 1837-47, of patents granted between 1791 and 1836, with accompanying name and date list. SEE ALSO 241.4. **Microfilm Publications:** T1235.

	241.3 RECORDS OF THE PATENT OFFICE RELATING TO NUMBERED PATENTS **1836-1973** **24,863 lin. ft.** **History:** Patent Office transferred to newly established Department of the Interior by an act of March 3, 1849 (9 Stat. 395). Transferred, effective April 1, 1925, to Department of Commerce, by EO 4175, March 17, 1925. Renamed the Patent and Trademark Office, 1975. SEE 241.1. **Textual Records:** General correspondence, 1836-68. Copies of specifications relating to claims for additional improvements, 1837-61. Case files for patent rights extensions, 1836-75. Copies of extensions of patent certificates, 1839-77. Registers of patent extension applications, 1866-77. Digests relating to assignments of patent property rights, 1837-1905, with indexes, 1837-1923. Patent assignment digests and indexes, 1922-57. Miscellaneous correspondence and rejected petitions, 1837-54. Letters received, 1872-82. Abandoned patent applications, 1894- 1937. Patent application files, 1837-1918 (19,874 ft.). Index of inventors filing applications for patents (series of 1935), ca. 1935-47. Serial registers of patent applications received (series of 1880, 1900, 1915, 1925, 1935, 1948, 1956, 1961, and 1970), 1880-1973. Index of inventors filing applications for design patents, 1922-48. Serial register, and examiner's serial register, of design applications received, 1924-48. Index of corporation patent assignments, 1938-46. Index of corporate trademark applications, 1924-61. Index of foreign firm patent assignments, 1938-46. Patent transfer books ("Liber Patent Transfer Volumes"), 1836. Patent assignment digest books, 1919. Interference case files, 1836-1919. Registers of interferences, 1839-1905. Copies of specifications relating to numbered patents, 1837-40, and to reissued patents, 1838-48. Letters sent by the Commissioner of Patents relating to patent models to be displayed at the 1893 World's Columbian Exposition (Chicago, IL), 1892-94. Caveat case files relating to inventions of Thomas A. Edison, 1872-82. Organization charts, 1929-39. **Engineering Plans (123,600 items):** Original patent drawings of inventions ("Utility Patents"), 1837-71 (112,000 items). Design patent drawings, 1842-77 (9,500 items). Drawings of additional improvements of patents, 1838-61 (300 items). Drawings to justify reissue of patents invalidated by unintentional inaccuracies in the original applications, 1838-70 (1,800 items). SEE ALSO 241.4. **Finding Aids:** James E. Primas, comp., "Lists of Names of Inventors in the Case Files Relating to the Extension of Patent Rights, 1836-75," NC 20 (1963); James A. Paulauskas, comp., Additional Improvement Patents, 1837-1861, SL 39 (1977). John P. Butler, comp., Patent Interference Case Files: 1838-1900, SL 59 (1993). **241.4 CARTOGRAPHIC RECORDS (GENERAL)** SEE Engineering Plans UNDER 241.2 and 241.3.3.
Connections	Archives are held by NARA: http://www.archives.gov/research/guide-fed-records/groups/241.html

16.1.32 President's Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research/Archives

Type of resource	Presidential Committee
Date	1978-1983
Institution	Georgetown University
Collections	The archive of the National Commission for the Protection of Human Subjects of Biomedical and Behavioral Researchov meetings. When accessing information on a subject in thecollection the information will either be in one of these formats folders separated by tabs (loose leaf), include but are not limited to:o Table of Contentso Lists of Participantso Curriculu Registerso News ClippingsAll meetings include tabs of "correspondence and "news clips" received and/or published dur (Boxes 22-23):Similar to the briefing books but instead include background material for the commission unrelated to par Transcripts (Boxes 24-33): Bound copies of the proceedings of that specific meeting. Each box contains multiple subjec variety of types of material, and the enormous amount of paper generated during the Commission's existence means th
Connections	https://bioethics.georgetown.edu/library-materials/digital-collections/us-bioethics-commissions/#PCSEPMBBR https://repository.library.georgetown.edu/bitstream/handle/10822/559326/A%20Guide%20to%20the%20National%20Co

16.1.33 Ronald Reagan Library/Archives

Type of Resource	Presidential Library
Date	1981-1989
Collection	WHITE HOUSE STAFF AND OFFICE FILES, 8,595 l.ft. This collection consists of individual folders from White House offices and specific staff members in the Reagan Administration. The staff of the National Security Council and its offices are included. The Reagan Library has over 700 individual staff and office collections.
References	Astrue, Michael
Connections	http://www.reagan.utexas.edu/ http://www.reagan.utexas.edu/archives/textual/smofmain.html http://www.reagan.utexas.edu/archives/textual/smof/astrue.htm

16.1.34 Social Security Administration/Archives

Type of resource	Government Archives
Date	1934-1986
Connections	http://www.archives.gov/research/guide-fed-records/groups/047.html

16.1.35 State of Kentucky/Archives

Type of resource	State Archives
Collections	Archived websites, documents, speeches, events and related information regarding Wendell Ford
Connections	https://archive-it.org/organizations/386?show=ArchivedPages&all=wendell+ford&exact=&none=&host=&hitsPerDupe=1&mimetype=0& http://kdla.ky.gov/records/e-archives/Pages/default.aspx Ford, Wendell

16.1.36 State of Massachusetts/Archives

Type of resource	State Archives
Content (type of)	Speeches, bills, press releases, photographs
Connections	http://www.mass.gov/anf/research-and-tech/legal-and-legislative-resources/tracing-ma-law.html Kennedy, Edward M.

16.1.37 State of Minnesota/Archives

Type of resource	State Archives
Content (type of)	Interview transcripts, notes, sound recordings, correspondence, briefing material, meeting files, speeches, news clippings
Connections	http://search.mnhs.org/index.php?q=walter+mondale&brand=findaids Mondale, Walter (2)

16.1.38 State of New Mexico/Archives

Type of resource	State Archives
Content (type of)	Correspondence
Connections	http://www.nmcpr.state.nm.us/archives/about-the-archives Domenici, Pete

16.1.39 State of Oregon/Archives

Type of resource	State Archives
Type of (content)	Bills, messages, minutes, reports, committee meetings
Connections	http://sos.state.or.us/archives/pages/records/governors/guides/state/hatfield/index.html http://arcweb.sos.state.or.us/pages/records/legislative/legislativeminutes/2003/house/health_human_svcs/HHS032620C http://arcweb.sos.state.or.us/pages/records/legislative/legislativeminutes/2001/senate/revenue/srev040201minutes.htm Hatfield, Mark

16.1.40 State of West Virginia/Archives

Type of resource	State Archives
Content (Type of)	Messages, bills, correspondence, memos, general counsel files
Connections	http://www.wvculture.org/history/ar1950.html Wise, Bob

16.1.41 State of Wisconsin/Archives

Type of resource	State Archives
Title	David R. Obey Papers, 1962-2010 (bulk 1969-2010)
Abstract	The papers concern both national and Wisconsin issues, with many topics such as educational reform, environmentalism, and health care bridging both. Wisconsin topics that are well documented include agriculture and the dairy industry, Native American treaty rights, Hmong refugee resettlement, transportation, and the decline of manufacturing. National topics of note are campaign finance and budget reform, foreign relations and international trade, abortion and religion in politics, and cancer research and occupational health and safety. His papers include speeches and writings, floor remarks, and interviews (some in audio and video form); correspondence; unofficial Appropriations Committee files; press releases, newsletters, clippings, photographs, and other press material; video tapes and sound recordings; district office files; campaign files; and extensive subject files created by members of his staff. A few files document his career as a member of the Wisconsin Assembly (1963-1969).
Date	1969-2010
Connections	http://digicoll.library.wisc.edu/cgi/f/findaid/findaid-idx?c=wiarchives;view=reslist;subview=standard;didno=uw-whs-stpt00bz Obey, David

16.1.42 U.S. Securities and Exchange Commission/Archives

Type of resource	Government Archives
Connections	http://www.archives.gov/research/guide-fed-records/groups/266.html

16.1.43 U.S. Senate/Archives

Type of resource	Government Archives
Connections	http://www.archives.gov/legislative/guide/senate/chapter-20.html Chiles, Lawton Domenici, Pete Ford, Wendell Harkin, Tom Hatch, Orrin Hatfield, Mark Humphrey, Gordon Kennedy, Edward M. Mikulski, Barbara Mondale, Walter Nickles, Don Pepper, Claude Snell, Rand Weicker, Lowell

16.1.44 U.S. Supreme Court/Archives

Type of resource	Government Archives
Connections	http://www.archives.gov/research/guide-fed-records/groups/267.html

16.1.45 US/Archives

Type of resource	Government Archives
Connections	https://www.archives.gov/research/vice-presidential-records/ Gore, Albert, Jr. https://reaganlibrary.archives.gov/ Reagan, Ronald Reagan, Nancy

16.1.46 US Department of Energy (DOE)/DOE Joint Genome Institute (DOE JGI)/Archives

Type of resource	Government Archives
Collections	**434.1 ADMINISTRATIVE HISTORY** **Established:** Effective October 1, 1977, by the Department of Energy Organization Act (91 Stat. 569), August 4, 1977, and EO 12009, September 13, 1977, consolidating functions formerly vested in the Energy Research and Development Administration, the Federal Energy Administration, the Federal Power Commission, and other agencies. **Predecessor Agencies:** 1. Energy Research and Development Administration (ERDA) and its predecessors: Manhattan Engineer District (MED), Office of the Chief of Engineers, War Department (1942-47) Atomic Energy Commission (AEC, 1946-74) Office of Coal Research (OCR), Department of the Interior (1960- 74)

ERDA (1974-77)

2. **Federal Energy Administration (FEA) and its predecessors:**
   a. **In the Department of the Interior:**

      Oil and Gas Division (1946-55)
      Office of Oil and Gas (1955-74)

      Oil Import Administration (OIA, 1959-71, functions to Office of Oil and Gas)

      Oil Import Appeals Board (OIAB, 1959-71)
      OIAB, Office of Hearings and Adjustment (1971-74)

      Office of Energy Conservation (1973-74)
      Office of Energy Data and Analysis (1973-74)
      Office of Petroleum Allocation (1973-74)

   b. **Federal Energy Office (FEO) and its predecessors:**

      National Energy Office, Executive Office of the President (EOP, 1973)
      Federal Energy Policy Office, EOP (1973)
      FEO (1973-74)

      FEA (1974-77)

3. **Other predecessors of the Department of Energy:**
   a. **In the Department of Commerce:**

      Office of Energy Programs (1975-77)

   b. **In the Department of the Interior:**

      Bonneville Power Administration (1937-77)
      Southwestern Power Administration (1943-77)
      Southeastern Power Administration (1950-77)
      Alaska Power Administration (1967-77)

   c. **Independent agencies:**

      Federal Power Commission (FPC, 1920-77)

Functions: Administers and coordinates federal energy programs, including the nuclear weapons program. Engages in energy technology research and development. Markets power generated by federal hydroelectric projects. Promotes energy conservation.

Regulated petroleum imports under Presidential Proclamation 3279, March 10, 1959, until repeal by Presidential Proclamation 5141, December 22, 1983.

Security-Classified Records: This record group may include material that is security-classified.

Related Records:
Record copies of publications of the Department of Energy in RG 287, Publications of the U.S. Government.
Records of the Federal Energy Regulatory Commission, RG 138.
Records of the Petroleum Administrative Board, RG 232.
Records of the Bonneville Power Administration, RG 305.
Records of the Atomic Energy Commission, RG 326.
Records of the Southwestern Power Administration, RG 387.
Records of the Energy Research and Development Administration, RG 430.
Records of the Nuclear Regulatory Commission, RG 431.

434.2 RECORDS OF THE FEDERAL ENERGY ADMINISTRATION AND ITS PREDECESSORS
1946-71

History: Oil and Gas Division established in Department of the Interior under authority of a Presidential letter, May 3, 1946, and Secretary of the Interior's implementing order, May 6, 1946. Responsible for unifying and coordinating federal petroleum policy for conservation and national petroleum security purposes. Redesignated Office of Oil and Gas, 1955.

Oil Import Administration established in Department of the Interior pursuant to Presidential Proclamation 3279, March 10, 1959, regulating importation of petroleum and petroleum products. Responsible for allocating imports and issuing import licenses. Merged into Office of Oil and Gas, October 22, 1971.

Oil Import Appeals Board established in Department of the Interior, also pursuant to Presidential Proclamation 3279, March 10, 1959, to hear petitions and appeals from persons affected by import regulations. Assigned to Office of Hearings and Appeals, Department of the Interior, December 23, 1971.

Office of Energy Conservation established in Department of the Interior by Secretarial Order 2953, May 7, 1973, to develop programs for energy conservation and more efficient utilization of energy resources.

Office of Energy Data and Analysis established in Department of the Interior by Secretarial Order 2953, May 7, 1973, to coordinate functions relating to gathering and analyzing energy data.

Office of Petroleum Allocation established in Department of the Interior by Secretarial Order 2956, November 6, 1973, to administer the petroleum allocation provisions of the Economic Stabilization Act Amendments of 1973 (87 Stat. 27), April 30, 1973.

National Energy Office established in Executive Office of the President by EO 11712, April 18, 1973, to advise the President on energy matters. Abolished by EO 11726, June 28, 1973, with functions transferred to Federal Energy Policy Office, EOP. Federal Energy Office, with independent agency status, established as successor to Federal Energy Policy Office by EO 11748, December 4, 1973.

Federal Energy Administration established as an independent agency, effective June 28, 1974, by the Federal Energy Administration Act of 1974 (88 Stat. 96), May 7, 1974, and implementing EO 11790, June 25, 1974, absorbing the Federal Energy Office; the Offices of Oil and Gas, Energy Conservation, Energy Data and Analysis, and Petroleum Allocation, Department of the Interior; and succeeding to the functions of the Department of the Interior with respect to allocation of petroleum imports and OIAB under terms of Presidential Proclamation 3279. FEA abolished, with functions transferred to DOE, 1977. SEE 434.1 and 434.3.

Textual Records: Central files of the Oil and Gas Division, 1946- 53. Allocation files of the Oil Import Administration, 1957-71.

434.3 RECORDS OF THE DOE CENTRAL OFFICE
1927-96 (bulk 1960-85)

History: In addition to incorporating FEA (SEE 434.2) and ERDA pursuant to the Department of Energy Organization Act, DOE absorbed the functions of the abolished Office of Energy Programs, Department of Commerce; continued the Bonneville, Southwestern, Southeastern, and Alaska Power Administrations, acquired from the Department of the Interior; and continued the formerly independent Federal Power Commission as the Federal Energy Regulatory Commission.

The Office of Energy Programs had been established in the Department of Commerce by Department Organization Order 25-7A, effective September 24, 1975, to implement industrial energy conservation and utilization programs.

The Bonneville, Southwestern, Southeastern, and Alaska Power Administrations had been established in the Department of the Interior to promote water resource development and to market surplus power generated by federal hydroelectric projects: Bonneville Power Administration by the Bonneville Project Act (50 Stat. 731), August 20, 1937; Southwestern Power Administration, effective September 1, 1943, by Secretarial Order 1865, August 31, 1943, pursuant to EO 9366, July 30, 1943, and EO 9373, August 30, 1943; Southeastern Power Administration by Secretarial Order 2558, March 21, 1950; and Alaska Power Administration by Secretarial Order 2900, June 16, 1967.

The Federal Power Commission had been established as an independent agency by the Federal Power Act (41 Stat. 1063), June 10, 1920, to regulate interstate aspects of the electric and natural gas industries.

434.3.1 Records of the Office of Public Affairs

Textual Records: Press releases, speeches, and fact sheets ("Information Files"), 1973-79.

Photographs (59,420 images): Research activities of DOE and its predecessors; atomic weapons testing; energy sources and uses, including nuclear power; portraits of AEC commissioners and Presidents Dwight D. Eisenhower, John F. Kennedy, and Lyndon B. Johnson, 1945-81 (SF, N, ND, NE; 54,900 images). Portraits of AEC commissioners and other officials of DOE and its predecessors; research staff; and prominent persons in government and the field of atomic energy, 1947-78 (PE, PN; 4,000 images). AEC research activities, 1960-63 (COP, CON; 520 images). SEE ALSO 434.6.

Motion Pictures (six 16mm reels): Network news documentaries relating to energy conservation policy development, 1974-77; films relating to technical fuel testing, 1982; publicity films for "Project Independence" national energy policy hearings, 1974; and Reserved for Tomorrow, a DOE film focusing on on the Strategic Oil Reserve program, 1977.

Video Recordings (67 items):

Press conferences held by President Jimmy Carter, Secretaries of Energy James R. Schlesinger and Charles W. Duncan, and other Department of Energy officials, 1977-80. Appearances by Schlesinger and Duncan at official DOE ceremonies and briefings, and on network news programs such as "Issues and Answers," "Face the Nation," and "Meet the Press," 1977-80. Lectures and interviews featuring various DOE employees, including doctors, administrators, and scientists, speaking about such subjects as nuclear waste disposal, radiation accidents, nuclear safety, and the design and development of nuclear reactors, 1983-86.

Sound Recordings (2 items):

Audiotape cassette recordings of "Face the Nation" interviews with Secretary of Energy James R. Schlesinger, 1977-78.

Color Slides (6,000 images): Energy sources and uses, 1965-80 (S). SEE ALSO 434.6.

Posters (59 images): Publicizing DOE programs and activities, for distribution during National Science and Technology Week and Energy Awareness Month, 1987-96 (P). SEE ALSO 434.6.

Finding Aids: Captions to series SF, N, ND, and NE.

434.3.2 Records of the Office of Safeguards and Security

Posters (59 images): Promoting safety and security awareness, 1983-93 (SP). SEE ALSO 434.6.

434.3.3 Records of the Office of Naval Petroleum and Oil Shale Reserves

Textual Records: Litigation files concerning Colorado River water rights, 1961-92. Statistical

summaries and reports on oil and gas production in the naval petroleum reserves, 1927-62.

Maps (40 items): Thirty-nine maps relating to Naval Petroleum Reserve No. 3, Casper/Natrona County, WY (including "Teapot Dome"), and one map relating to Naval Petroleum Reserve No. 4, Point Barrow, AK, c. 1922-38.

Color Slides (730 images): Navy clean-up efforts at Naval Petroleum Reserve No. 4, Point Barrow, AK, 1969-76 (NPR). SEE ALSO 434.6.

Lantern Slides (27 images): Views of Naval Petroleum Reserve No. 1, Elk Hills, CA; and graphs and maps relating to crude oil supply and demand, n.d. (LS). SEE ALSO 434.6.

434.3.4 Records of the Office of Strategic Petroleum Reserve

Photographic Prints (50 images): Views of six strategic petroleum reserve installations, 1978-80 (PR). SEE ALSO 434.6.

434.3.5 Records of the Office of Domestic and International Energy Policy

Textual records: Declassified national energy strategy subject files, 1987-93.

434.3.6 Records of the History Division of the Office of the Executive Secretariat

Textual Records: File containing memorandums, transcripts of interviews, and news clippings, 1940-85, compiled in connection with a Department of Defense project to restore the McDonald Ranch House, Alamagordo, NM, assembly site of the first atomic bomb.

434.3.7 Other records

Textual Records: Research and development reports ("Intra-bureau Reports"), 1945-57, compiled by the Division of Interfuels Studies of the Bureau of Mines of the Department of the Interior, and transferred to DOE custody following abolition of the division in 1977 and transfer of its personnel to DOE. Report of the National Petroleum Council on petroleum storage and transportation capacities, 1979. Records of the Division of Biomedical and Environmental Research relating to the study of health and mortality among atomic energy workers ("Mancuso Study"), 1957-79. Records of the Office of the Federal Inspector for the Alaska Natural Gas Transportation System (ANGTS), including reports to Congress and the President, 1979-92; legislation files, 1977-88; newsletters, press releases, publicity brochures and other general project information products, 1979-82; budget analyses and related documents, 1979-91; ANGTS "Eastern Leg" historical reports, 1982-84; and various compliance manuals, n.d.

Photographs (3024 images): Color prints (441), negatives (44), and slides (2539) produced by the Office of the Federal Inspector for the Alaska Natural Gas Transportation System (ANGTS) to document various stages in the development of the Alaska Natural Gas Transportation System and the Trans-Alaska Pipeline System, 1980-82, and to appear as illustrations in 1983 and 1984 ANGTS textual reports.

434.4 RECORDS OF DOE FIELD OFFICES
1915-94

434.4.1 Records of the Argonne National Laboratory, Idaho Falls, ID

Textual Records: Security-classified reports, laboratory notebooks, and logs, 1942-78. Legal correspondence of EG&G, Inc.,an ERDA contractor, 1946 and prior. Project planning and description files and master planning files, including interfiled as-built design drawings, relating to the construction of the nuclear reactor ("Borax Building") at the Idaho Falls branch of Argonne National Laboratory, 1953-80 (in Seattle).

434.4.2 Records of the Lawrence Berkeley Laboratory, Berkeley, CA

Textual Records (in San Francisco): Records originated and collected by Director Edwin McMillan, including correspondence, 1973-84; scientific notes, 1931-82; "crank file," 1927-84; daybooks and calendars, 1940-83; and research papers and published reports, including nuclear studies, 1920-84. Research records and correspondence of physicist Luis Alvarez, 1946-81. Records and correspondence of biochemist and Chemical Biodynamics Laboratory

	Director Melvin Calvin, 1960-77. Records relating to the Time Production Chamber Project, 1976-78. Records of the Scientific and Educational Advisory Committee, 1972-78. Operations logs and other records relating to the 184-inch cyclotron, 1946-87. Significant project planning and design files, 1941-87. **Photographs (4,525 images, in San Francisco):** Laboratory buildings, equipment, scientists, and activities, 1915-84, collected by Director McMillan (1,525 images). Continuous tone prints of laboratory research, 1973-80 (3,000 images). SEE ALSO 434.6. **434.4.3 Records of other field sites** **Textual records:** Record set of publications documenting the history of the Office of Scientific and Technical Information, 1946-94. **Photographs (15,250 images):** Construction, facilities, and community life at Manhattan Project sites, Oak Ridge, TN, 1942-46 (OR, ORN). SEE ALSO 434.6. **Posters (4 images):** Promoting work site safety, Richland Operations Office, WA, ca. 1982 (RP). SEE ALSO 434.6. **Finding Aids:** Shelf list to series OR and ORN. **434.5 MOTION PICTURES (GENERAL)** **1948-82** Public information films, produced or acquired by the Department of Energy and its predecessors, for distribution through the Technical Information Center, Oak Ridge, TN, and relating mainly to the peaceful uses of atomic energy, but including also such subjects as solar and geothermal energy, photosynthesis, nuclear materials safeguards and management, coal research, and nuclear weapons tests, 1948-82. **434.6 STILL PICTURES (GENERAL)** SEE Photographs UNDER 434.3.1, 434.4.2, and 434.4.3. SEE Photographic Prints UNDER 434.3.4. SEE Color Slides UNDER 434.3.1 and 434.3.3. SEE Lantern Slides UNDER 434.3.3. SEE Posters UNDER 434.3.1, 434.3.2, and 434.4.3.
Connections	http://www.archives.gov/research/guide-fed-records/groups/434.html Anderson, Norman DeLisi, Charles Barnhart, Ben (Benjamin J.) Decker, James Mendelsohn, Mortimer Murray, Matthew Patrinos, Aristides Smith, David Trivelpiece, Alvin Yesley, Michael Branscomb, Elbert Hawkins, Trevor Rubin, Edward

16.1.47 US Department of Health and Human Services/Archives

Type of resource	Government Archives
Collections	**Advisory Committees** **Archived since:** Sep, 2013 **Description:**

	This collection includes materials from HHS-supported Advisory Committees with responsibilities for providing advice or recommendations to the government. **Subject:** Government - US Federal, Science & Health **Creator:** HHS Digital Communications Division**Appeals and Decisions** **Archived since:** Nov, 2013 **Description:** This collection includes legal appeals and decisions rendered by the HHS and the Departmental Appeals Board (DAB) under more than 60 statutory provisions. **Subject:** Government - US Federal **Biographies of Past HHS Leaders** **Archived since:** Aug, 2014 **Description:** This collection provides biographies of former high-level Department of Health and Human Service staff. **Subject:** Government - US Federal, Government **Creator:** HHS/ASPA **Budget and Performance** **Archived since:** Sep, 2013 **Description:** This collection includes past budgets (FY2000+) and performance documentation. **Subject:** Government - US Federal, Science & Health **Creator:** HHS Digital Communications Division **Incident Response** **Archived since:** Sep, 2013 **Description:** This collection includes websites with HHS responses to various human and natural disasters and outbreaks. **Subject:** Government - US Federal, Science & Health **Creator:** HHS Digital Communications Division **News Releases** **Archived since:** Sep, 2013 **Description:** This collection includes HHS news and announcements from 1991+. **Subject:** Government - US Federal, Science & Health **Creator:** OS/ASPA **Policies, Regulations, and Related Guidance** **Archived since:** Jun, 2014 **Description:** This collection provides archived policies, regulations, and related guidance from HHS. **Subject:** Government - US Federal **Creator:** HHS **Date:** 2008 to present **Programs & Initiatives** **Archived since:** Sep, 2013 **Description:** This collection preserves website materials from HHS programs and initiatives that have been completed, replaced or retired. **Subject:** Government - US Federal **Reports** **Archived since:** Sep, 2013 **Description:** This collection includes reports such as past agency financial reports, management progress plans and reports, and topical material. **Subject:** Government - US Federal, Science & Health **Creator:** HHS Digital Communications Division **Secretary Kathleen Sebelius (21st: 2009-2014)** **Archived since:** May, 2014 **Description:** This collection includes material from the administration of Secretary Sebelius

	Subject: Government - US Federal **Creator:** HHS/ASPA **Date:** 2009-2014 **Secretary Michael O. Leavitt (20th; 2005-2009)** **Archived since:** Sep, 2013 **Description:** This collection includes material from the administration of Secretary Leavitt. **Subject:** Government - US Federal, Science & Health **Creator:** HHS Digital Communications Division **Speeches & Op-Eds** **Archived since:** Sep, 2013 **Description:** This collection includes speeches and opinion materials with speeches from HHS leadership since 1989. **Subject:** Government - US Federal, Science & Health **Creator:** HHS Digital Communications Division **Testimony to Congress** **Archived since:** Nov, 2013 **Description:** Testimonies by HHS Officials to Congress by year **Subject:** Government - US Federal **Creator:** HHS/ASL/ **Date:** 1996-2011 **Websites, Retired** **Archived since:** Sep, 2013 **Description:** This collection includes retired HHS and HHS-sponsored websites. **Subject:** Government - US Federal, Science & Health **Creator:** OS
Connections	https://archive-it.org/organizations/745

16.1.48 US House of Representatives/Archives

Type of resource	Government Archives
Connections	http://www.archives.gov/research/guide-fed-records/groups/233.html

16.1.49 William J. Clinton Presidential Library/Archives

Type of resource	Government Archives
Connections	http://clinton.presidentiallibraries.us/ Clinton, William J.

16.2 Research Institute/Consortia Archives

16.2.1 Carnegie Institution of Washington/Archives

Type of resource	Foundation

Content (Type of)	**Series 4: General Files, 1890-1996** This subseries consists of administrative records of the Carnegie Institution of Washington from its founding. The subseries is something of a catchall with a variety of records, including correspondence, grant requests, budgetary materials, publications, financial materials, personnel materials, clippings, government reports and photographs. It also contains material related to the overall operation of the Institution as an entity and relationships with individual grantees and others affiliated with the Institution but not with any particular department. In processing, an effort was made to tie in keywords with grantees. A run of Annual Meeting transcripts from 1902-1929 may be of interest. Chronological files exist for many of the Annual Meetings.**Series 5: Patents, 1902-1994** Most of the files in this series center around three patents: Vannevar Bush's Justifying Typewriter, David Schwartz's Pulsed Oriented Electrophoresis, and S.L. McKnight's GA Binding Protein. There is also a small amount of material showing the development of the patent policy at the institution.**Series 6: Personnel, 1902-Present** The main personnel files are still in use by the Institution and are kept in a secure location for legal and privacy reasons. It should be noted that folders for individuals located in the General Files may contain personnel information. It appears filing was inconsistent; therefore, it may be helpful to seek permission to look at the Personnel files for information about a particular individual. There are a few folders from 1922-1955, located in the Archive which are labeled Biographical Data and are broken down into alphabetical sections. Actuarial data for each department from 1913-1950 is also found here.**Series 7: President's Files, 1902-2001** This series is arranged chronologically and includes the files of the Executive Officers. Related materials may be found under the president's name in the General Files, or (in the case of Gilman) in the Trustees information. There are no records from Daniel Gilman's presidency in this series; there are files from 1902-1908 located in Series 8: Subseries 1: Trustees Information. Additional files from Robert S. Woodward's term (and beyond1902-1970) are located in Series 4: General Files. There are no files from James Ebert's presidency (1978-1987), though some records may be found in Series 2: Subseries 11: Department of Embryology. The arrangement of the files in this series is chronological by term of service as follows: Robert S. Woodward (1904-1920), 1912-1920 John C. Merriam (1921-1938), 1911-1938 Walter Gilbert (executive officer), 1913-1941 Vannevar Bush (1939-1955), 1928-1956, 1964-1965 Caryl P. Haskins (1956-1971), 1959-1970 Paul A. Scherer (executive officer), 1945-1957 Philip H. Abelson (1971-1978), 1971-1978 Edward A. Ackerman (executive officer), 1971-1973 M.H. Walburn (executive officer), 1971-1974 Edward E. David, Jr., acting president (1987-1988), 1987-1988 Maxine F. Singer (1988-2002), 1988-1999**Series 8: Trustees, 1901-1993** This series is made up of two subseries which relate to the role of the trustees at the Institution. **Series 8, Subseries 1: Trustees Information, 1901-1993** This subseries is made up of information about past and present trustees, as well as persons nominated for a trustee position, but declined or were rejected. The folders contain biographical information, correspondence, and other relevant materials. There is also a very small amount of information pertaining to board structure, address lists, invitations, etc. **Series 8, Subseries 2: Trustee Meetings and Committees, 1902-1993** This subseries contains the files of the Trustees and its various committees. Transcripts, meeting agendas, meeting minutes, and correspondence make up the bulk of the materials. During the first half of the twentieth century Board of Trustee minutes were bound and occasionally include a typescript index. In addition to the bound volumes, one loose copy of each set of Trustee minutes was kept. The committee files which follow the Trustee records are arranged alphabetically, with the exception of the Executive Committee and Finance Committee, which start the run of records due to their bulk. Arrangement is as follows:

	Board of Trustees Executive Committee Finance Committee Advisory Committees Auditing Committee Employee Benefits Committee Exhibits Committee Lecture Committee Nominating Committee Special Committees
Connections	http://publicationsonline.carnegiescience.edu/legacy/findingaids/CIW-Administration-Records.html Brown, DonaldSinger, Maxine

16.2.2 Cold Spring Harbor Laboratory (CSHL)/Archives

Type of resource	Not-for-profit Laboratory
Content (type of)	CSHL Archives houses the archival collections of: Sydney Brenner, Walter Gilbert, Hermann J. Muller, James D. Watson & Norton Zinder. Collections contain information related to William Haseltine, Dick McCombie, Joseph Sambrook, and Michael Wigler. See links below to each collection.
Connections	Brenner, Sydney: http://library.cshl.edu/personal-collections/sydney-brenner Gilbert, Walter: http://library.cshl.edu/personal-collections/walter-gilbert Haseltine, William (James D. Watson Collection) McCombie, Dick (James D. Watson Collection) Muller, H.J. (Hermann): http://library.cshl.edu/personal-collections/hermann-j-muller Sambrook, Joseph (James D. Watson Collection) Watson, James D. http://library.cshl.edu/personal-collections/james-d-watson Wigler, Michael (James D. Watson Collection) Zinder, Norton http://library.cshl.edu/personal-collections/norton-zinder CSHL Oral History Collection: Genome Research http://library.cshl.edu/oralhistory/category/genome-research/

16.2.3 European Molecular Biology Laboratory (EMBL)/Archives

Type of resource	Intergovernmental Laboratory
Content (type of)	The EMBL Archive will mainly comprise material from EMBL staff, alumni and close partners of the Laboratory. Over the next few years, we will be gathering all kinds of materials to help us capture the history of EMBL and molecular biology, and the stories of those who worked at any of the its five sites.
Connections	Philipson, Lennart Tooze, John http://www.embl.de/aboutus/archive/contact/index.html

16.2.4 Hastings Center/Archives

Type of resource	Research Institute
Content (type of)	Bioethical material/projects related to the Human Genome Project.
Connections	http://www.thehastingscenter.org/Search/Results.aspx?searchtext=human%20genome%20project

16.2.5 Institute for Advanced Study/Archives

Type of resource	Institute Archives
Content (type of)	The records in the Archives Center collection date from the 1930s and include official correspondence of the Director's Office, minutes of meetings of the Faculty and the Board of Trustees, correspondence concerning past Faculty and Members, records of the Electronic Computer Project, and the papers of select Faculty members. The archives also include the Institute's photograph collection and a growing oral history collection.
Connections	https://library.ias.edu/archives/collections

16.2.6 J. Craig Venter Institute (JCVI)/Archives

Type of resource	Institute Archives
Content (type of)	Collection contains the personal papers of distinguished scientists and Nobel Laureates in molecular biology and allied fields. Materials were collected by Jeremy Norman and his colleague Al Seckel from 1999-2002 and acquired by the J. Craig Venter Institute in 2005. This collection includes a comprehensive array of documents and artifacts marking significant milestones in the history of molecular biology from the discovery of DNA's double helix structure to related discoveries and developments that form the foundation of molecular biology. Included in the collection are archival materials from Sydney Brenner, Francis Crick, James Watson, Max Delbruck, Rosalind Franklin, Aaron Klug, Linus and Peter Pauling, Max Perutz, and Maurice Wilkins, among others. The materials highlight the relationships, dynamics, and roles these individuals played in the discovery of the DNA structure as well as provides historical context for the discovery of the structure of RNA, transfer RNA, messenger RNA, various viruses and biologically important proteins.
Title	The J. Craig Venter Institute History of Molecular Biology Collection
Connections	Venter, J. Craig Watson, James D. http://www.oac.cdlib.org/institutions/J.+Craig+Venter+Institute

16.2.7 Jackson Laboratory/Archives

Type of resource	Not-for-profit Laboratory Archives
Content (type of)	The Jackson Laboratory Historical Archives Collection includes the C.C. Little Papers, 1929-1954; The Jackson Laboratory Staff Personal Papers, including the George Snell Papers; The Jackson Laboratory Publications; a Photograph Collection of over 5,000 prints and negatives; and numerous media and museum collections.
Connections	https://www.jax.org/research-and-faculty/tools/joan-staats-library-at-the-jackson-laboratory

16.2.8 Marine Biological Laboratory (MBL)/Archives

Type of resource	Not-for-profit Laboratory
Content (type of)	The Marine Biological Laboratory (MBL) history project seeks to document the wonderfully rich history of the MBL.
Connections	Burris, John Willard, Huntington http://history.archives.mbl.edu/home

16.2.9 MRC Laboratory of Molecular Biology/ British Medical Research Council (MRC) Laboratory of Molecular Biology/Archives

Type of resource	Institutional Archives
Content (type of	**The papers of Francis Crick (1916-2004) are deposited in the Wellcome Library, London** **Polypeptides and proteins: X-ray studies.** A dissertation submitted for the degree of Doctor of Philosophy in the University of Cambridge. Gonville and Caius. July 1953. *Bound photocopy* Miscellaneous collection of Crick material has been collected by Mark Bretscher – see entry under Bretscher, Mark **Papers and correspondence of Aaron Klug** The archive collection of Aaron Klug is deposited in the Churchill Archives Centre, Churchill College, Cambridge **Papers and correspondence of Max Perutz** The archive collection of Max Perutz is deposited in the Churchill Archives Centre, Churchill College, Cambridge **The crystal structure of horse methaemoglobin.** A dissertation submitted by Perutz for the degree of Doctor of Philosophy in the University of Cambridge. Peterhouse, 16 December 1939. *Original, signed copy.* **Fred Sanger: The complete set of laboratory notebooks (1945-1982)** The Laboratory notebooks of Fred Sanger have been donated to the Biochemical Society Archives.
Connections	http://www2.mrc-lmb.cam.ac.uk/about-lmb/archive-and-alumni/manuscripts-correspondence/ Crick, Francis Klug, Aaron Perutz, Max Sanger, Frederick

16.2.10 Sanger Centre/Wellcome Trust Sanger Institute/Archives

Type of resource	Institute Archives
Abstract	**Ian Dunham Collection** The Collection contains records regarding Dr Ian Dunham's work in genomics. The majority of records related to his wor of the Human Genome Project and include: laboratory notebooks; conference papers; presentation slides; and draft pub genomic research that Dunham worked on. There are also Sanger Institute publications including annual reports and strategic plans and there is material relating to Original file titles have been retained where they exist **John Sulston Collection** This collection contains the working papers of John Sulston, including laboratory notebooks, mapping and sequencing d managerial papers and press cuttings. They relate to his work undertaken at the Laboratory of Molecular Biology and la The papers cover Sulston's extensive research on the nematode *Caenorhabditis elegans*, from studying the ventral cord genome with Alan Coulson and Robert (Bob) Waterston. The papers also cover Sulston's tenure as Director of the Sang work undertaken after stepping down as Director. Original file titles have been retained where they exist.
Connections	Dunham, Ian http://search.wellcomelibrary.org/iii/encore/record/C__Rb2254752__Sdunham%2C%20ian__Orightresult__U__X3?lang Sulston, John http://archives.wellcomelibrary.org/DServe/dserve.exe?dsqIni=Dserve.ini&dsqApp=Archive&dsqCmd=Show.tcl&dsqDb=

16.2.11 Washington Advisory Group/Archives

Type of resource	Independent Advisory Group
Content (type of)	Archived Website
Abstract	Over its 14-year history, The Washington Advisory Group worked with and for a broadly representative group of sophisticated research and higher education institutions.
Connections	http://www.arestrategies.com/wag/ Caskey, C. Thomas

16.2.12 Wellcome Trust Sanger Institute/Archives

16.2.12.1 The Carol Churcher Archives, 1986-2005

Records from Carol Churcher's sequencing work at the MRC Laboratory of Molecular Biology (LMB) in Cambridge and the Wellcome Trust Sanger Institute in Hinxton. Includes information on sequencing protocols c1986-2006; material on the first automated sequencing machine used at the LMB, an ABI 370A; material from her pathogen sequencing work; and a guide for using Staden software dated March 1992.

16.2.12.2 The Ian Dunham Archives, 1985-2007

The Collection contains records regarding Dr Ian Dunham's work in genomics. The majority of records related to his work on mapping and sequencing human chromosome 22, before and as part of the Human Genome Project and include: laboratory notebooks; conference papers; presentation slides; and draft publications. The Collection also contains material regarding other areas of genomic research that Dunham worked on.

There are also Sanger Institute publications including annual reports and strategic plans and there is material relating to Ian Dunham's role as writer of the Sanger Centre pantomime.

16.2.12.3 The Richard Durbin Archives, 1982-2007

The Collection contains records regarding Dr Richard Durbin's work as a computational geneticist. The majority of the records relate to his work on the nematode worm *C. elegans*, both his PhD research on the worm's nervous system and his contribution to efforts to sequence the worm's genome. The records include: laboratory notebooks and working papers; presentations given; meetings and conferences attended; projects and committees that he was involved with; manuscripts and correspondence for published papers; correspondence.

There are also records relating to the administration of the Sanger Institute from Durbin's time on the Board of Management. These cover strategic planning, the Finance and Budget Committee, staffing and staff training and campus building works.

A small section of records relate to the organisation of Durbin's Postdoctoral Research Fellowship at Stanford University, California in the late 1980s

16.2.12.4 The John Sulston Archives, 1968-2010

This collection contains the working papers of John Sulston, including laboratory notebooks, mapping and sequencing data, journal article manuscripts, conference papers, correspondence, managerial papers and press cuttings. They relate to his work undertaken at the Laboratory of Molecular Biology and later the Sanger Centre.

The papers cover Sulston's extensive research on the nematode *Caenorhabditis elegans*, from studying the ventral cord to recording the cell lineage and then mapping and sequencing its genome with Alan Coulson and Robert (Bob) Waterston. The papers also cover Sulston's tenure as Director of the Sanger Centre, his

involvement in the international Human Genome Project and work undertaken after stepping down as Director.

16.2.12.5 The Matthew Jones Archives, 1993-1998

Laboratory notebooks from Matthew Jones' subcloning work at the Wellcome Trust Sanger Institute in Hinxton. They contain material about work for the human genome and the *C. elegans* genome.

Type of resource	Not-for-Profit Library
Content (type of)	Archives
Connections	Churcher, Carol Dunham, Ian Durbin, Richard Jones, Matthew Sulston, John

16.2.13 Whitehead Institute, MIT/Archives

Type of resource	Non-profit Research & Educational Institute
Content (type of)	Archives are held by MIT Archives & consist of bulletins, reports, oral histories, photographs, speeches related to the Whitehead Institute and also to Paul Berg,
Connections	https://cse.google.com/cse?cx=016240528703941589557%3A5me3o8yigi0&ie=UTF-8&q=whitehead&sa=Search#gsc.tab=0&gsc.q=whitehead%20institute Berg, Paul https://libraries.mit.edu/archives/oral-history/mit_oral_history_biography_a-m.htm#B Lander, Eric https://cse.google.com/cse?cx=016240528703941589557%3A5me3o8yigi0&ie=UTF-8&q=whitehead&sa=Search#gsc.tab=0&gsc.q=eric%20lander Weinberg, Robert A. https://cse.google.com/cse?cx=016240528703941589557%3A5me3o8yigi0&ie=UTF-8&q=whitehead&sa=Search#gsc.tab=0&gsc.q=robert%20weinberg

16.2.14 Women's Bioethics Project/Archives

Type of resource	Non-profit Group
Content (type of)	Archived Website & Report of Key Activities and Members
Abstract	The Women's Bioethics Project was a nonprofit, nonpartisan public policy think-tank dedicated to ensuring that women's voices, health concerns and unique life experiences have an influence on bioethical decisions in health care and biotechnology.
Date	2004-2010
Connections	http://www.womensbioethics.org/ http://www.womensbioethics.org/WBP_Highlights.pdf Yesley, Michael

16.2.15 Woods Hole Oceanographic Institution/Archives

Type of resource	Institute Archives
Content (type of)	The Data Library & Archives of Woods Hole holds a diverse collection of administrative records, photographs, scientists' personal papers, film and video, historical instruments, cruise

	data, ship logbooks, diaries, blueprints and oral histories, as well as WHOI publications, maps, atlases, books and technical reports.
Connections	http://dla.whoi.edu/

16.3 Society/Association Archives

16.3.1 Academia Europæa/Archives

Type of resource	Oral Histories Invitation to Dialogue: the first 20 years of the Academia Europaea: interviews with the founding members. This is the first of a number of such structured interviews. It is part of a project that explores the extent to which the Academy of Europe has met with the original founders' perceptions of what the Academy was set up to do. It will be used to inform future development plans for the Academy. A project funded by the Academia Eurioaea new initiatives fund and lead by Prof. Anne Buttimer (University College Dublin).
Connections	http://www.ae-info.org/ae/Acad_Main/About_us/History/Founding_Visions Curien, Hubert

16.3.2 AIP Array of Contemporary American Physics/Archives

Type of resource	Archives
Abstract	Largely personal letters from George Gamow to Alex Rich, on RNA Tie Club Stationery A series of letters written by George Gamow on the subject of long-range navigational methods and anti-submarine defe One letter is co-authored by H. H. (Henry Homes) Porter. Letters include discussion of vertical measurement, magnetic
Connections	http://libserv.aip.org:81/ipac20/ipac.jsp?session=14622S4308U0X.12849&profile=newcustom-icos&source=~!horizon&view=subscriptionsummary&uri=full=3100006~!4272~!1&ri=1&aspect=subtab129&menu=searc http://libserv.aip.org:81/ipac20/ipac.jsp?session=1PV22N4590731.12850&profile=newcustom-icos&source=~!horizon&view=subscriptionsummary&uri=full=3100006~!29719~!6&ri=1&aspect=subtab129&menu=sear Gamow, George

16.3.3 American Association for the Advancement of Sciences (AAAS)/Science magazine/Archives

Type of resource	Archives
Connections	http://archives.aaas.org/about.shtml Alberts, Bruce Lewin, Roger Roberts, Leslie Trivelpiece, Alvin

16.3.4 American Philosophical Society (APS)/Archives

Type of resource	Society Archives
Connections	http://www.amphilsoc.org/collections/view?docId=ead/APS.Archives-ead.xml

Possible Connections	Caspersson, Torbjorn O. Chargaff, Erwin Goad, Walter Judson, Horace Rous, Peyton

16.3.5 American Society for Bioethics and Humanities/Archives

Type of resource	Society Archives
Connections Possible Connections	http://www.asbh.org/about/history/index.html Asch, Adrienne

16.3.6 American Society of Human Genetics/Archives

Type of resource	Society
Abstract	Search the abstracts of of previous American Society of Human Genetics Meetings
Dates	1948-2015
Connections	http://www.ashg.org/meetings/meetings_abstract_search.shtml

16.3.7 American Society of Microbiology/Archives

Type of resource	Society Archives
Connections	http://www.asm.org/index.php/choma3

16.3.8 Council for Responsible Genetics/Archives

Type of resource	Organization
Abstract	**GENEWATCH ARCHIVES** Over time, Council for Responsible Genetics hopes to expand our GeneWatch archives to include all articles from all twenty years of publication.
Dates	2003-2015
Connections	http://www.councilforresponsiblegenetics.org/GeneWatch/GeneWatchArchives.aspx

16.3.9 GenBank/Archives

Type of resource	Database
Connections	http://www.ncbi.nlm.nih.gov/genbank/

16.3.10 Institute of Medicine (IOM)/Archives

Type of resource	Annual Reports
Abstract	From 2007 to 2014, the Institute of Medicine program division of the National Academies of Sciences, Engineering, and Medicine produced an annual report. The yearly publication provided insights into the impact and finances of the IOM program division of the National Academies of Sciences, Engineering, and Medicine, now named the Health and Medicine Division.

Connections	http://www.nationalacademies.org/hmd/About-HMD.aspx

16.3.11 Kurt Godel Society/Archives

Type of resource	Society
Connections	http://kgs.logic.at/index.php?id=5 Godel, Kurt

16.3.12 Minnesota Historical Society/Archives

Type of resource	Historical Society Archives
Abstract	**Walter F. Mondale** • **Walter F. Mondale Papers (1927-2004).** Those portions of Walter Mondale's files that are available for public use comprise several sets of office files, public relations and publicity materials, and constituent services files from his service as United States Senator from Minnesota (1964-1976) and Vice President of the United States (1977-1981), as well as materials pertaining to his subsequent career as a lawyer and lecturer, and a few files relating to his service as ambassador to Japan (1993-1996). Senatorial materials include outgoing correspondence ("control" files), sampled constituent correspondence and constituent services files, files on his schedule and appointments, press releases, and speeches. Vice presidential materials include the VP office's central correspondence and subject files, scheduling and appointment files, trip files, speeches, press releases, assorted domestic policy and briefing materials, and files of a task force to study the public financing of election campaigns. • **Walter Mondale Memorandum to Jimmy Carter, 1976.** Walter Mondale and Jimmy Carter shared the opinion that the vice presidency was a wasted national asset and that there were opportunities for a real partnership with a president willing to delegate authority. In December 1976, Mondale wrote a memo outlining his thoughts on the role the vice president could play, some specific contributions that he personally could make, and the degree of involvement in the Carter administration that such a relationship would require. A copy of the memorandum is in the Walter F. Mondale Papers. Also, the Minnesota Historical Society website contains digital images and a searchable transcription of the memo. • **Excerpts From the Speeches of Walter F. Mondale: Campaign for the Presidency, 1982-1984.** Washington, D.C.: Walter F. Mondale, 1985. *MHS call number:* E 840.8.M66 E92 1985 **Joan Mondale** • **Personal Papers (bulk 1960-2006).** Speech and trip files, correspondence files, subject files, clippings, calendars, and sound and visual materials documenting Joan Mondale's activities as the wife of a politician and diplomat, and as an advocate for, and promoter of, the arts. • **Second Lady's Office Files (bulk 1976-1981).** Trip and speaking files, which include itineraries and speeches, form the bulk of the collection. They document Mondale's many trips throughout the United States and abroad including campaign appearances, official visits to other countries with the Vice President, and speaking engagements as an advocate for the arts. There is information about politics and politicians; presidential and other election campaigns; Macalester College; Joan Mondale's interest in and support of the visual and performing arts; artists and art exhibitions; Japanese art; and the Mondales' life and activities in Japan while Walter served as United States ambassador (1993-1996). Correspondents include politicians and their

	wives, political supporters, campaign workers, family members, and artists and members of arts organizations.
Connections	http://www.mnhs.org/ http://libguides.mnhs.org/mondale/primary Mondale, Walter

16.3.13 National Academy of Sciences (NAS)/Archives

Type of resource	Society Archives
Connections	http://www.nasonline.org/about-nas/history/archives/ http://www.nasonline.org/about-nas/history/highlights/bruce-michael-alberts.html Alberts, Bruce

16.3.14 National Research Council/National Academies/Archives

Type of resource	Organization
Connections	http://www.nationalacademies.org/ Burris, John

16.3.15 United Nations Educational, Scientific, and Cultural Organization (UNESCO)/Archives

Type of resource	Organization Archives
Connections	http://www.unesco.org/archives/new2010/index.html Grisolia, Santiago

16.3.16 World Health Organization (WHO)/Archives

Type of resource	Organization Archives
Connections	http://www.who.int/archives/about/archives/en/ Capron, Alexander

16.4 University/College Archives

16.4.1 Baylor College of Medicine Collection Information

The BCM Archives has a very limited amount of material related to the BCM Human Genome Sequencing Center (HGSC) and the Human Genome Project. A total of a dozen or so folders containing clippings from 1993 to the present, publications and press releases regarding the 2007 celebration of the completion of Dr. James Watson's genome, a 1995 fact sheet, a couple of reports and other similar material.

Type of resource	Medical College Archives

Connections	http://library.tmc.edu/mcgovern/
Possible People Connected	Beaudet, Arthur L Gibbs, Richard Ledbetter, David HNelson, David L.

16.4.2 Caltech (California Institute of Technology)/Archives

Papers of David Baltimore, ca. 1997-2006

David Baltimore was president of Caltech from 1997 to 2006. His presidential papers consist of both paper and electronic records from the period of his tenure in office at Caltech. The first material deposited in the Caltech Archives was electronic files accessioned in December 2003. The transfer of paper records began in June 2006. These records contain travel files, 1997-2004 (4 boxes); and misc. files relating to previous presidents Everhart and Goldberger and to Caltech commencements (2 boxes). Additional papers (12 boxes correspondence, speeches, committee work, desk files) and misc. framed items and memorabilia were transferred August 8-9, 2006. Additional electronic records to 8/3/2006 were transferred to the Archives 9/12/06. Per Institute policy, the collection is closed to researchers for 25 years from the date of the president's departure from office. An exception is copies of speeches by David Baltimore, which are open (3 boxes).

Finding Aid:
http://www.archives.caltech.edu/search_catalog.cfm?results_file=Detail_View&recsPerPage=1&firstRecToShow=17&search_field=&entry_type=NonPhoto&photo_id=&cat_series=Manuscript%20Collection

Type of resource	University Archives
Connections Possible People Connected	http://archives.caltech.edu/ Baltimore, David Britten, Roy J Delbruck, Max Dulbecco, Renato Hunkapiller, Tim Murray, Matthew Pauling, Linus Simon, Mel Smith, LloydSturtevant, Alfred
Actual People Connected	Baltimore, David

16.4.3 The Papers of Rosalind Franklin (1937-2008 (bulk 1937-1976))

A lot of the material within the collection relates to Rosalind Franklin's work on the structure of deoxyribonucleic acid (DNA). Consisting of publications, working papers, notebooks, reports and correspondence, this material is of considerable historical interest to those studying the discovery of the structure of DNA. There is also an extensive collection of papers relating to Franklin's work on the Tobacco Mosaic Virus (TMV), which took place at Birkbeck College in London. There are few papers relating to Franklin's work at the Laboratoire Centrale des Services Chimiques de l'Etat in Paris, where she used X-ray diffraction methods to study coals and chars.

In addition there are a number of photographs taken by Rosalind Franklin during her research, as well as papers relating to conferences, a large number of articles written and collected by Franklin, her undergraduate notes and articles written about Rosalind Franklin.

Type of resource	College Archives
Connections	http://janus.lib.cam.ac.uk/db/node.xsp?id=EAD%2FGBR%2F0014%2FFRKN Franklin, Rosalind

16.4.4 William Armstrong Papers

16.4.4.1 Collection Description:

A few uncataloged items primarily related to William Armstrong's time at the university.

Type of resource	University Archives
Connections	http://www.ccu.edu/about/history/ Armstrong, William

16.4.5 Cornell University/Archives

16.4.5.1 Daniel S. Greenberg Papers (1961-2010)

Extent: 24 Boxes

Bio:

Science journalist and author. Daniel S. Greenberg graduated from Columbia University in 1953. In 1961, he became the first editor of the "News and Comment " section of the journal Science. He also worked as a science reporter for the Washington Post. In 1971 he founded the Science and Government Report, a fortnightly review of government grants, reports, and activities in science. He served as its editor until 1997, when it was acquired by John Wiley & Sons. He also authored several books on the politics of science in the United States, including The Politics of Pure Science (1967), Science, Money and Politics (2001), Science for Sale (2007), and Tech Transfer (2010).

Collection Description:

Files consist of research materials from his books and other reporting, including media clips, Congressional reports, transcripts, and agency reports, filed alphabetically by topic (with various subtopics, changes over time, etc.) Files also contain some interview notes, partial transcripts of interviews, and correspondence. Files about subjects: Human Genome and Human Research.

Finding Aid:

http://rmc.library.cornell.edu/EAD/htmldocs/RMM06993.html

16.4.5.2 William B. Provine Papers (1963-2008)

Extent: 1 Box and Bound Volumes

Bio:

William B. Provine is an emeritus professor of the history of biology in the Department of Ecology and Evolutionary Biology at Cornell University. He holds a B.S. in mathematics and an M.A. and Ph.D. in the

history of science from the University of Chicago. He has published extensively on topics in the history of genetics and evolutionary biology, and has received numerous awards for his research.

Collection Description:

Collection consists mainly of research notes, including notes for Provine's books on American geneticist Sewall Wright and on population genetics, and plans for further publications. Also, a diary that Provine kept for a few months in 1963; letters to him from friends and colleagues, including Carl Sagan, Bert Theunissen, and John C. Sanford; an essay by philosopher of science Alex[ander] Rosenberg, "Evolution, Drift and Subjective Probability," with marginal notes and comments by Provine; and notes by evolutionary biologist A.J. Cain, including two drafts of a book review. Also included are ephemera: a program of the lectures to be given to the Biological Society of Cornell University, 1904-1905; a pamphlet issued by the publisher Heritage Club, advertising its edition of the Voyage of H.M.S. Beagle; and two anti-evolution pamphlets.

Finding Aid:

http://rmc.library.cornell.edu/EAD/htmldocs/RMM04734.html

16.4.5.3 Gerard Salton Papers (ca. 1960s-1990s)

Extent: 89 Boxes

Bio:

Professor of Computer Science, Cornell University. Salton has worked in the areas of natural language text processing, automatic text processing, and informational retrieval; editor-in-chief, Association for Computing Machinery Communications; Guggenheim Fellow, 1963.

Collection Description:

Subject files, correspondence, class notebooks, videocassettes, reprints, and other papers and records deriving from Salton's work in text processing, information retrieval, and computer science. One folder related to the Human Genome.

Finding Aid:

http://rmc.library.cornell.edu/EAD/htmldocs/RMA02908.html

16.4.5.4 Adrian M. Srb Papers, (ca. 1947-1997)

Extent: 7 Boxes

Professional papers include correspondence with colleagues and students; class and course notes for general genetics and human genetics courses; research materials, including notes and charts relating to *Neurospora*; files relating to professional organizations, seminars, and conferences; files relating to activities at Cornell, particularly the creation of the Division of Biological Sciences; grant applications; and manuscripts for books.

16.4.5.5 Robert R. Wilson Papers, (1936-2000)

Extent: 16 Boxes

Bio:Robert Rathbun Wilson was born in 1914 in Frontier Wyoming, received an A.B. from the University of California, Berkeley, 1936, and after studying with Prof. Ernest O. Lawrence, a Ph.D. in 1940.He participated

in an early effort led by Enrico Fermi at Columbia University to build a nuclear reactor as part of a joint effort with Princeton University, where he was a lecturer and assistant professor, 1940-1942. He worked for Princeton University's reactor project, 1941-1942; becoming technical head of their isotope separation project, 1942-1943, and developing a uranium isotope-separating machine. He moved to Los Alamos Laboratory in 1943, one of the first to reside there, helping with early organization and formation of the Cyclotron Group, and becoming Head of the Research Division, 1944-1945. In 1945 he became Associate Professor of Physics at Harvard University where he designed the 150 MeV cyclotron and suggested radiological use of high-energy heavy particles for cancer therapy. He also worked on scattering of protons by protons to higher energies, using the cyclotron at the Radiation Laboratory at Berkeley, 1946-1947.He came to Cornell University in 1947, working on building a series of electron synchrotrons, beginning with a 300 MeV machine and achieving 10 GeV in 1967. He and his colleagues made many discoveries regarding the inner structure of the proton including discovery of the first excited state of the proton and its next two excited states as well as scattering of electrons by protons. They were able to measure the production of K-mesons by X-ray beam. Dr. Wilson made the first measurement of the scattering of protons by the electric field of the nucleus of the atom, continuing this work while serving as Prof. d'Exchange at the University of Paris, France, in 1956. Also during his tenure at Cornell he conceived the idea to achieve the result of a high temperature in plasma by producing an imploding shock wave in an ionized gas through the sudden application of a strong magnetic field. He was one of the first to use the Monte Carlo method of mathematical computation, applying it to electron and proton initiated showers, invented the Quantometer to precisely measure the intensity of high-energy X-ray beams.In 1967 he became first Director of Fermi National Accelerator Laboratory (Fermilab) in Batavia, Illinois. He held this position during its founding and assisted in the design and construction of the entire complex, which included a 500 GeV proton accelerator. The most notable of the approximately 250 experiments concerned interaction of neutrinos and muons at high energy and discovery of the "b quark." He also initiated to design and construction of the Tevatron, a system of superconducting magnets to raise the energy of the Fermilab synchrotron to one TeV (1000 GeV). In 1978 he was made Emeritus Director.He then held the position of Peter B. Ritzma Professor at University of Chicago, 1978-1980, being named "Emeritus" in 1980. His then became I. I. Rabi Visiting Professor of Science and Human Relations at Columbia University in 1979; and the Michael Pupin Prof. at Columbia University, 1980-1982, becoming "Emeritus" in 1982.During his career he assisted in the design and construction of cyclotrons and synchrotrons in the United States and Europe and participated in many international symposia relating to high energy physics. He became a member of the American Physical Society in 1938, president in 1985; helped found the Federation of American Scientists, Chairman in 1946 and 1963; was elected to the National Academy of Sciences in 1957, the American Academy of Arts and Sciences in 1968, and the American Philosophical Society in 1969. He served on the Editorial Board of the magazine Daedalus. He was also affiliated with many other organizations having to do with teaching physics and high energy physics research, as well as arts and letters.He received the Elliot Cresson Award in 1964, National Medal of Science in 1973, Enrico Fermi Award in 1984, del Gado Gold Medal of Radiology in 1989, and the Gemant Award in 1995. He has received honorary degrees from University of Notre Dame, Sci Dr 1969; North Central College, ScD 1975; University of Bonn, ScD 1978; Harvard University, Sci Dr 1986, and Wesleyan University, Sci Dr 1987. He co-authored, with Raphael Littauer, the book "Accelerators" published in 1958.Dr. Wilson has been active in international physics attending numerous meetings including the conference organizing CERN, 1952, in Copenhagen; one of the earliest in the USSR, 1954; the Peoples Republic of China, 1974; meetings in New Orleans, 1975; Moscow, 1976; Hamburg, 1977; and Fermilab, 1978. He participated in the organization of the International Committee for Future Accelerators (ICFA), of which he was an American delegate.

Collection Description:

Manuscripts, correspondence (including many requests to give talks or seminars or advice on building accelerators), papers, talks, articles, clippings, notes and notebooks, course materials, photographs, and memorabilia documenting the development of atomic energy research and high energy physics in the United States, Europe , and Asia. Dr. Wilson was a renowned expert on designing and constructing cyclotrons and synchrotrons, serving as consultant on projects around the world. He was also highly regarded as a lecturer and teacher of physics and historian of world affairs relating to the developing uses of atomic energy.

Included in his professional papers are drawings, designs and photographs of some of the buildings, accelerators and equipment he helped design, as well as some of his sculptures. Among the personal papers in the collection are some family letters, documents and photographs, as well as designs and plans for his homes in New Mexico and Florida.Correspondents include: Len Ackland, J. B. Adams, Paul Aebersold, Samuel K. Allison, Luis Alvarez, Edoardo Amaldi, Robert Bacher, Kenneth T. Bainbridge, Charles Parker Baker, Gilberto Bernardini, Hans A. Bethe, Norris Bradbury, Gregory Breit, Morton Camac, James Cassels, Wen-yu Chang, Stirling Colgate, Alice Cook, Donald Cooksey, Dan Cooper, Robert Cornog, Dale R. Corson, L. S. Cottrell, Ed Creutz, Karl K. Darrow, John DeWire, Pierre Donzelot, Philippe Eberhard, Bernard Feld, Dennis Flanagan, William A. Fowler, Jerome H. Fregau, R. C. Gibbs, William T. Golden, Maurice Goldhaber, Edwin L. Goldwasser, L. Goldzahl, S. Goutsmit, Kenneth Greisen, T. C. Griffith, Gaylord P. Harnwell, W. W. Havens, Jr., David Hawkins, Leland J. Haworth, S. S. Hecker, William Higenbotham, Frederic de Hoffmann, Robert Hofstadter, Gerald Holton, David R. Inglis, W. K. Jentschke, Donald W. Kerst, Seishi Kikuchi, Raymond N. Knellberg, George A. Kolstad, James A. Krumhansl, Hirao Kumagai, L. Jackson Laslett, Ernest O. Lawrence, Leon M. Lederman, T. D. Lee, A. J. Leigh, J. S. Levinger, Maurice M. Levy, Urner Liddel, Raphael Littauer, M. Stanley Livingston, Edward J. Lofgren, Franklin A. Long, Harry Lustig, T. W. Mackesey, John H. Manley, Robert E. Marshak, Boyce D. McDaniel, Paul W. McDaniel, Edwin M. McMillan, J. Howard McMillen, Richard L. Meier, E. E. Minett, Philip Moon, Philip Morrison, Paul M. O'Leary, Frank Oppenheimer, J. Robert Oppenheimer, Jay Orear, Philip S. Owen, Wolfgang K. H. Panofsky, and Richard Parmenter.Correspondents also include: Lyman G. Parratt, R. E. Peierls, James A. Perkins, F. Perrin, Melba Phillips, Bruno Pontecorvo, William Preston, Federico Quercia, Norman Ramsey, Leonard M. Rieser, Arthur Roberts, Thomas R. Rogers, Edward T. Rosenbaum, Arthur E. Ruark, Robert G. Sachs, Carl Sagan, Giorgio Salvini, Joseph Halle Schaffner, Herwig Schopper, Emilio SegrÃ¡e, Frederick Seitz, R. S. Shankland, A. H. Shapley, Kai Siegbahn, Albert Silverman, Daniel M. Singer, Ralph Carlisle Smith, H. D. Smyth, Jack Steinberger, Jeremy J. Stone, Sandro Stringari, S. Cushing Strout, John M. Swomley, Leo Szilard, John T. Tate, Edward Teller, Emily Thompson, John S. Toll, Timothy E. Toohig, Robert L. Walker, Alvin M. Weinberg, Victor F. Weisskopf, John A. Wheeler, Harry J. White, Milton G. White, E. P. Wigner, Herman S. Wigodsky, Frederic H. Williams, John H. Williams, Robert Williams, Richard Wilson, Michael Witherell, William M. Woodward, T. P. Wright, William E. Wright, Chien Shiung Wu, Yuan Chia-liu, and A. Zichichi.One folder related to the Human Genome Project.

Finding Aid:

http://rmc.library.cornell.edu/EAD/htmldocs/RMA03093.html

16.4.5.6 Ray Wu Papers, (ca. 1966-2007)

Extent: 24 Boxes

Bio:

Professor of Molecular Biology and Genetics. Dr. Wu developed the first method for sequencing DNA and some of the fundamental tools for DNA cloning in 1970. He led research on genetic modification of rice and other crops to increase resistance to pests, drought, heat, salt, and other environmental stresses. Dr. Wu died in Ithaca on February 10, 2008.

Collection Description:

Professional papers journal articles and reprints, manuscript reviews, thesis reviews, course material, photographs and correspondence of Professor Ray Wu.

Finding Aid:

http://rmc.library.cornell.edu/EAD/htmldocs/RMA03771.html

Type of resource	University Archives
Connections	http://rmc.library.cornell.edu/collections/cuhist.html Greenberg, Daniel S. Provine, William B. Salton, Gerard Srb, Adrian M. Wilson, Robert R. Wu, Ray

16.4.6 Duke University Medical Center/Archives

16.4.6.1 Huntington F. Willard Papers and Records (1975-2012)

Extent: 149 Storage Boxes

Collection Description:

Contains records of the laboratory work and files of Huntington F. Willard, first director of the Institute for Genome Sciences and Policy at Duke University, vice Chancellor for Genome Sciences and professor in the Department of Molecular Genetics and Microbiology. Types of materials include laboratory notebooks created by students, research associates, and Willard in the course of research in genetics. Major subjects include the Dept. of Molecular Genetics and Microbiology at Duke University, medical genetics, and faculty of Duke University Medical Center. Correspondence and files pertaining to topics such as travel, environmental safety, radiation safety, and the HUGO Human Genome Mapping Committee are also included.

Note: The majority of this collection requires consent by Dr. Willard before access may be granted.

Finding Aid:

https://archives.mc.duke.edu/xml?faids=collection-294.xml#series591

16.4.6.2 Duke Center for Human Genome Variation Records (2005-2015)

Note: Because these materials are less than 25 years old, a finding aid is not available on DUMC's Website. (This collection is restricted, but may be accessed with the permission of the records creator.)

Type of resource	Medical Center Archives
Connections	https://archives.mc.duke.edu/ Willard, Huntington Duke Center for Human Genome Variation Records

16.4.7 Claude Pepper Papers

16.4.7.1 Extent: 1200 Linear Feet

16.4.7.2 Collection Description:

The Mildred and Claude Pepper Collection was donated by Congressman Claude Pepper to the Florida State University Libraries in 1979. Subsequent donations were made during the 1980s, and additional materials were acquired following his death in 1989. Initially, the Pepper Collection was housed at Dodd Hall on the Florida State University campus but was relocated in 1998 to a new state-of-the-art archival space located on the first floor of the Claude Pepper Center Building. Containing over two million pages, the collection includes his official correspondence, speeches, legislative, committee, and campaign files. In addition, there are files of his personal correspondence, speeches, photographs, recordings, and memorabilia. Also included are the personal papers, photographs, recordings, and memorabilia of his wife, Mildred Irene Webster Pepper. Mrs. Pepper always took a deep interest in public affairs and in helping her husband in his political career. She vigorously supported medical research, urban beautification, conservation, and actively participated in charitable and humanitarian organizations. There are also personal papers of the Pepper/Webster family, largely consisting of correspondence from parents, brothers, sisters, and other family members.

These materials document the political and personal life of one of the most politically active individuals throughout most of this century, and in terms of size, content, and national significance, they have been compared to prestigious presidential collections, including the Papers of President Franklin D. Roosevelt. In addition to its value to historical research, these materials will enable current policy makers to build upon Claude Pepper's achievements as they continue to focus on his unfinished work. Because of his noteworthy legacy, it is vital that the Claude Pepper Collection should always be accessible and preserved for future generations of scholars and researchers. Personal letters from Winston Churchill, Franklin D. and Eleanor Roosevelt, Harry S. Truman, and John F. Kennedy are among the treasures to be found here. The photographs include many individuals of historical significance, such as Pope Paul VI, Albert Einstein, and Martin Luther King, Jr. There are also recordings of such political notables as Lyndon Johnson, Tip O'Neill, and Hubert Humphrey. The Pepper Collection not only documents the career of one of the most politically active individuals of this century, it reflects the changes that have taken place in every area of American life. It contains a wealth of material on a variety of topics. Research using the Pepper Collection has focused on topics as diverse as the World War II "Mother's Movement,", American Indian land claims, national health care, Social Security, the Vietnamese conflict, and organized labor. Currently, the collection is being digitized to provide researchers with the opportunity to study his collection from anywhere around the world.

16.4.7.3 Finding Aid: http://fsuarchon.fcla.edu/index.php?p=collections/findingaid&id=3507&q=pepper&rootcontentid=70408#id70408

Type of resource	University Archives
Connections	https://www.lib.fsu.edu/specialcollections Pepper, Claude

16.4.8 George Washington University/Archives

16.4.8.1 Gamow (George) Papers, (1934-1955)

Extent: 1 Box

Collection Description:

Materials in this collection include correspondence, manuscripts, articles by George Gamow, and printed materials about George Gamow. These materials cover the dates 1934-55. George Gamow was a world renowned physicist and these materials constitute some of his academic work.

Finding Aid: https://library.gwu.edu/ead/ms0252.xml

16.4.8.2 Marcus Raskin papers, (1952-2013)

Extent: 28 Boxes

Collection Description:

This collection contains correspondence, articles, lecture notes, essays, biographical data, and subject and research files. These materials represent the personal papers of Marcus Raskin, the materials he created and collected with the Institute for Policy Studies and as a professor at The George Washington University. The materials date from 1979-2009. One folder related to the Human Genome Project.

Finding Aid: https://library.gwu.edu/ead/ms2297.xml

Type of resource	University Archives
Connections Possible People Connected	http://library.gwu.edu/scrc/university-archives Gamow, George Judson, Horace
Actual People Connected	Gamow, George Raskin, Marcus

16.4.9 Harvard Cancer Center/Dana Farber/Archives

16.4.9.1 Note: The following collections have access restrictions, please view each collection's finding aid for details.

16.4.9.2 Jonathan R. Beckwith papers, (1933-2011 (inclusive), 1965-2004 (bulk))

Extent: 31 records center cartons, 1 half letter size document box, 2 oversize boxes, 1 oversize flat file drawer, and 1.002 GB of electronic records on 2 3.5 inch floppy disks and 1 zip disk.

Bio:

Jonathan R. Beckwith (born 1935), A.B., Ph.D., Harvard University, Cambridge, Massachusetts, is the American Cancer Society Research Professor of Microbiology and Molecular Genetics at Harvard Medical School. He is a microbiologist and geneticist who has focused throughout his career on bacterial genetics, including gene expression, membrane proteins, protein secretion, disulfide bonds, and cell division. With James Shapiro (born 1943) and Lawrence J. Eron (born 1944), he is credited with isolating the first gene from a bacterial chromosome in 1969. He is also known for his social activism in the science community, advocating for social responsibility in scientific and genetic research, and arguing against genetic, racial, and gender discrimination in science and society.

Collection Description:

The Jonathan R. Beckwith papers, 1933-2011 (inclusive), 1965-2004 (bulk), are the product of Jonathan Beckwith's professional, research, teaching, and publishing activities throughout the course of his career. Harvard Medical School Appointments Files (Series I) consist of teaching records, visual teaching aids, and committee and administrative records for Beckwith's teaching, administrative, and campus activist activities at Harvard Medical School. Research records include grant applications, laboratory notebooks, and research data generated by Beckwith during his tenure at Harvard Medical School and throughout his postdoctoral fellowships. Professional Activities Files (Series III) contains lectures, administrative records, collected resources, and related correspondence for his public speaking activities, and his service in various professional organizations. The collection also contains: personal and professional correspondence, personnel records, research records, and collected publications of Beckwith's colleagues and postdoctoral fellows (Series IV); publication correspondence, scientific paper reprints, manuscript drafts, and newspaper clippings by Beckwith concerning various topics in microbiology, bacteriology, genetics, and the social aspects of science (Series V); and collected publications and resources related to his research and social-activism interests (Series VI).

Finding Aid: http://oasis.lib.harvard.edu/oasis/primo?id=med00203&q=undefined

16.4.9.3 Boston Women's Health Book Collective. Subject files, (1980-2000)

Extent: 103 records center cartons

Bio:

The Boston Women's Health Book Collective is a nonprofit, public interest women's health education, advocacy, and consulting organization which was formally established in 1972 and published Our Bodies, Ourselves in 1973.

Collection Description:

Contains vertical files gathered by the organization about a wide range of women's health issues including abortion, birth control, and childbearing in the United States and abroad. Contains one file about the Human Genome Project.

Finding Aid:
http://oasis.lib.harvard.edu/oasis/deliver/deepLink?_collection=oasis&uniqueId=med00085

16.4.9.4 Bernard D. Davis Papers, (1909-1995 (inclusive), 1939-1994 (bulk))

Extent: 31 records center cartons and 1 flat oversize box

Bio:

Bernard D. Davis, 1916-1994, AB, 1936, Harvard College; MD, 1940, Harvard Medical School, bacteriologist, microbiologist, professor, and author and researcher focusing on protein synthesis, aminoglycides, ribosomes and protein transport, as well as the ethical and social aspects of science and academia. Bernard D. Davis was born in Franklin, Massachusetts on January 7, 1916. Davis was an Officer of the United States Public Health Service, and worked in the laboratory of Elvin Kabat at Columbia University, and then with Jules Freund at the Public Health Research Institute. After working for two years under René Dubos at the Rockefeller Institute, Davis ran a laboratory studying the disease at Cornell University Medical College

(1947). In 1954, he was appointed the head of Pharmacology at New York University College of Medicine, and in 1957, when he became the Chair of the Department of Bacteriology and Immunology at Harvard Medical School, Boston. In 1968, he was named the Adele Lehman Professor of Bacterial Physiology. Davis was elected to the National Academy of Science and was a fellow of the American Academy of Arts and Sciences. He died on January 19, 1994, in Belmont, Massachusetts.

Collection Description:

The Bernard D. Davis Papers, 1909-1995 (inclusive), 1939-1994 (bulk), are the product of Davis's professional, research, teaching, and publishing activities throughout the course of his career as a researcher in the fields of microbiolgy and bacteriology, and in his roles as the Chair of the Department of Bacteriology and Immunology at Harvard Medical School (1957-1968) and as the Adele Lehman Professor of Bacterial Physiology (1968-1984). Davis's research focused on protein synthesis, aminoglycides, ribosomes and protein transport; he also conducted innovative gene studies. Later work relates to the social, ethical, legal, and political aspects of science and academia, sociobiology, genetic engineering and recombinant DNA, affirmative action and academic standards, and scientific fraud.

Finding Aid: http://id.lib.harvard.edu/aleph/007828301/catalog

16.4.9.5 Leon Eisenberg Papers, (1905-2009 (inclusive), 1968-2005 (bulk))

Extent: 55 records center cartons, 1 half letter size document box, and 1 legal size document box) and 6.79 GB of electronic records (17 3.5 inch floppy disks, 4 compact discs, and a shared network drive

Bio:

Leon Eisenberg (1922-2009), A.B., 1944, University of Pennsylvania, Philadelphia; M.D., 1946, University of Pennsylvania School of Medicine, Philadelphia, was the Maude and Lillian Presley Professor of Social Medicine and Professor of Psychiatry at Harvard Medical School, as well as Chief of Child Psychiatry (1959-1967) at The Johns Hopkins Hospital, Baltimore, Maryland, Chief of Psychiatric Services (1967-1974) at Massachusetts General Hospital, Boston, and Chairman of the Department of Social Medicine and Health Policy (1980-1991) (now the Department of Global Health and Social Medicine) at Harvard Medical School, Boston, Massachusetts. Eisenberg was known for his research in autism, advances in pediatric clinical trials and psychopharmacology, and his role in developing the affirmative action program at Harvard Medical School.

Collection Description:

The Leon Eisenberg papers, 1905-2009 (inclusive), 1968-2005 (bulk), are the product of Eisenberg's activities as a psychiatrist, educator, lecturer, and contributing member of national and international organizations. Alphabetical files (Series I) comprise the bulk of the collection and consist of administrative and teaching records, meeting minutes, reports, subject files, personnel records, personal and professional correspondence, and Eisenberg's lectures. Predominant topics of lectures, collected articles and reprints, and correspondence include autism, attention-deficit hyperactivity disorder, bipolar disorder, schizophrenia, affirmative action, ethics, and conflict of interest. Writings and publications (Series II) consist of article and lecture drafts, reprints of Eisenberg's articles, notes, and correspondence supporting the development of Eisenberg's writings. The papers also contain: collected reprints, newspaper clippings, and notes about health care reform, affirmative action, sexual abuse, and human rights (Series III); and electronic records consisting of Eisenberg's lectures, manuscript drafts, letters of recommendation, photographs, and correspondence with friends, family, and colleagues (Series IV).

Finding Aid:
http://oasis.lib.harvard.edu/oasis/deliver/findingAidDisplay?_collection=oasis&inoid=165&histno=0

16.4.9.6 William A. Haseltine papers, (circa 1944-2008 (inclusive), 1962-2008 (bulk))

Extent: 171 records center cartons, 10 letter size document boxes, 1 half letter size document box, 3 oversize flat storage boxes, and 4.16 gigabytes of electronic records

Bio:

William Alan Haseltine (born 1944), B.A., 1966, University of California, Berkeley; Ph.D., 1973, Harvard University, Cambridge, Massachusetts, is Chairman and President of ACCESS Health International, Inc., Chairman of the Haseltine Foundation for Medical Sciences and the Arts, and formerly a Professor at Harvard Medical School in the Department of Pathology (1988-1995) and a Professor at Harvard School of Public Health in the Department of Cancer Biology (1989-1995), as well as Chairman of the Board of Directors and Chief Executive Officer of Human Genome Sciences, Inc. (1993-2004). Haseltine's main areas of research include cancer, HIV and AIDS, and genomics. Haseltine was a Postdoctoral Fellow at Massachusetts Institute of Technology's Center for Cancer Research, Cambridge, from 1973 to 1975 and then went on to hold various positions at Dana-Farber Cancer Institute (DFCI), Boston, Massachusetts, Harvard Medical School, and Harvard School of Public Health. Haseltine was a Professor at DFCI in the Division of Human Retrovirology (1988-1995) and while at DFCI, he created and served as chair of two academic departments, the Division of Cancer Pharmacology and the Division of Human Retrovirology (1989-1993). Haseltine founded several companies including Cambridge BioScience Corporation (1981), Virus Research Institute (1990), and Activated Cell Therapy, Inc. (1992). In 1992, Haseltine moved to Maryland to form Human Genome Sciences, Inc. (HGS), a company that conducted research on therapeutics and diagnostics for human disease using human and microbial genes. Haseltine retired as Chairman of the Board of Directors and Chief Executive Officer of HGS in 2004; he is currently the Chairman and President of ACCESS Health International, Inc., Chairman of the Haseltine Foundation for Medical Sciences and the Arts, and a consultant to various organizations.

Collection Description:

The William A. Haseltine papers, circa 1944-2008 (inclusive), are the product of Haseltine's activities as a researcher, business executive, educator, lecturer, consultant, and contributing member of national and international organizations. Professional Records (Series I) comprise the bulk of the collection and consist of administrative and research records, meeting minutes, reports, subject files, personnel records, correspondence, presentations, and drafts produced by Haseltine and his colleagues at the various companies and organizations he was employed at or founded, including Human Genome Sciences, Inc., Dana-Farber Cancer Institute, and Cambridge BioScience Corporation. Travel records (Series II) contain lecture drafts, meeting programs, and correspondence from Haseltine's amfAR meetings and conferences on AIDS research. Subject files (Series III) consist of articles, notes, newspaper clippings, and correspondence about Alzheimer's disease, nanotechnology, stem cells, cancer, HIV, and AIDS. Personal records (Series IV) contain correspondence with friends and family, school notebooks, letters of recommendation, journals, and invitations to social events. The papers also include Haseltine's manuscript drafts and reprints, collected reprints on HIV and AIDS, and videotapes and audiotapes from Human Genome Sciences and Dana-Farber Cancer Institute meetings (Series V, VI, and VII).

Finding Aid: **http://oasis.lib.harvard.edu/oasis/primo?id=med00190&q=undefined**

Type of resource	Medical School Archives
Connections Possible People Connected	https://legacy.countway.harvard.edu/menuNavigation/chom/arm.html Beckwith, Jonathan Capecchi, Mario Church, George Gusella, James F. Kucherlapati, Raju S.

Actual People Connected	Beckwith, Jonathan Boston Women's Health Book Collective Davis, Bernard D. Eisenberg, Leon Haseltine, William

16.4.10 Harvard Schlesinger Library/Archives

16.4.10.1 Records of Bass and Howes, Inc., (1957-2002 (inclusive), 1986-2002 (bulk))

Extent: 283 file boxes, 1 half file box, 1 card file box) plus 1 folio+ folder, 1 oversize folder, 1 supersize folder, 13 photograph folders, 14 audiotapes, 11 videotapes, 8 objects, electronic records

Bio:

A public policy and public affairs consulting firm, Bass and Howes, Inc. (referred to hereafter as Bass and Howes) was founded by political consultants Marie Bass and Joanne Howes in Washington, D.C., in 1986. As the former national campaign director for ERAmerica and a lobbyist for Planned Parenthood Federation of America, Marie Bass and Joanne Howes brought together over 30 years of experience to form Bass and Howes, Inc. While it operated largely in a male-dominated field, Bass and Howes came to be centrally involved in most of the key women's policy issues of the 1980s and 1990s, including reproductive rights, women's health, family and medical leave, domestic violence, and women in politics. With offices in Washington, D.C., and New York City, Bass and Howes worked with clients including the National Women's Law Center, National Breast Cancer Coalition, and Physicians for Reproductive Choice and Health among many others. Bass and Howes provided its clients with services including grassroots organizing and network building around progressive issues; electoral strategies and programs for political action committees; policy research, action, and development; services for candidates and public officials; resource development and fundraising; planning and carrying out conferences and symposia; writing and production of publications; and lobbying strategies and representation for organizations. In 2002, the firm was acquired by DDB Worldwide, a leading advertising and public relations agency located in Washington, D.C.

Collection Description:

The Bass and Howes records contain administrative, financial, client, and subject files, as well as audiovisual material and memorabilia. While administrative files and financial records offer insight into the internal operations of Bass and Howes, client files make up the majority of material in this collection. Contains one file about the Human Genome Research.

Finding Aid:
http://oasis.lib.harvard.edu/oasis/deliver/findingAidDisplay?_collection=oasis&inoid=1270&histno=0

16.4.10.2 Papers of Kay Dickersin, (1976-2004)

Extent: (36 file boxes, 1 half file box) plus 1 folio+ folder, 1 oversize folder, electronic records

Bio:

Professor of epidemiology and advocate for breast cancer survivors, Kay Dickersin attended the University of California, Berkeley (BA in Zoology, 1974; MA in Cell Biology, 1975) and the Johns Hopkins University School of Public Health (PhD, 1989). She has served on the faculty at the University of Maryland School of Medicine in the Departments of Ophthalmology and Epidemiology and Preventive Medicine in various

capacities (1989-1998) and on the faculty at Brown University (1998-2005). She has lectured at the Johns Hopkins University Bloomberg School of Public Health since 1991, and, since 2005, she has been Professor of Epidemiology and the Director of the Center for Clinical Trials where she is involved in methodologic research, overseeing coordination of data collection and analysis of clinical trials, and systematic reviews. Dickersin was diagnosed with breast cancer when she was 34 years old. A breast cancer survivor, she dedicated much of her career to breast cancer research advocacy. Dickersin and fellow advocate and nurse, Marsha Oakley, cofounded Arm-in-Arm, a Baltimore-based breast cancer support group and the support arm of the Maryland Women's Health Coalition, in 1984.
The National Breast Cancer Coalition (NBCC) was born as the Breast Cancer Coalition in May 1991, when organizations that belonged to the National Alliance of Breast Cancer Organizations (NABCO), and others met in Washington, D.C., to form a political action group centered on issues of breast cancer. At this meeting, Susan Hester (Mary Helen Mautner Project for Lesbians with Cancer), Susan Love (breast surgeon), Amy Langer (NABCO), and others presented the concept of the Coalition. Arm-in-Arm was an original member of the working board of NBCC. Through Arm-in-Arm, and because of her expertise as an epidemiologist specializing in clinical trials, Dickersin became a leader within NBCC.
Patricia Barr was born in 1951. Diagnosed with breast cancer in 1987, she died in 2003 from the disease. Barr was a leading activist for breast cancer research and advocacy. In addition to being a founding partner in the law firm Barr, Sternberg, Moss, Lawrence, Silver & Saltonstall, P.C., she was the president of the advocacy and support organization Breast Cancer Network of Southern Vermont. This organization originally formed as the Bennington chapter of the Breast Cancer Action Group of Vermont in 1992. The chapter became a separate organization in 1993, and, in 2001, Breast Cancer Network changed its name to Vermont Cancer Network. Barr represented the Breast Cancer Network on the board of the NBCC and was also one of its founders and original directors.
Annette Drummond was born in 1927. For most of her life, Drummond was a middle school science teacher in Baltimore, Maryland, and taught at Woodbourne Junior High School in Baltimore (1957-1968), and later at both Cockeysville Junior High School and Ridgeley Middle School (1970-1981). She also taught in the computer literacy project at Catonsville Community College (1984-1985). Until her death of breast cancer in 2001, Drummond was an advocate for breast cancer patients. She served as the treasurer at Arm-in-Arm and was the grassroots coordinator for NBCC in Maryland.
Mary Jo Kahn was a founding member and the first president of the Virginia Breast Cancer Foundation, an advocacy and support organization. Kahn, who was diagnosed with breast cancer in 1989, started the Foundation with other activists who met in a breast cancer support group in 1991. The Foundation was involved with the working group that later became the board of directors of the NBCC. It was also the first chair of the grassroots taskforce for NBCC where its members played a central role in organizing NBCC's first campaign, in October 1991.

Collection Description:

Collection includes professional papers of Kay Dickersin, Patricia Barr, Annette Drummond, and Mary Jo Kahn, advocates for the fight against breast cancer who were active on the board of the National Breast Cancer Coalition, as well as through other breast cancer advocacy organizations. Reports, correspondence, press releases, research materials, photographs, etc., document how these women and organizations worked within the public, political, and scientific arenas to impart the importance of and to increase funding for more research.

Finding Aid: http://oasis.lib.harvard.edu/oasis/primo?id=sch01173&q=undefined

16.4.10.3 Papers of Ruth Hubbard, (1920-2007 (inclusive), 1980-2005 (bulk))

Extent: 31 file boxes, plus 1 folio folder, 1 folio+ folder, 1 oversize folder, 1 supersize folder, 5 photograph folders, 9 audiotapes, 13 videotapes, electronic records

Bio:

Biologist and feminist Ruth Hoffmann Hubbard was born in Vienna, Austria. In 1938 her family emigrated to the United States, settling in Brookline, Massachusetts. She graduated from Radcliffe College in 1944 with a B.A. in Biochemical Sciences and worked as a research assistant at Harvard University and as a laboratory technician for the Tennessee Public Health Service before returning to Radcliffe and receiving her Ph.D. She married Frank Hubbard in 1942; they divorced in 1951 and she married George Wald, Harvard professor and Nobel Laureate, in 1959. They had two children, Elijah and Deborah.
In 1950 Hubbard began working as a research fellow at Harvard University. She was promoted to research associate in 1958 and to lecturer in 1968. Her research made major contributions to the understanding of the photochemistry and biochemistry of vision in vertebrates and invertebrates, and in 1973, she became the first woman to be awarded a tenured biology professorship at Harvard. In the late 1960s, prompted by the Vietnam War and the women's liberation movement, her interests shifted from research towards political and social issues. She has written and lectured on the politics of health care, the importance of educating women about their bodies, the sociology of science, ethical standards in genetic research, and the emphasis on genes as the determining factor in individuals' sexuality and other characteristics. In 1982, she was one of the founders of the Council for Responsible Genetics, a nonprofit non-governmental agency aiming to represent the public interest on issues in biotechnology. She has served on the boards of the Boston Women's Fund and the Civil Liberties Union of Massachusetts, and as a consultant to the Boston Women's Health Book Collective. She is the author of more than 150 articles and the editor and author of many books including The Shape of Red: Insider/Outsider Reflections, co-written with Margaret Randall (1988); The Politics of Women's Biology (1990); Profitable Promises: Essays on Women, Science and Health (1995); and Exploding the Gene Myth, co-written with Elijah Wald (1993). She retired from Harvard in 1990.

Collection Description:

Collection includes correspondence; conference and speech material; writings; photographs; and files relating to organizations with which she was active, including the Boston Women's Health Book Collective and the Boston Committee for Palestinian Rights; and audio and videotapes.

Finding Aid: http://oasis.lib.harvard.edu/oasis/primo?id=sch01418&q=undefined

16.4.10.4 Papers of Evelyn Fox Keller, (1966-2005)

Extent: 31 file boxes, 1 half file box) plus 1 folio folder, 2 folio+ folders, 1 oversize folder, 1 supersize folder, 1 photograph folder, 1 folio+ photograph folder, 2 videotapes, and 1 DVD

Bio:

Evelyn Fox Keller was born in New York City and graduated from Brandeis University (B.A. 1957), Radcliffe College (M.A. 1959) and Harvard University (Ph.D. 1963). In 1963 she married the mathematician Joseph Bishop Keller; they had two children, Jeffrey and Sarah, and divorced in 1976. She has taught, lectured, and written in a number of fields, including the history and philosophy of science, mathematical and molecular biology, and theoretical physics. Her research focuses on the intersection of science and gender, and on the philosophy and history of modern biology. She is the author of A Feeling for the Organism: The Life and Work of Barbara McClintock (1983), Reflections on Gender and Science (1985), Three Cultures: Fifteen Lectures on the Confrontation of Academic Cultures (1989), Secrets of Life/Secrets of Death: Essays on Language, Gender and Science (1992), Refiguring Life: Metaphors of Twentieth-century Biology (1995), Feminism and Science (co-edited with Helen Longino, 1996), Keywords in Evolutionary Biology (co-edited with Elisabeth Lloyd, 1998), The Century of the Gene (2000), Making Sense of Life: Explaining Biological Development with Models, Metaphors, and Machines (2002), and The Mirage of a Space between Nature and Nurture (2010). Since 1992, she has been a professor of the history and philosophy of science at the Massachusetts Institute of Technology.

Collection Description:

Collection includes correspondence; teaching material, including syllabi, lecture notes, and reading packets; articles and speeches; correspondence, drafts, and interviews for Keller's book on Barbara McClintock; photographs; and videotapes. Additional material received as electronic files will be reformatted at some future date for inclusion in this collection.

Extent: http://oasis.lib.harvard.edu/oasis/primo?id=sch01382&q=undefined

16.4.10.5 Papers of Susan Moller Okin, (1966-2004)

Extent: (23 file boxes) plus 1 photograph folder, electronic records

Bio:

Known for establishing the research field of gender and political science, Susan Moller Okin was a liberal theorist whose feminist perspective challenged the established thinking on political philosophers regarding questions about gender and the family. Okin was born in 1946, in Auckland, New Zealand. She earned a bachelor's degree from the University of Auckland in 1967; a master of philosophy degree from Somerville College in Oxford, England in 1970; and a doctorate from Harvard University in 1975. Okin taught political science and philosophy courses at the University of Auckland (1971), Vassar College (1975-1976), Brandeis University (1976-1990), and Harvard University (1990) before joining Stanford University's Department of Political Science in the fall of 1990. In 1992 she was named Stanford's Marta Sutton Weeks Professor and served as the director of the Ethics in Society Program from 1993 to 1996. In 2003 she was invited to the Radcliffe Institute for Advanced Study as the Matina S. Horner Distinguished Visiting Professor in the Department of Political Science and Ethics in Society to research "Gender, Economic Development, and Women's Human Rights." Okin died of unknown causes at the age of 57 on March 3, 2004, during the spring semester of her visiting professorship at Radcliffe.

Collection Description:

Collection includes correspondence with colleagues and publishers, typewritten draft manuscripts, syllabi, teaching notes, and class readings. They document Okin's development of her gender and political science courses and her struggles asserting herself in an academic male-dominated department.

Finding Aid: http://oasis.lib.harvard.edu/oasis/primo?id=sch01405&q=undefined

Type of resource	University/ Women's History Archives
Connections	https://www.radcliffe.harvard.edu/schlesinger-library Bass & Howes, Inc. Dickersin, Kay Hubbard, Ruth Keller, Evelyn Fox Okin, Susan Moller

16.4.11 Papers of James Dewey Watson , (1945-1968 (inclusive), 1945-1954 (bulk))

Extent: 6 document boxes, 1 pamphlet binder

16.4.11.1 Collection Description:

Includes personal correspondence, 1945-1953; manuscripts of writings, such as drafts of The Double Helix; laboratory and other research notes and related reports and memoranda; outlines of lectures given outside Harvard; and scientific photos.

16.4.11.2 Catalog Link:

http://hollis.harvard.edu/primo_library/libweb/action/dlDisplay.do?vid=HVD&search_scope=default_scope&docId=HVD_ALEPH000604715&fn=permalink

Type of resource	University Archives
Connections	http://library.harvard.edu/university-archives
People Connected	Watson, James D.

16.4.12 Johns Hopkins Medical Institutions Alan Mason Chesney Medical Archives

16.4.12.1 George O. Gey Collection, 1918-1974

The George O. Gey Collection spans his entire career, with the bulk of the material from his tenure as Director of the Finney-Howell Cancer Research Laboratory. Included are correspondence with individuals, industries, granting agencies, foundations, and other organizations; grant records (including proposals, applications, budgets, and reports); laboratory progress reports; and reprints. Other professional materials include records of the Tissue Culture Association and Gey's notes and reprints.Photographic materials include images of HeLa cells and early examples of George Gey's roller tube experiments. The collection also contains a selection of personal materials, such as photographs, family correspondence, items from World War I, picture postcards, certificates, and memorabilia. In addition there are reels of motion picture film, books, surgical instruments, and laboratory equipment.

16.4.12.2 Victor Almon McKusick Collection, 1921-2008

The Victor Almon McKusick Collection spans his entire career at Johns Hopkins. It documents his various activities as clinician, researcher, teacher, and administrator. The collection includes professional correspondence, research data, photographs, lecture notes, financial records, student records, reprints, manuscripts, audio tapes, committee minutes, patient records, slides, diplomas, and awards. Also included are family papers, including biographical information, undergraduate notes, and transcripts of interviews with McKusick and family members.

16.4.12.3 Daniel Nathans Collection

The Daniel Nathans Collection documents his entire career. Included are lab notebooks, reprints, correspondence and administrative documents.Memorabilia relating to the award of the Nobel Prize in Medicine to microbiologists Daniel Nathans, M.D. and Hamilton O. Smith, M.D. Nathans and Smith received the award in l978 for their discovery of restriction enzymes and the application of their discovery to molecular genetics. Included among the memorabilia are 10 photographs of the award ceremony, flags and a Nobel medal, press releases, reprints of their restriction enzyme research, articles by A. McGhee Harvey on Nobel Prize winners from Hopkins, and a transcript of a faculty meeting address, October l978, at which both Nathans and Smith spoke about their work. Total: 29 items.

Type of resource	University Archives
Connections	http://www.medicalarchives.jhmi.edu/papers/mckusick.html http://www.medicalarchives.jhmi.edu/finding_aids/george_gey/george_gey-103414.html
People Connected	Gey, George O. McKusick, Victor A. Nathans, Daniel

16.4.13 Papers of Maurice Hugh Frederick Wilkins, (1854-2004)

Extent: 170 Boxes

16.4.13.1 Bio:

Born Pongaroa, New Zealand, 1916; family moved to Birmingham, UK, 1923; educated, King Edward School, Birmingham, 1929-1935, and St John's College, Cambridge, 1935-1938; joined Cambridge Scientists Anti-War Group and Communist Party; conducted research on luminescence in solids under John Randall, Physics Dept, Birmingham University, 1938-1940; PhD on thermoluminescence in solids, 1940; worked on improvements to radar screens, Ministry of Home Security and Aircraft Production, 1940-1941; worked on the separation of uranium isotopes for British atomic bomb research, codenamed the Tube Alloys Project, 1941-1944; worked at University of California at Berkeley, USA, on the Manhattan Project for the production of the atomic bomb, 1944-1945; Lecturer in Physics, St Andrews University, 1945; Researcher, Medical Research Council Biophysics Unit, Physics Department, King's College London, 1946-1958; Lecturer in Biophysics, King's College London, 1958-1963; awarded Nobel Prize for Medicine, 1962, jointly with James Watson and Francis Crick; Professor of Molecular Biology, King's College London, 1963-1970; President and co-founder, British Society for Social Responsibility in Science (BSSRS), 1969-1991; Professor of Biophysics, King's College London, 1970-1981; devised inter-disciplinary undergraduate course, 'The social impact of the biosciences', 1972; Director, Medical Research Council Cell Biophysics Unit, 1974-1981; Emeritus Professor of Biophysics, KCL, 1981-2004; President, Food and Disarmament International, 1984-2004; died, 2004.

16.4.13.2 Collection Description:

Papers of Maurice Hugh Frederick Wilkins, 1854-2004, including: laboratory notebooks, graphs, data sets, notes, x-ray diffraction photographs and published articles relating to his scientific research, 1948-1976, chiefly his work on the structure of DNA, 1947-1966; correspondence, 1948-2004, with and about scientific colleagues, including Struther Arnott, Allen Blaurock, Francis Crick, Boris Ephrussi, Harriet Ephrussi-Taylor, Bruce Fraser, Meyer Friedman, Raymond Gosling, Leonard Hamilton, John Kendrew, Robert Langridge, Don Marvin, Linus Pauling, Max Perutz, John Randall, Alec Stokes, James Watson and Herbert Wilson. Correspondence, notes and articles, 1950-2003, relating to research on the history of the discovery of the structure of DNA, including: copies of Rosalind Franklin's laboratory notebooks and articles, 1951-1953, relating to her DNA research; correspondence, 1967-2003, with writers on DNA history, including Aaron Klug, Robert Olby, Meyer Friedman, Horace Judson and Watson Fuller; unpublished articles and talks on DNA history by Wilkins, 1975-1987. Drafts, notes, correspondence and collected background research relating to Wilkins' autobiography, *The third man of the double helix* (Oxford University Press, 2003). Papers relating to Wilkins' education and early career, 1928-1942, including: teenage essays and fiction on the role of science, 1928-1934; notes, articles and photographs, 1937-1938, relating to his student activities, including physics experiments, and photographs relating to his incendiary bomb testing for Cambridge Scientists Anti-War Group, 1938. Correspondence, memoranda, minutes, reports and notes, 1962-1982, relating to the administration of the Medical Research Council (MRC) Biophysics Unit, King's College London (from 1964, the Department of Biophysics), on topics including funding, staffing, equipment provision and teaching. Correspondence, course handouts, student essays (CLOSED) and background material, 1971-1996, relating to the undergraduate course, 'The social impact of the biosciences', created and run by Wilkins, 1972-1982. Correspondence, newsletters and conference papers relating to Wilkins' involvement in political pressure

groups, 1968-2003, notably the British Society for Social Responsibility in Science (of which Wilkins was founding President, 1969-1991), Food and Disarmament International (Wilkins' was founding President, 1984-2004), the Campaign for Nuclear Disarmament (CND), and the Pugwash Conferences on World Affairs. Audio recordings, 1972-1996, including lectures by Wilkins on: social responsibility in science; his Eddington Memorial Lectures,Cambridge, 1977-1978, on the history and philosophy of science; nuclear disarmament, 1981; his retirement speech, 1982; the history of DNA.

Finding Aid: http://www.kingscollections.org/catalogues/kclca/collection/w/wilkins-maurice/?searchterms=wilkins%2C+maurice

Digital Archives (large portion are available freely online via Wellcome Library's Website): http://wellcomelibrary.org/collections/digital-collections/makers-of-modern-genetics/digitised-archives/maurice-wilkins-mrc-biophysics-unit-archive/

Type of resource	College Archives
Connections	http://www.kcl.ac.uk/library/collections/archivespec/index.aspx
People Connected	Wilkins, Maurice

16.4.14 Manuscript Collections Listed (No Finding Aids Available)

16.4.14.1 David Botstein Manuscript Collection, MC277

16.4.14.2 Maurice Fox Manuscript Collection, MC390

16.4.14.3 Robert A. Weinberg Manuscript Collection, MC258

Type of resource	University Archives
Connections	http://libraries.mit.edu/archives/
People Connected	Botstein, David Fox, Maurice Weinberg, Robert A.

16.4.15 Records created or inherited by the Medical Research Council, (1901-2008)

Records of the Medical Research Committee and Medical Research Council touching all aspects of medical research carried out in the UK.

These include general and administrative records, those of research units of the Medical Research Council and those of the research boards of the Medical Research Committee and the Medical Research Council.

Type of resource	College Archives
Connections	http://discovery.nationalarchives.gov.uk/details/r/C121

16.4.16 Senator Pete V. Domenici Papers

Extent: 1.25 linear feet

Currently being processed (as of November 2015).

Type of resource	University Archives
Connections	http://lib.nmsu.edu/depts/archives/ Domenici, Pete

16.4.17 Material Related to the Human Genome Project:

A lecture by Dr. Silverman from 1992, some photographs and a campus newspaper article.

Type of resource	University Archives
Connections	http://library.northeastern.edu/archives-special-collections

16.4.18 Guide to the Office of Administration and Facilities, Eileen Buckley, 1959-1995 (Bulk 1964-1989)

One folder: Nelkin, Dorothy, Box 29 Folder 50, undated

Type of resource	University Archives
Connections	http://www.nyu.edu/library/bobst/research/arch/
People Connected	Nelkin, Dorothy

16.4.19 Oklahoma State University

Connections	http://www.library.okstate.edu/ Nickles, Don

16.4.20 Oregon State University/Archives

16.4.20.1 Christopher Mathews

Christopher Mathews Papers, 1962-2010

Collection Description:

The Christopher Mathews Papers are composed of approximately 6 linear feet of personal correspondence and organizational records dated 1962-2010, 8 megabytes of email correspondence from 1996-2010, and 146 megabytes of miscellaneous digital correspondence and documents from 2004-2010. These materials span Mathews' employment at Yale University, the University of Arizona, and Oregon State University.

An addition was made to the Christopher Mathews Papers (Accession 2012:064) that consists of 3.5" floppy disks that appear to contain a wide variety of documents from 1992-2004 relating to Chris Mathews' position with the OSU Dept. of Biochemistry and Biophysics including grant proposals, search committee records, administrative forms, professional correspondence, course materials, and research data.

URL: http://scarc.library.oregonstate.edu/coll/mathews/index.html

16.4.20.2 Linus Pauling

Ava Helen and Linus Pauling Papers, 1873-2013

Collection Description:

Linus Pauling (1901-1994), a 1922 OSU graduate and the only recipient of two unshared Nobel Prizes, (Chemistry, 1954; Peace, 1962) undertook a wide range of studies during his seventy-year career as a scientist, humanitarian and peace activist. The collection, comprised of over five hundred thousand items, contains all of Pauling's personal and scientific papers, research materials, correspondence, photographs, awards, and memorabilia. Not only does the Pauling archive reflect Linus Pauling's long and varied scientific career, the presence of Ava Helen Pauling's (1903-1981) papers also indicates their mutual devotion to world peace and to each other.

URL: http://scarc.library.oregonstate.edu/coll/pauling/index.html

16.4.20.3 Theodore Rockwell

Collection Description:

The Theodore Rockwell Papers document the life and career of Ted Rockwell, a member of the Manhattan Project, technical director for the U.S. Navy's nuclear propulsion initiative under Admiral H. G. Rickover, and co-founder of engineering firm MPR Associates, Inc. and nuclear advocacy group Radiation, Science, and Health, Inc. The collection includes correspondence, publications, research files, administrative documents, and memorabilia from his career. The collection also documents Rockwell's interest in parapsychology and includes extensive research materials on consciousness studies, telekinesis, dowsing, extraterrestrials, and other phenomena.

Theodore Rockwell Papers, 1915-2013

URL: http://scarc.library.oregonstate.edu/coll/rockwell/index.html

Type of resource	University Archives
People	Mathews, Christopher Pauling, Linus Rockwell, Theodore
Connections	http://scarc.library.oregonstate.edu/

16.4.21 Princeton University/Archives

Files on specific people involved in Human Genome Project listed below:

16.4.21.1 Alberts, Bruce

Office of the Secretary Records » Series 4: Honorary Degrees 1867-2000

Subseries 4B: Honorary Degree Recipients, 1867-2000

URL: http://findingaids.princeton.edu/collections/AC190

Office of the President Records: William G. Bowen subgroup: Series 9: Personnel 1952-1988:Subseries 9B: Faculty and Staff Individuals 1959-1988

URL: http://findingaids.princeton.edu/collections/AC187

16.4.21.2 Botstein, David

Office of the President Records: Shirley Tilghman Subgroup » Series 8: Personal 2001-2013 » Subseries 8F: Letters of Recommendation 2001-2013

Office of the President Records: Shirley Tilghman Subgroup » Series 9: Personnel 1973-2013 » Subseries 9B: Faculty and Staff 1973-2013

URL: http://findingaids.princeton.edu/collections/AC37

16.4.21.3 Rosenberg, Leon E.

Office of Communications Records » Series 5: Recent Accessions 1946-2013 » Subseries 5A: Faculty and Staff Biographical File Additions circa 1946-2014

URL: http://findingaids.princeton.edu/collections/AC168

Woodrow Wilson School Policy Seminar Papers *1930-2014*

URL:http://findingaids.princeton.edu/collections/AC103

16.4.21.4 Tilghman, Shirley

Broadcast Center Recordings 1980-2014URL: http://findingaids.princeton.edu/collections/AC362/c01565

Princeton University. Office of the President.Office of the President Records: S:circa 1960-2014 (mostly 2001-2013)

URL: http://findingaids.princeton.edu/collections/AC379

Historical Subject Files Collection

Series 3. Administration 1861-Present. Presidents 1902-2004

URL:http://findingaids.princeton.edu/collections/AC109

Princeton University. Office of the Dean of the College.Office of the Dean of the College Records 1919-2015

Series 21: Nancy Malkiel Files 1916-2011, 1980-2009 » Subseries 21B: Nancy Malkiel Files, Transferred in October 2012 circa 1978-2011

URL: http://findingaids.princeton.edu/collections/AC149/c000002974

Office of the President Records:

Shirley Tilghman Subgroup, Box 123

URL: http://findingaids.princeton.edu/collections/AC379/c2646

Office of Government Affairs Records

Series 3: August 2010 Accession, Princeton Plasma Physics Laboratory, Chris Carter Files 1986-2003

URL: http://findingaids.princeton.edu/collections/AC213

Office of the President Records

Shirley Tilghman Subgroup » Series 2: Administration 1990-2013 » Subseries 2A: Board of Trustees 1991-2013

URL: http://findingaids.princeton.edu/collections/AC379

Office of Communications Records

Series 4: Photographs 1950-2005. Subseries 4B: Denise Applewhite 1970-2005

URL: http://findingaids.princeton.edu/collections/AC168

Type of resource	University Archives
Connections	http://library.princeton.edu/databases/subject/special-collections
Actual People Connected	Alberts, Bruce Botstein, David Rosenberg, Leon E. Tilghman, Shirley

16.4.22 Auston, David Gordon, William E., 1918-

Rice University Guide to the Rice University Provost's Office records (Gordon, Lane, Kinsey, Auston, Minter, Levy), 1980-2004 UA 220

Type of resource	University Archives
Connections	http://library.rice.edu/woodson
People Connected	Lane, Neal

16.4.23 Rockefeller University/Archives

Type of resource	Institutional Archives
Connections	http://www.rockarch.org/ Avery, Oswald T. Baltimore, David Burley, Stephen Friedman, Jeff McCarty, Maclyn Ott, Jürg Rous, Peyton Tooze, JohnZinder, Norton

16.4.24 Stanford University/Archives

16.4.24.1 Human Genome Project

"Select Issues in Biomedical Ethics" video recording

URL: http://www.oac.cdlib.org/findaid/ark:/13030/kt209nf12m/?query=human+genome+project

Guide to Guide to the Stanford Alumni Association Video recordings

URL: http://www.oac.cdlib.org/findaid/ark:/13030/kt567nf1w8/?query=human+genome+project

Guide to the Stanford Channel Master Video recordings

URL: http://www.oac.cdlib.org/findaid/ark:/13030/kt2779r5x1/?query=human+genome+project

Guide to the Stanford University, Centennial Office, Records

URL: http://www.oac.cdlib.org/findaid/ark:/13030/kt787037t3/?query=human+genome+project

Stephen Jay Gould Papers, 1899-2004

URL: http://www.oac.cdlib.org/findaid/ark:/13030/kt229036tr/?query=human+genome+project

Philosophy Talk

URL:http://www.oac.cdlib.org/findaid/ark:/13030/c88051mc/?query=human+genome+project

Guide to Stanford Pioneers in Science video recording

Box 3 Paul Berg On Genetics, May 20, 2009

URL: http://www.oac.cdlib.org/findaid/ark:/13030/c8vq31qg/dsc/?query=human%20genome%20project;dsc.position=1#hitNum1

Guide to the Stanford University Video Collection

Series: Videos

V185 **The Human Genome Project : Second Centennial Symposium, January 1991 1991 Jan 11-13**

URL: http://www.oac.cdlib.org/findaid/ark:/13030/kt500040p2/?query=human+genome+project

Guide to the Stanford University Founders' Day Collection

Box 3U 2007 Prof. Richard Myers on the Human Genome Project

URL: http://www.oac.cdlib.org/findaid/ark:/13030/kt9v19s3z4/?query=human+genome+project

Guide to the Steven Chu Papers

Series: GrantsBox 4, Folder 16 Department of Energy Grant Related to Human Genome Project

URL: http://www.oac.cdlib.org/findaid/ark:/13030/kt100035k7/dsc/?query=human%20genome%20project;dsc.position=1#hitNum1

16.4.24.2 Paul Berg

Berg (Paul) Papers 1953-1998

URL:http://www.oac.cdlib.org/findaid/ark:/13030/tf1x0n98jp/?query=berg,+paul

Press conference on receipt of Nobel Prize in biochemistry 1980

URL:http://www.oac.cdlib.org/findaid/ark:/13030/c8736scf/?query=berg,+paul

Nobel Perspectives on Ethics in Science Video recordings 1996

URL:http://www.oac.cdlib.org/findaid/ark:/13030/kt7n39s448/?query=berg,+paul

Stanford Pioneers in Science video recording 2008-2010

URL:http://www.oac.cdlib.org/findaid/ark:/13030/c8vq31qg/?query=berg,+paul

Stanford University Biographical Files Collection circa 1891-2011

URL:http://www.oac.cdlib.org/findaid/ark:/13030/c80g3kpg/?query=berg,+paul

Stanford University Video Collection 1934-2009

URL:http://www.oac.cdlib.org/findaid/ark:/13030/kt500040p2/?query=berg,+paul

Stanford Historical Photograph Collection circa 1887-circa 1996

URL:http://www.oac.cdlib.org/findaid/ark:/13030/kt5c60381q/?query=berg,+paul

Stanford University, News and Publication Service, Notable Teachers Series Audio Recordings 1979-1984

URL:http://www.oac.cdlib.org/findaid/ark:/13030/c83b5xwm/?query=berg,+paul

16.4.24.3 David Botstein

S tanford University Biographical Files Collection circa 1891-2011

URL:http://www.oac.cdlib.org/findaid/ark:/13030/c80g3kpg/?query=botstein,+david

Stanford University, News and Publication Service, Audiovisual Recordings 1936-2011

Series: VideorecordingsBox 11 01-0206-1 David Botsteinhttp://www.oac.cdlib.org/findaid/ark:/13030/c8dn43sv/dsc/?query=botstein,%20david;dsc.position=1#hitNum2, Russ Altman, SGI Supercomputer Partnership 02/06/2001URL:http://www.oac.cdlib.org/findaid/ark:/13030/c8dn43sv/?query=botstein,+david

Stanford Channel Master Video Recordings 1995-2001

Box 3

95-107 **The Human Genome Project Part 2: David Botstein**

URL:http://www.oac.cdlib.org/findaid/ark:/13030/kt2779r5x1/dsc/?query=botstein,%20david;dsc.position=1#hitNum1

16.4.24.4 Luigi Luca Cavalli-Sforza

Stanford Emeriti Council Collection 2006-2011

Series: Audio Visual RecordingsBox 1.1U Cavalli- Sforza , L. L. (Luigi Luca), 1922- 2008-04-23

URL:http://www.oac.cdlib.org/findaid/ark:/13030/kt5k403701/dsc/?query=Cavalli-Sforza;dsc.position=1#hitNum5

Olkin (Ingram) Papers 1945-2005

Series: PapersBox 11, Folder 44 Cavalli-Sforza, 1975
URL:http://www.oac.cdlib.org/findaid/ark:/13030/c8w380q2/?query=Cavalli-Sforza

Stanford University Biographical Files Collection circa 1891-2011

Series: Biographical FilesBox 5, Folder 178 Cavalli- Sforza , Luigi L.
URL:http://www.oac.cdlib.org/findaid/ark:/13030/c80g3kpg/?query=Cavalli-Sforza

16.4.24.5 Arthur Kornberg

Kornberg (Arthur) Papers 1938-2007

URL:http://www.oac.cdlib.org/findaid/ark:/13030/tf8n39p01d/?query=kornberg,+arthur

Interview with Arthur Kornberg Video Recording undated

URL:http://www.oac.cdlib.org/findaid/ark:/13030/kt8m3nf7x7/?query=kornberg,+arthur

Nobel Perspectives on Ethics in Science Videorecordings 1996

Box 1 V192.3 **Biotechnology: Biology or Technology, http://www.oac.cdlib.org/view?style=oac4;view=admin;docId=kt7n39s448;query=kornberg,%20arthur#hitNum4 Arthur Kornberg 1996 Oct**

URL:http://www.oac.cdlib.org/findaid/ark:/13030/kt7n39s448/?query=kornberg,+arthur

Stanford University, School of Medicine, Department of Biochemistry, Bound Reprint Collection 1961-1997

URL:http://www.oac.cdlib.org/findaid/ark:/13030/kt396nf3ch/?query=kornberg,+arthur

This set of bound reprints of articles by faculty in the Department of Biochemistry was Arthur Kornberg's set.

Stanford University Biographical Files Collection circa 1891-2011

Series: Biographical FilesBox 18, Folder 174 Kornberg, Arthur

URL:http://www.oac.cdlib.org/findaid/ark:/13030/c80g3kpg/?query=kornberg,+arthur

Stanford University Faculty Publications 1881-2009

Series: Pamphlets and Reprints

Box 48 Kornberg, Arthur

URL:http://www.oac.cdlib.org/findaid/ark:/13030/kt7m3nf4f7/?query=kornberg,+arthur

Holub (Leo) Photographs of Stanford University 1946-1992

Series: Photographs/Box 1, Folder 10 Faculty, Board Members

Box 4 Nobel Faculty

URL:http://www.oac.cdlib.org/findaid/ark:/13030/kt958038nz/?query=kornberg,+arthur

Stanford Historical Photograph Collection circa 1887-circa 1996

Series: Biographical PhotographsBox 16, Folder 12 Kornberg, ArthurURL:http://www.oac.cdlib.org/findaid/ark:/13030/kt5c60381q/?query=kornberg,+arthur

Stanford University Video Collection 1834-2009

V167: DNA Replication by Arthur Kornberg [Scientific Symposium Tape #1: Genes and Chromosomes] 1980 Mar 27-28 Physical Description: 1 videotape(s) (U-matic) V170 Interview with Arthur Kornberghttp://www.oac.cdlib.org/findaid/ark:/13030/kt500040p2/dsc/?query=kornberg,%20arthur;dsc.position=1#hitNum4 [Alpha Omega Alpha: leaders in American medicine] 1994 Dec

URL:http://www.oac.cdlib.org/findaid/ark:/13030/kt500040p2/?query=kornberg,+arthur

Stanford Emeriti Council Collection 2006-2011

Series: Audiovisual RecordingsBox 1.2U Kornberg, Arthur 1918-2007 2007-05-14URL: http://www.oac.cdlib.org/findaid/ark:/13030/kt5k403701/?query=kornberg,+arthur

Stanford Historical Society Oral History Program Interviews 1999-2015

Faculty and Staff Interviews

URL: http://www.oac.cdlib.org/findaid/ark:/13030/kt9v19s1vm/?query=kornberg,+arthur

Ehrlich (Paul) Papers, 1954-2001

Series: General Files and Correspondence

Box 28 Folder 79 Kornberg, Arthur (1968)

URL:http://www.oac.cdlib.org/findaid/ark:/13030/kt3r29r8pf/?query=kornberg,+arthur

Terman (Frederick Emmons) Papers 1920-1978

URL:http://www.oac.cdlib.org/findaid/ark:/13030/tf029000zm/admin/?query=kornberg,%20arthur#hitNum1

Lederberg (Esther M) papers 1906-2013

Series: Additional MaterialBox 3, Folder 7 Letters of recommendation including Arthur Kornberg, Allan Campbell, Edward Tatum, H.G. duBuy, H.F. Fraser and Alvin J. Clarke, 1944, 1971URL: http://www.oac.cdlib.org/findaid/ark:/13030/kt829040sn/?query=kornberg,+arthur

S tanford Channel Master Video Recordings 1995-2001

Box 74 95-704 Interview with Arthur Kornberg

URL:http://www.oac.cdlib.org/findaid/ark:/13030/kt2779r5x1/?query=kornberg,+arthur

Type of resource	University Archives
Connections	https://library.stanford.edu/spc

Actual People Connected	Berg, Paul Botstein, David Cavalli-Sforza, Luigi Luca Kornberg, Arthur

16.4.25 University of California, Berkeley/Archives

16.4.25.1 Human Genome Project

Finding Aid to the Allan Wilson Papers, 1953-1998, bulk 1962-1991

Series: Publications

Carton 2, Folder 46 *Call for a Worldwide Survey of Human Genetic Diversity: A Vanishing Opportunity for the Human Genome Project .* 1991

URL:http://www.oac.cdlib.org/findaid/ark:/13030/kt958035w4/?query=human+genome+project

16.4.25.2 George Gamow

16.4.25.3 Guide to the Raymond Thayer Birge Papers, 1909-1969

Series: Personalia and miscellanyCopy of a letter, Nov. 30, 1953, to him from Gamow

http://www.oac.cdlib.org/findaid/ark:/13030/tf0q2n985c/dsc/?query=gamow;dsc.position=1#hitNum2
Gamow , George, 1904-19688 letters, 1949-54

URL:
http://www.oac.cdlib.org/findaid/ark:/13030/tf0q2n985c/dsc/?query=gamow;dsc.position=1#hitNum3

16.4.25.4 Guide to the Ernest O. Lawrence Papers, [ca. 1920-1968]

SERIES 1: GENERAL FILES

Folder 25 Gamow, George

URL:http://www.oac.cdlib.org/findaid/ark:/13030/tf0g5001n2/dsc/?query=gamow;dsc.position=1#hitNum1

16.4.25.5 Guide to the Wendell M. Stanley papers, 1926-1972

SERIES 1: Correspondence, 1929-1972 Incoming Correspondence from Individuals, 1929-1971

Folder 77 Gamow , George 1946-1960

16.4.25.6 Guide to the Gunther S. Stent Papers, 1915-1998

Series 1: Personal And Professional Correspondence, 1946-1998.
Folder 5 George Gamow, 1955-1960

Series 9: Reprints By Others, 1915-1996.
Gamow , George 1954-1956
URL: http://www.oac.cdlib.org/findaid/ark:/13030/ft509nb1mh/dsc/?query=gamow;dsc.position=1#hitNum2

16.4.25.7 Guide to the Donald and Katharine Foley Collection of Penguin Books, 1935-1965

Box 324 BIRTH AND DEATH OF THE SUN, THEAuthor: Gamow, George URL: http://www.oac.cdlib.org/findaid/ark:/13030/kt096n97b6/entire_text/?query=gamow#hitNum2

16.4.25.8 Arthur Kornberg

16.4.25.9 Biochemistry at Stanford, biotechnology at DNAX : oral history transcript / 1998

URL: http://www.oac.cdlib.org/search?query=kornberg;idT=UCb110939219

16.4.25.10 Daniel Israel Arnon papers, 1928-2001

CorrespondenceCtn. 3, folder 8 **Kornberg , Arthur. 1952-1971**
URL: http://www.oac.cdlib.org/findaid/ark:/13030/tf5489n7nf/dsc/?query=kornberg;dsc.position=1#hitNum1

16.4.25.11 Guide to the William Zev Hassid Papers, 1915-1974

Kornberg , Arthur, 1918- Letter, n.d
URL:h**ttp://www.oac.cdlib.org/findaid/ark:/13030/tf0z09n4p6/?query=kornberg**

16.4.25.12 Jesse Rabinowitz Papers, 1944-1999, bulk 1948-1995

Carton 2, Folder 40
Kornberg , Arthur 1964-1995
URL: http://www.oac.cdlib.org/findaid/ark:/13030/kt596nd2c6/dsc/?query=kornberg;dsc.position=1#hitNum1

16.4.25.13 Horace Albert Barker Papers, 1933-1992

Incoming Correspondence
Carton 2, Folder 38 Kornberg, Arthur 1951-1990
URL: http://www.oac.cdlib.org/findaid/ark:/13030/hb0t1n991f/dsc/?query=kornberg#c02-1.3.6.2.5

16.4.25.14 Guide to the Wendell M. Stanley papers, 1926-1972

Series 1: Correspondence, 1929-1972 Incoming Correspondence from Individuals, 1929-1971.folder 164 Kornberg, Arthur 1956-
1964**http://www.oac.cdlib.org/findaid/ark:/13030/tf3p3003vc/dsc/?query=kornberg;dsc.position=1#hitN**

um1URL:
http://www.oac.cdlib.org/findaid/ark:/13030/tf3p3003vc/dsc/?query=kornberg;dsc.position=1#hitNum1

16.4.25.15 Guide to the Hardin B. Jones Papers, 1937-1978

Partial List of Correspondents

Kornberg , Arthur, 1918- Letter, Sept. 28, 1962

URL:
http://www.oac.cdlib.org/findaid/ark:/13030/tf9n39p0k0/dsc/?query=kornberg;dsc.position=1#hitNum1

16.4.25.16 Guide to the Gunther S. Stent Papers, 1915-1998

Series 1: Personal And Professional Correspondence, 1946-1998folder 49 Kornberg, Arthur 1959-1963

Series 9: Reprints By Others, 1915-1996.folder 19 Kornberg, Arthur 1958-1967

URL:
http://www.oac.cdlib.org/findaid/ark:/13030/ft509nb1mh/dsc/?query=kornberg;dsc.position=1#hitNum2

16.4.25.17 Guide to the San Francisco News-Call Bulletin Newspaper Photograph Archive, ca. 1915-1965

Part 3, General File (1951-1965)

1959 Nobel Prize winner biochemist Arthur Kornberg [03-00-60, 6 negatives] URL: http://www.oac.cdlib.org/findaid/ark:/13030/tf338n99v6/dsc/?query=kornberg;dsc.position=55001;#hitNum1

16.4.25.18 Finding Aid to the Fang family San Francisco examiner photograph archive negative files, circa 1930-2000

Box 1301 Nobel prize winner Dr. Arthur
http://www.oac.cdlib.org/view?style=oac4;view=dsc;docId=hb6t1nb85b;query=kornberg;dsc.position=1;#hitNum0

Figure 2 previous hit

[136046, 1 sleeve].

URL: http://www.oac.cdlib.org/findaid/ark:/13030/hb6t1nb85b/?query=kornberg

16.4.25.19 Daniel Koshland

Finding Aid to the Daniel E. Koshland , Jr. papers, circa 1949-2007 (bulk 1965-2007)

URL: http://www.oac.cdlib.org/findaid/ark:/13030/c82z171h/?query=koshland

16.4.25.20 Allan C. Wilson

Allan Wilson Papers, 1953-1998, bulk 1962-1991

URL: http://www.oac.cdlib.org/findaid/ark:/13030/kt958035w4/dsc/?query=genome;dsc.position=1#hitNum1

16.4.25.21 Ignacio Tinoco

Guide to the Photographs of University of California, Berkeley

URL: http://www.oac.cdlib.org/findaid/ark:/13030/kt4s201924/dsc/?query=Tinoco;dsc.position=2501#hitNum1

Type of resource	University Archives
Connections	http://bancroft.berkeley.edu/collections/uarc.html
Actual People Connected	Gamow, George Kornberg, Arthur Koshland, Daniel Tinoco, Ignacio Wilson, Allan C.

16.4.26 University of California, Irvine/Archives

16.4.26.1 UCI Communications photographs, AS-061

Images of John Wasmuth

21 S01278 10/01/1990 10/01/1990 Faculty/Staff Faculty Professor John Wasmuth in science lab. 20 35mm CS

21 S01279 10/01/1990 10/01/1990 Faculty/Staff Faculty Professor John Wasmuth in science lab. 20 35mm CS

21 S01280 10/01/1990 10/01/1990 Faculty/Staff Faculty Professor John Wasmuth in science lab. 20 35mm CS

21 S01281 10/01/1990 10/01/1990 Faculty/Staff Faculty Professor John Wasmuth in science lab. 15 35mm CS

21 S01282 08/01/1994 08/01/1994 Faculty/Staff Faculty; Press conferences Professor John Wasmuth at a press conference. 19 35mm CS

FB1 01/01/1990 01/01/1995 Faculty/Staff Faculty; Students Professor John Wasmuth in science lab, with students. (8 strips of 120 film)

94 A89 -027 01/01/1989 01/01/1989 Faculty

95 A89 -180 01/01/1989

95 A89 -18h 01/01/1989 01/01/1989 General

109 A90 -706 01/01/1990 01/01/1990

121 A94 -142 01/01/1994 01/01/

121 A94 -143 01/01/1994 01/01/1994 Campus Life Faculty; L

144 PS82k 01/01/1984 01/01/1987 Public Affairs Chancellors; Donors; Visitors; Faculty; Portraits; Awards;

157 PS170c 01/01/1985 01/01/1995 Individuals: Visitors/Donors Portraits; Visitors; Donors

URL: http://www.oac.cdlib.org/findaid/ark:/13030/c8tt4pp0/admin/?query=Wasmuth#hitNum1

16.4.26.2 Guide to the University of California, Irvine, University Communications Audio and Video Recordings AS.081

Box 1

Archival original AS-081-027-APhysical Description: 1.0 VHS videocassette.

John Wasmuth Segment from Cycle of Life program: DNA Blueprint for Life 1996 January 8

URL: http://www.oac.cdlib.org/findaid/ark:/13030/kt9r29s44j/dsc/?query=Wasmuth#ref8

Type of resource	University Archives
Connections	http://special.lib.uci.edu/
Actual People Connected	Wasmuth, John J.

16.4.27 University of California at San Diego (UCSD)/Archives

16.4.27.1 Francis Crick Personal Papers, 1938 - 2007 MSS 660

National Human Genome Research Institute, 2003

Box 8 Folder 4 Contains email and agendas regarding Crick's involvement in "Scientific Symposium: From Double Helix to Human Sequence - and Beyond," and "Bringing the Genome to You."URL:http://libraries.ucsd.edu/speccoll/findingaids/mss0660.htmlNote: This collection has many important scientists related to HGP

16.4.27.2 Russell Doolittle Biochemistry Laboratory Records, 1971 - 1998 MSS 77

The records (1971-1998) of Dr. Russell F. Doolittle's biochemistry laboratory at the University of California, San Diego include notebooks related to the first determination of the complete sequence of amino acids in the human fibrinogen molecule, paper files for the amino acid sequences contained in the protein sequence data bank called NEWAT, as well as other research, correspondence and Protein Society files.

URL: http://libraries.ucsd.edu/speccoll/findingaids/mss0077.html

16.4.27.3 Frieman, Edward A. Papers, 1959-2000

The Collection includes biographical files, notes, manuscripts of scientific papers and speeches, correspondence, computations, photographs, subject files and other material documenting the career of Dr. Frieman. The collection includes research files documenting Frieman's years at Princeton University Plasma Physics Laboratory and manuscripts for two unfinished books on plasma physics. The collection includes a scrapbook, calendars and other material documenting Frieman's service as Director of Energy Research at the U.S. Department of Energy, 1979-1981. The collection includes files documenting Frieman's years as a science administrator and vice president at Science Applications International Corporation, 1981-1999. The collection includes files documenting his career as a faculty member at the University of California, San Diego, and especially his work on committees of the National Academy of Sciences and his work as vice-chair of the White House Science Council, 1982-1989. The collection documents Frieman's work on numerous committees concerned with climate change, the Superconducting Super Collider and the NASA Earth Observing System. The collection is particularly strong in documenting science policy in the U.S. government during the period 1979-1999, especially in the area of physics, geophysics, energy, and oceanography.

URL: http://libraries.ucsd.edu/speccoll/findingaids/Frieman96-07.pdf

16.4.27.4 Marguerite Vogt Collection, 1925 - 2001 MSS 688

The collection includes correspondence with colleagues and friends and family photograph albums. In addition, the folders include miscellaneous biographical materials and audio-cassette tape interviews with Marguerite Vogt, Marthe Vogt and Martin Haas.

Ted Friedmann Box: 3 Folder: 13

URL: http://libraries.ucsd.edu/speccoll/findingaids/mss0688.html

Type of resource	University Archives
Connections	http://libraries.ucsd.edu/collections/sca/collections/ucsd-archives.html
Actual People Connected	Crick, Francis Doolittle, Russell Frieman, Edward A.

16.4.28 University of California Los Angeles (UCLA) School of Medicine/Archives

Interview of Lynn Cooley

URL: http://digital2.library.ucla.edu/viewItem.do?ark=21198/zz0008zsc0

Type of resource	Medical School Library
Connections	http://www.library.ucla.edu/biomed
Actual People Connecated	Cooley, Lynn

16.4.29 University of California San Francisco (UCSF)/Archives

16.4.29.1 Bruce M. Alberts Papers, 1960-94, MSS 94-56:

URL: http://www.oac.cdlib.org/findaid/ark:/13030/tf6q2nb557/

16.4.29.2 William J. Rutter Papers, MSS 94-54:

URL: http://www.oac.cdlib.org/findaid/ark:/13030/tf5k40083c/

16.4.29.3 Keith R. Yamamoto papers, 1975-2001, MSS 2002-16:

URL: http://ucsfcat.library.ucsf.edu/record=b2126039~S0

16.4.29.4 Harold E. Varmus Papers, 1975-1987, bulk 1983-1987, MSS 88-47:

URL: http://www.oac.cdlib.org/findaid/ark:/13030/kt4n39q9j2/

16.4.29.5 Harold E. Varmus Papers, 1971-1987, bulk 1974-1980, MSS 84-25:

URL:http://www.oac.cdlib.org/findaid/ark:/13030/kt4f59q9k8/

16.4.29.6 Harold E. Varmus Papers, 1967-1993, bulk 1983-1993, MSS 93-51:

URL: http://www.oac.cdlib.org/findaid/ark:/13030/kt767nd39m/

16.4.29.7 J. Michael Bishop Papers, MSS 2007-21 (this collection will be processed by the end of 2016):

URL: http://ucsfcat.library.ucsf.edu/record=b1894718~S0

16.4.29.8 Susan J. Fisher Papers (unprocessed, uncatalogued)

URL: http://profiles.ucsf.edu/susan.fisher

16.4.29.9 Walter Miller Papers (unprocessed, uncatalogued)

URL: http://profiles.ucsf.edu/walter.miller

16.4.29.10 Charles Epstein Papers (unprocessed, uncatalogued)

URL: https://www.ucsf.edu/news/2010/08/3359/down-syndrome-and-medical-genetics-leader-charles-epstein-lauded

16.4.29.11 Ira Herskowitz Papers (unprocessed, uncatalogued)

URL:https://www.ucsf.edu/news/2003/04/4772/world-renowned-geneticist-ucsf-dies

16.4.29.12 Oral Histories with Dr. William J. Rutter,

URL:http://content.cdlib.org/ark:/13030/kt7q2nb2hm/

16.4.29.13 Oral History with Dr. Herbert Boyer,

URL: http://content.cdlib.org/ark:/13030/kt5d5nb0zs/

Type of resource	University Archives
Connections	https://www.library.ucsf.edu/collections/archives/ucsf
People Connected	Alberts, Bruce Bishop, J. Michael Boyer, Herbert Epstein, Charles Fisher, Susan J. Herskowitz, Ira Miller, Walter Rutter, William J. Varmus, Harold Yamamoto, Keith

16.4.30 University of California San Francisco (UCSF) School of Medicine/Archives

16.4.30.1 Register of the William J. Rutter Papers

Series V -- Travel: Conferences, Seminars, Meetings, RetreatsCarton Cartons 9-10 Folder 42

Stanford Human Genome Project -- Boon or Bane? --CA" Jan. 11-13, 1991

URL:http://www.oac.cdlib.org/findaid/ark:/13030/tf5k40083c/entire_text/?query=human%20genome%20project#hitNum1

16.4.30.2 Register of the Bruce M. Alberts Papers, 1960-94, n.d.

Series IV: Professional Activities 1976-93, n.d.Carton 8 Folder 20

National Science Foundation -- Robert Mullan Cook-Deegan [Humane Genome Project] 1990-91

URL:
http://www.oac.cdlib.org/findaid/ark:/13030/tf6q2nb557/entire_text/?query=human%20genome%20project#hitNum1

Type of resource	University Archives
Connections	https://www.library.ucsf.edu/collections/archives
People Connected	Rutter, William J. Alberts, Bruce

16.4.31 University of California Santa Cruz (UCSC)/Archives

16.4.31.1 Carol Foote photographs

16.4.31.2 Robert Edgar

Box 1 Book 1 Date/Job Title 78-06 Biology Board.: Robert Edgar, Jack Davis, Victor Rocha

Box 1 Book 1 Date/Job Title 78-07 Biology Board.: Victor Rocha, Robert Edgar, Harry Noller, equipment

16.4.31.3 Robert Ludwig

http://digitalcollections.ucsc.edu/cdm/singleitem/collection/p265101coll25/id/4013/rec/5

http://digitalcollections.ucsc.edu/cdm/singleitem/collection/p265101coll25/id/4012/rec/4

http://digitalcollections.ucsc.edu/cdm/singleitem/collection/p265101coll25/id/11130/rec/6

http://digitalcollections.ucsc.edu/cdm/singleitem/collection/p265101coll25/id/10606/rec/7

Type of resource	University Archives
Connections	http://guides.library.ucsc.edu/speccoll/
People Connected	Edgar, Robert

16.4.32 University of Cambridge/Cambridge University/Archives

Type of resource	University Archives
Connections	Ashburner, Michael Bobrow, Martin Darwin, Charles Ferguson-Smith, Malcolm Fortey, Richard Hawking, Stephen Perutz, MaxSanger, Frederick
External Links	http://www.lib.cam.ac.uk/deptserv/manuscripts/

16.4.33 University of Cambridge Laboratory of Molecular Biology/Archives

Type of resource	Institutional Archives
Connections	http://www2.mrc-lmb.cam.ac.uk/about-lmb/archive-and-alumni/

16.4.34 Human Genome Project

16.4.34.1 Guide to the University of Chicago MacLean Center for Clinical Medical Ethics Records 1961-2009

Box 130 Folder 5

National Bioethics Advisory Commission drafts and National Human Genome Research Institute guidebook, 1999

Box 66 Folder 15

Ethical, Legal, and Social Implications Program National Center for Human Genome Research, 1990-1991

URL: http://www.lib.uchicago.edu/e/scrc/findingaids/view.php?eadid=ICU.SPCL.MACLEANCTR&q=genome

Type of resource	University Archives
Connections	http://www.lib.uchicago.edu/e/scrc/collections/archives/

16.4.35 Guide to the David Hawkins Papers, 1863-2001

"The Spirit of Play. A memoir for Stan Ulam," *Los Alamos Science Special Issue* (1987), pp.39- Box 6 Folder 2

"Theory of Multiplicative Processes. I,"—with S. Ulam, Los Alamos, November 14, 1944 Box 6 Folder 2

DH, "The Spirit of Play: A Memoir for Stan Ulam," *Los Alamos Science Special Issue* (1987), pp.39- Box 13 Folder 7

Analogies Between Analogies: The Mathematical Reports of S.M. Ulam and His Los Alamos Collaborators (Berkeley: University of California Press, 1990 Box 13 Folder 7

Correspondence, n.d. Box 13 Folder 7

"On Recursively Defined Geometrical Objects and Patterns of Growth," *Los Alamos Scientific Laboratory. Report LA-3762*, August 15, 1967—with R.G. Schrandt Box 13 Folder 7 Mathematical calculations

"Guess a Number—with Lying" or "20 questions with some lying answers allowed"—correspondence in 1984 of Dr. Solomon W. Golomb and Stan Ulam. This problem originated with DH. Box 17 Folder 10

URL: http://rmoa.unm.edu/docviewer.php?docId=cou2hawkins.xml

Type of resource	University Archives
Connections	http://ucblibraries.colorado.edu/archives/
People Connected	Ulam, Stanislaw

16.4.36 Audiovisual Records of the College of Medicine Lecture Series, 1972-1998

Box 1 Folder 162 Francis S. Collins, M.D. PhD, "The Human Genome Project and the Future of Medicine"

URL: http://aspace.lib.uiowa.edu/repositories/3/resources/1204

Type of resource	University Archives
Connections Possible People Connected	http://www.lib.uiowa.edu/sc/archives/ Murray, Jeffrey

16.4.37 Chair of Developmental Biology (Faculty of Biological Sciences), Joint Committee, 1998-1999

URL: http://library.leeds.ac.uk/special-collections-explore/11217/chair_of_developmental_biology_faculty_of_biologi?query=handyside%2C%20alan&resultOffset=1

Type of resource	University Archives
Connections	http://library.leeds.ac.uk/special-collections
Actual People Connected	Handyside, Alan

16.4.38 University of Michigan/Archives

16.4.38.1 Bentley Historical Library

16.4.38.2 Human Gene Therapy Initiative records, 1988-1992. URL: http://quod.lib.umich.edu/cgi/f/findaid/findaid-idx?c=bhlead&idno=umich-bhl-9426

16.4.38.3 Papers of John Dingell:

1955-2015, approximately 550 linear feet. The papers of John Dingell are not yet processed or available to researchers. These papers are expected to be opened to the public in 2017 after they have been processed by the congressional records archivist.

16.4.38.4 News and Information Services (University of Michigan) Faculty and Staff Files 1944-2005 (bulk 1960-1995)

Box 38 Eisenberg, Rebecca

Box 95 Neil, James V.

URL: http://quod.lib.umich.edu/b/bhlead/umich-bhl-2009097?byte=9110545;focusrgn=frontmatter;rgn=Entire+Finding+Aid;size=25;sort=occur;start=1;subview=standard;type=simple;view=reslist;q1=Eisenberg%2C+Rebecca

16.4.38.5 Dept. of Human Genetics University of Michigan Records, 1937-1977

Series: Institute of Human Biology, 1941-1956

Subject: James Neel

URL: http://quod.lib.umich.edu/b/bhlead/umich-bhl-0184?rgn=Entire+Finding+Aid;view=text;q1=Neel%2C+James+V.

16.4.38.6 BMC Media Services records, 1951-2003

Series: Faculty and Staff Portraits

Box 6: Neel, James V. Human Genetics, 1961, 1968, 1970, 1975, 1999

URL: http://quod.lib.umich.edu/b/bhlead/umich-bhl-93851?byte=83895203;focusrgn=frontmatter;rgn=Entire+Finding+Aid;size=25;sort=occur;start=1;subview=standard;type=simple;view=reslist;q1=Neel%2C+James+V.

16.4.38.7 Library (University of Michigan) Clipping File ca 1920-1980

Box 21 James v. Neel

URL: http://quod.lib.umich.edu/b/bhlead/umich-bhl-87237?byte=105302089;focusrgn=frontmatter;rgn=Entire+Finding+Aid;size=25;sort=occur;start=1;subview=standard;type=simple;view=reslist;q1=Neel%2C+James+V.

16.4.38.8 The Michigan Daily Record 1950-1995

Series: Faculty, Staff, and Administrators - Biographical Files

Box 16:

16.4.38.9 The University of Michigan Assorted Publications ca. 1920-2014 (bulk 1970s-1990s) URL: http://quod.lib.umich.edu/b/bhlead/umich-bhl-0715?byte=189740037;focusrgn=C02;rgn=Entire+Finding+Aid;type=simple;view=text;q1=human+genome Alumni Association (University of Michigan) records, 1859-1998

16.4.38.10 " The Human Genome Project and the Future of Medicine, #190, 11/24/1992". URL: http://quod.lib.umich.edu/b/bhlead/umich-bhl-8730?byte=106496169;focusrgn=C01;rgn=Entire+Finding+Aid;sort=occur;type=simple;view=text;q1=human+genome+project Office of the Vice-President for Research (University of Michigan) records 1950-2010 Box 102 "Human Genome Project, 1990 URL: http://quod.lib.umich.edu/b/bhlead/umich-bhl-87258?byte=53178797;focusrgn=C02;rgn=Entire+Finding+Aid;sort=occur;type=simple;view=text;q1=human+genome+project

Type of resource	University Archives
Connections	http://bentley.umich.edu/
Actual People Connected	Dingell, John Eisenberg, Rebecca Neel, James V.

16.4.39 University of Notre Dame/Archives

16.4.39.1 Ralph M. McInerny Papers, 1943-2010

AMCN 31455 *CB* : Lecture 5: Martinez Hewlett - Biotechnology and the Human Genome Project 1998

AMCN 32301 *VH* : Martinez Hewlett - Biotechnology and Human Genome Project; Issues in Modern Biology 1998

URL: http://archives.nd.edu/findaids/ead/xml/mcn.xml

16.4.39.2 Satellite Theological Education Program: Records

ASTP 37648 *DVL* : Maura Ryan: Human Genome Project and the Option for the Poor Lecture 2004/0630

URL: http://archives.nd.edu/cgi-bin/display.pl?STP001.HTM+16

Type of resource	University Archives
Connections Possible People connected:	http://archives.nd.edu/ Dovichi, Norman

16.4.40 J. Newell Stannard Papers MS.2020

Series V: Source Materials, 1948-1989, undated

Box 7 Folder 24 Human Genome Project

URL:
http://dlc.lib.utk.edu/spc/view?docId=ead/0012_002437_000000_0000/0012_002437_000000_0000.xml;query=human%20genome%20project;brand=default

Type of resource	University Archives
People Connected	Stannard, J. Newell

16.4.41 University of Utah/Archives

16.4.41.1 William R. and Erlyn Gould Distinguished Lecture on Technology and the Quality of Life Series Video Recordings, 1992-2006

URL:
http://archiveswest.orbiscascade.org/ark:/80444/xv22717/op=context.aspx?t=k&q=human+genome+project

16.4.41.2 Duane E. Jeffrey Papers, 1814-2011

Series 3: Research Materials, 1814-2011

Box 110 Folder 5 Genome Evolution, 1985

Box 110 Folder 6 Genome General 1997-2000

Box 110 Folder 7 Genome, Human 1986-2001

Box 110, Folder 8 Genome Project 1990-2000

Box 110 Folder 9 Genome Sequence 1997

Box 110 Folder 10 Genomics Imprinting 1989-1998

Box 110 Folder 11 Genomics 1997-1998

URL: http://archiveswest.orbiscascade.org/ark:/80444/xv27096

16.4.41.3 Tom Korologos Papers, 1955-2003

Series: Documents, 1956-1996

Human Genome Project and Patenting Human DNA Sequences Carton 1 Folder 62

URL:http://archiveswest.orbiscascade.org/ark:/80444/xv68914/op=fstyle.aspx?t=k&q=human+genome+project

16.4.41.4 University of Utah Archives photograph collection circa 1890-1989

Gesteland, Raymond (5 Items, Biology

Skolnick, Mark - (3 Items), Biophysics

16.4.41.5 University of Utah Historical Faculty Files

Rechsteiner, Martin - (2) items, Biology

Type of resource	University Archives

Connections Possible People connected	Capecchi, Mario Lalouel, Jean-Marc Francine Stirling
Actual People Connected	Gesteland, Ray Jeffrey, Duane Korologos, Tom Rechsteiner, Martin Skolnick, Mark

16.4.42 University of Wisconsin - Madison/Archives

16.4.42.1 Helen Willa Samuels Papers, 1940-2004

Series: 4. Correspondence and Subject Files, 1972-2004 Human Genome Project, 1990-1994 Box 15 Folder 11Series: 4. Correspondence and Subject Files, 1972-2004 Human Genome Project, 1994 Box 17 Folder 28

Series: 4. Correspondence and Subject Files, 1972-2004 Human Genome Project, Georgetown, 1990 Box 17 Folder 29
URL: http://digital.library.wisc.edu/1711.dl/wiarchives.uw-mil-uwmmss0255

16.4.42.2 David R. Obey Papers, 1962-2010

Series: Staff Files Human Genome Box 573 Folder 10Series: Staff Files Human Genome Project Box 595 Folders 11-19, Box 596 Folders 1-6 URL: http://digital.library.wisc.edu/1711.dl/wiarchives.uw-whs-stpt00bz

Type of resource	University Archives
Actual People Connected	Helen Willa Samuels David R. Obey

16.4.43 Vanderbilt University Historical Images and Biographies

Max Delbrück Biographical File

URL: http://www.mc.vanderbilt.edu/diglib/sc_diglib/archColl/455.html

Type of resource	University Archives
Connections	http://www.library.vanderbilt.edu/speccol/ Delbrück, Max

16.4.44 University Archives University Records Washington University Photographic Services Collection, 1850-2006

Series 4: Photographs of People Affiliated with the University Box S-2 Folder 11: Schlessinger, David

Note: University Archives/Medical Archives

Type of resource	University Archives

Actual People Connected	Weinstock, George

16.4.45 Washington University School of Medicine/Archives

16.4.45.1 University Archives University Records Office of Public Affairs, Assembly Series Lectures, 1949-2012

Series 5: Assembly Series Lectures, 1990-1999 Folder 283: ASL97-16 Item 1: Living With the Human Genome Project, September 3, 1997

16.4.45.2 Washington University Photographic Services Collection, 1850-2006

Series 4: Photographs of People Affiliated with the University Box K-3 Folder 34: Kornberg, Prof. Arthur

16.4.45.3 University Archives University Records Office of Public Affairs, Biographical Faculty Files, circa 1920-present

Box K6 Folder 5: Kornberg, Arthur

Type of resource	University Archives
Actual People Connected	Kornberg, Arthur

16.4.46 Yale University/Archives

16.4.46.1 Richard Erdos

Guide to the Richard Erdoes Papers,

URL: http://hdl.handle.net/10079/fa/beinecke.erdoesK

16.4.46.2 Guide to the Office of Cooperative Research, Yale University, Records

Guide to the Office of Cooperative Research, Yale University, Records,

URL: http://hdl.handle.net/10079/fa/mssa.ru.08

16.4.46.3 Arthur William Galston

Guide to the Arthur William Galston Papers,

URL: http://hdl.handle.net/10079/fa/mssa.ms.1712

Type of resource	University Archives
Connections	http://web.library.yale.edu/mssa
Actual People Connected	Erdos, Richard Galston, Arthur William

16.5 Other Archival Collections

16.5.1 American Museum of Natural History (AMNH)/Archives

Type of resource	Museum Archives
Connections	Tattersall, Ian http://www.amnh.org/content/search?SearchText=tattersall

16.5.2 Chemical Heritage Foundation (CHF)/Archives

16.5.2.1 Howard B. Bishop Collection, 1885-1963

Includes personal and business correspondence, company documents, reports, patents, photographs, and a small number of artifacts.

16.5.2.2 Paul J. Flory Collection, 1931-1984

Includes correspondence and working papers related to Flory's published articles. Also contains research notes, course lectures, and source material for texts.

16.5.2.3 Laurence E. Strong Collection, 1941-1967

Includes reports from Strong's tenure at the Department of Physical Chemistry of the Harvard Medical School as well as working papers for an improved high-school chemistry curriculum, titled "Chemical Bond Approach."

Type of resource	Library/Museum/Archives
Connections	http://www.chemheritage.org/ Bishop, Howard B. Flory, Paul J. Strong, Laurence E.

16.5.3 Richard Fortey Papers (1976-2000)

Contains: Notes relating to the first cladistic analysis of Burgess Shale, Briggs and Fortey, Science, 1984 International Symposium on the Relationships of Major Arthropod Groups, Programme and Abstracts, Apr 1996 Richard Fortey's drawings, mostly for Fortey and Chatterton, Palaeontology, 1988 Photographic originals used in 'Trilobite! Eyewitness to Evolution', 2000 Original analyses of Fortey and Mellish, Terra Nova, 1992 Richard Fortey's drawings for Ontogeny, Palaeontology, 1990 Watercolours and drawings relating to Fortey, Paläontologische Zeitschrift, 1986 Photograph of 'smiley faces' taken through the lens of the trilobite Phacps, published in Science, 1973 Interview with Fortey from The Independent, 4 Dec 1993 Original figure drawn for Pflagic Trilobites, Earth and Environmental Science Transactions of The Royal Society if Edinburgh, 1976

Type of resource	Museum Library/Archives
Connections	http://www.nhm.ac.uk/our-science/departments-and-staff/library-and-archives.html Fortey, Richard

16.5.4 Rational Optimist/Archives

Type of resource	Professional Website
Related Material	Matt Ridley's book: *Genome: The Autobiography of a Species in 23 Chapters* Abstract:The human genome, the complete set of genes in 23 pairs of chromosomes, is nothing less than an autobiography of our species. Spelled out in a billion three-letter words using the four-letter alphabet of DNA, the genome has been edited, abridged, altered and added to as it has been handed down, generation to generation, over more than three billion years. This generation is the first to read this extraordinary book, and to gain hitherto unimaginable insights into what it means to be alive, to be human, to be conscious or to be ill. By picking one newly discovered gene from each of the 23 human chromosomes, and telling its story, Matt Ridley recounts the history of our species and its ancestors from the dawn of life to the brink of future medicine.
Connections	http://www.mattridley.co.uk/ Ridley, Matt

16.5.5 Oswald T. Avery papers, Rockefeller University Faculty (1913-1955)

This collection of papers of about 2½ linear feet consists primarily of memorabilia (honorary capes; medals; musical instrument) which was given to the Rockefeller University Archives by Dr. Avery's sister-in-law. It includes a small amount of administrative correspondence, photographs, bibliography and complete collection of reprints, many obituary articles and several articles about DNA. Includes photocopy of letter (1943) from Avery to his brother, Roy C. Avery, detailing his work on the transforming nature of DNA.

Type of resource	Archives
Connections	http://dimes.rockarch.org/xtf/search Avery, Oswald T.

17 APPENDICES

17.1 Acronyms

- AAAS— American Association for the Advancement of Science (AAAS)
- AAHC— Association of Academic Health Centers
- AAMC— Association of American Medical Colleges
- ABC— Association of Biotechnology Companies
- ABCC— Atomic Bomb Casualty Commission
- ACLI— American Council of Life Insurers
- ADA— Americans with Disabilities Act
- AEC— Atomic Energy Commission
- AFM— Association Francaise contre les Myopathies
- ANL— Argonne National Laboratory
- APA— American Psychiatric Association
- ASBMB— American Society for Biochemistry and Molecular Biology
- ASHG— American Society of Human Genetics
- ASLME— American Society of Law, Medicine, and Ethics
- ASM— American Society for Microbiology
- BA— British Association for the Advancement of Science
- BAC— Bacterial Artificial Chromosomes
- BBN— Bolt, Beranek & Newman (BBN)
- BEAC— Biomedical Ethics Advisory Committee
- CDC— Centers for Disease Control
- CEPH— Centre d'Etude du Polymorphisme Humaine
- CODIS— Combined DNA Index System of FBI
- CRG— Council for Responsible Genetics
- CSHL— Cold Spring Harbor Laboratory
- CSSP— Council of Scientific Society Presidents
- DCSWA— D.C. Science Writers Association
- DNA— Deoxyribonucleic acid
- DOD— U.S. Department of Defense
- DOE— U.S. Department of Energy
- EBI— European Bioinformatics Institute
- EC— European Community

- EEOC— Equal Employment Opportunity Commission
- ELSI— Ethical, legal, and social implications
- EMBO— European Molecular Biology Organization
- ENCODE— ENCODE Project: Encyclopedia Of DNA Elements
- EPO— European Patent Office
- ERDA— Energy Research and Development Administration
- ESF— European Science Foundation
- EST— Expressed Sequence Tags
- EU— European Union
- FBI— Federal Bureau of Investigation (FBI)
- FDA— Food and Drug Administration (FDA)
- FY— Federal fiscal year (October 1 to September 30)
- GBF— German Research Centre for Biotechnology
- GINA— Genetic Information Nondiscrimination Act
- GIP— Groupement d'Interet Public Genopole
- GRAIL (acronym)— Gene Recognition and Analysis Internet Link
- HeLa— HeLa Cell
- HERAC— Health and Environmental Research Advisory Committee
- HEW— U.S. Department of Health, Education, and Welfare
- HGI— Human Genome Initiative
- HGM— Human Gene Mapping
- HGP— Human Genome Project; Human Genome Program
- HGSC— Human Genome Steering Committee
- HHMI— Howard Hughes Medical Institute
- HHS— U.S. Department of Health and Human Services
- HIAA— Health Insurance Association of America
- HUGO— Human Genome Organization
- IBA— Industrial Biotechnology Association
- ICPEMC— International Commission for Protection Against Environmental Mutagens and Carcinogens
- ICRF— Imperial Cancer Research Fund
- IMAGE— Integrated Molecular Analysis of Gene Expression
- IOM— Institute of Medicine
- JCVI— J. Craig Venter Institute
- JCVSF— J. Craig Venter Science Foundation
- JGI— Joint Genome Institute
- Kb— *kilobase*
- LANL— Los Alamos National Laboratory
- LBNL— Lawrence Berkeley National Laboratory

- LLNL— Lawrence Livermore National Laboratory
- LMB— Laboratory of Molecular Biology, Cambridge
- Mb— mega base pairs
- MESC— Monbusho (Ministry of Education, Science, and Culture)
- MGP— Microbial Genome Project
- MIT— Massachusetts Institute of Technology
- MITI— Ministry of International Trade and Industry
- MOU— Memorandum of understanding
- MRC— Medical Research Council
- mRNA— Messenger ribonucleic acid; messenger RNA
- NAS— National Academy of Sciences
- NCHGR— National Center for Human Genome Research at National Institutes of Health (NIH)
- NCI— National Cancer Institute
- NHGRI— National Human Genome Research Institute at National Institutes of Health (NIH)
- NIAID— National Institute of Allergy and Infectious Diseases
- NIEHS— National Institute for Environmental Health Science
- NIGMS— National Institute of General Medical Sciences at National Institutes of Health (NIH)
- NIH— National Institutes of Health
- NIKKD— National Institute of Diabetes, Digestive and Kidney Diseases
- NINCDS— National Institute of Neurological and Communicative Disorders and Stroke
- NINDS— National Institute of Neurological Disorders and Stroke
- NLM— National Library of Medicine
- NRC— National Research Council
- NSABB— National Science Advisory Board for Biosecurity
- NSF— National Science Foundation
- OBER— Office of Biological and Environmental Research, U.S. Department of Energy (formerly Office of Health and Environmental Research)
- OHER— Office of Health and Environmental Research
- OMB— Office of Management and Budget
- OMIM— Online Mendelian Inheritance in Man
- ORNL— Oak Ridge National Laboratory
- OSRD— Office of Scientific Research and Development
- OTA— Office of Technology Assessment
- OTT— Office of Technology Transfer, NIH
- PCR— Polymerase chain reaction
- PE— Perkin-Elmer
- PI— Principal investigator
- PMC— Personalized Medicine Coalition

- PTO— Patent and Trademark Office
- R&D— Research and Development
- RCP— Royal College of Physicians
- RERF— Radiation Effects Research Foundation
- RFLP— Restriction Fragment Length Polymorphisms
- RPCI— Roswell Park Cancer Institute
- SBH— Sequencing by hybridization
- SEC— Securities and Exchange Commission, U.S.
- SNP— Single Nucleotide Polymorphisms
- STA— Science and Technology Agency
- STS— Sequence-Tagged Sites
- SUNY— State University of New York
- TCAG— The Center for the Advancement of Genomics; The Genome Action Coalition
- TIGR— The Institute for Genomic Research
- UCLA— University of California, Los Angeles
- UCSC— University of California, Santa Cruz
- UCSD— University of California, San Diego
- UCSF— University of California, San Francisco
- UNESCO— United Nations Educational, Scientific, and Cultural Organization
- WHO— World Health Organization
- WHOI— Woods Hole Oceanographic Institution
- YAC— Yeast Artificial Chromosomes

17.2 Terminology

17.2.1 Arabidopsis thaliana

Arabidopsis thaliana, thale cress, mouse-ear cress or arabidopsis is a small flowering plant native to Eurasia. A. thaliana is edible by humans and, as with other mustard greens, is used in salads or sautéed, like many species in the Brassicacea. A. thaliana is considered a weed; it is found by roadsides and in disturbed lands. A winter annual with a relatively short life cycle, Arabidopsis is a popular model organism in plant biology and genetics.

17.2.2 Assembly

Assembly refers to aligning and merging fragments from a longer DNA sequence in order to reconstruct the original sequence. This is needed as DNA sequencing technology cannot read whole genomes in one go, but rather reads small pieces of between 20 and 30000 bases, depending on the technology used.

17.2.3 Automated sequencing

Automated sequencing refers to the technique that was invented by Leroy Hood and Lloyd M. Smith and introduced by the Applied Biosystems Model 370A DNA Sequencing System in 1987. This sequencer utilized the Sanger sequencing method and a then-novel fluorescent labeling technique which enabled all four dideoxynucleotides to be identified in a single lane simultaneously. This technology formed the basis of the “first generation” of DNA sequencers and enabled the completion of the Human Genome Proj

17.2.4 BAC library

A BAC library is a series of Bacterial Artificial Chromosomes (BACs) grouped together to store fragments of target DNA to create a "library" containing the target genome.

17.2.5 Bacterial artificial chromosome (BAC)

A Bacterial Artificial Chromosome (BAC) is a DNA construct, based on a functional fertility plasmid (or F-plasmid), used for transforming and cloning in bacteria, usually E. coli. BACs are often used to sequence the genomes of organisms in genome projects, such as in the Human Genome Project.

17.2.6 Bacteriophage

A bacteriophage (also known simply as a phage) is a bacterial virus, that is, a virus that targets and infects bacterial cells. Bacteriophages have been important to molecular biology. During the field's early years, phages were used as a model organism in order to study basic biological processes such as DNA replication.

17.2.7 Base

A base is a single unit of DNA, composed of one of the four nucleotides that make up the molecule.

17.2.8 Behavioral genetics

Behavioral genetics is the study of of the genetic basis of behavioral traits. This field must tease apart the impact of both genetic and environmental influences. Common approaches include twin and adoption studies. Despite considerable technological progress, the genetic influences in most complex behavioral traits are still difficult to pin down.

17.2.9 Bioinformatics

Bioinformatics is a subfield of biology that focuses on analyzing biological data sets.

17.2.10 Biosecurity

Biosecurity refers to procedures designed to protect humans or animals against biological threats or agents.

17.2.11 Biotechnology

Biotechnology is an industry that arose from the genetic engineering revolution of the 1970s focusing largely on drug development. Biotech companies were initially focused on monoclonal antibodies rather than small-molecule drugs, but lines have since blurred.

17.2.12 Caenorhabditis elegans (C. elegans)

C. elegans is a small worm (specifically a nematode) whose size and simplicity have made it a popular model organism for several decades.

17.2.13 Cancer virus

A cancer virus is any virus that can cause cancer by inducing tumor growth. It is also known as a tumor virus or oncovirus.

17.2.14 Capillary DNA sequencer

A capillary DNA sequencer uses capillary electrophoresis as its method of sequencing. The DNA goes through a very thin fiber called a capillary, which separates the molecule by size. The development of capillary DNA sequencing represented an improvement over older, gel-based sequencing processes, significantly increasing the speed of the work.

17.2.15 Capillary electrophoresis (method)

Capillary electrophoresis is an efficient method by which large molecules such as DNA are separated by size, aiding in their analysis. For DNA sequencing, the fluorescently tagged molecule is fed through a long, thin capillary and separated using a conducting medium and and electric field. Capillary electrophoresis is an improvement upon earlier methods of gel electrophoresis, which were slower and required much more manual work from researchers.

17.2.16 Carcinogen

A carcinogen is any substance or agent that has the potential to cause cancer.

17.2.17 Centimorgan (cM)

A centimorgan (also written "centiMorgan" and abbreviated "cM") is a unit of genetic recombination, named in honor of the Drosophila geneticist Thomas Hunt Morgan. It is not a set physical distance, as it is a measurement of recombinant frequency. One centimorgan, however, is on average about 1 million base pairs.

17.2.18 Chromosome

Chromosomes are the threadlike packages containing DNA that are inside all living cells.

17.2.19 Chromosome map

A chromosome map is a map of the position of genes on an individual chromosome. It is typically the prelude to determining the complete sequence of that chromosome.

17.2.20 Chromosome mapping (method)

Chromosome mapping is the process of finding the position or location of specific genes on a chromosome.

17.2.21 Chromosome paint

Chromosome paint is a fluorescent probe used to distinguish and identify individual chromosome in in situ hybridization experiments.

17.2.22 Chromosome sequencing

Chromosome sequencing is the determination of the full nucleotide sequence of an individual chromosome. The Human Genome Project could therefore be divided into 24 discrete chapters, as the draft sequence of each human chromosome was published.

17.2.23 Cloning (glossary)

Cloning is the isolation of a particular DNA sequence and the replication of it using vectors and recombinant DNA methods.

17.2.24 Comma-free code

A comma-free code was an early, elegant but flawed model for the genetic code proposed in the mid-1950s by Francis Crick.

17.2.25 Commercial instrument

Commercial instruments are those tools manufactured and distributed by for-profit companies. Although technology often has its roots in academic labs, commercial companies play a vital role in developing, improving, and optimizing those technologies. The Human Genome Project was only made possible through the participation of such firms and the use of their products.

17.2.26 Communicative disorder

A communicative disorder is any disorder that affects a person's ability to communicate with others, either because of partial or full impairment of the ability to speak, hear, or process language and speech information.

17.2.27 Complementary deoxyribonucleic acid (cDNA)

Complementary DNA is a DNA strand that is artificially created from a strand of messenger RNA. Complementary DNA is a key tool in cloning genes.

17.2.28 Complementary DNA (cDNA) probe

A cDNA probe is a probe (i.e. a fragment of DNA) consisting of the DNA copy of an active, transcribed gene.

17.2.29 Complete sequence

A complete sequence is the full, entire sequence of a gene, chromosome, or genome. Determining the complete sequence of a chromosome or genome is hampered by repetitive DNA, heterochromatin and structures such as centromeres.

17.2.30 Deoxyribonucleic acid (DNA)

DNA is the molecule that encodes all organisms' genetic "blueprint."

17.2.31 Designer baby

A designer baby is the concept of a child that has been selected for desirable traits. The concept raises important ethical concerns about eugenics and the future of genetic screening and personalized medicine.

17.2.32 DNA chip

The DNA chip, also known as a DNA microarray, was developed in the 1990s to measure gene expression and variation.

17.2.33 DNA clone

A DNA clone is an isolated fragment of DNA propagated in a vector such as a plasmid or artificial chromosome.

17.2.34 DNA clone (cosmid) library

A DNA clone library is a collection of fragments of DNA used to

17.2.35 DNA fingerprinting

DNA fingerprinting was discovered by SIr Alec Jeffreys (Leicester, UK) in 1983 and published in 1984. It is the use of repetitive DNA elements to provide a genetic "fingerprint." It began to be used in criminal cases and transformed forensic science and also paternity cases.

17.2.36 DNA forensics

DNA forensics refers to the use of DNA as a forensic tool. This was made possible by the discovery of DNA fingerprinting.

17.2.37 DNA methylation

DNA methylation refers to the presence of methyl groups on the DNA molecule. Methyl groups modify the expression of genes and the function of DNA in general.

17.2.38 DNA sequencing instrument

These are lab instruments used to determine the sequence of nucleotides in a DNA strand. The first commercial automated DNA sequencing machine was produced by Applied Biosystems in 1986. Subsequent machines provided the technology for the Human Genome Project.

17.2.39 Double helix

The double helix is the "winding staircase" structure of DNA, discovered by James Watson and Francis Crick in 1953.

17.2.40 Draft sequence

A draft sequence refers to a "rough draft" of a complete genome sequence that needs more work for refinement and accuracy. The draft sequence of the human genome was completed in 2001, two years before the final sequence was published.

17.2.41 Epigenome

The epigenome is a genomic map of epigenetic modifications.

17.2.42 EST (expressed sequence tag) strategy

The use of expressed sequence tags, or fragments of active genes, was championed by J. Craig Venter and colleagues as a rapid means to acquire sequence information on the most important regions of the human genome. The strategy was published in Science (Adams et. al.) in 1991.

17.2.43 Ethical, legal, and social implications (ELSI)

ELSI refers to the study of the possible effects of genetics and genomics research on individuals, communities, and broader society. It was an important component of the Human Genome Project: inaugural director James Watson authorized 3% of HGP funds be directed to the study of ethical, legal, and social issues (ELSI) surrounding genome mapping and screening.

17.2.44 Expressed gene

An expressed gene is a gene that is actively switched on in certain tissues and/or stages of development.

17.2.45 Expressed sequence tag (EST)

EST (expressed sequence tag) was a term coined by J. Craig Venter, Mark Adams and colleagues at the NIH in a landmark 1991 article in Science. As originally defined, an EST was a cDNA fragment selected at random and partially sequenced, prior to searching for sequence homologues in GenBank.

17.2.46 Fetal tissue transplantation

Fetal tissue transplantation is an experimental procedure in which fetal tissue could produce chemicals to treat neurological diseases including Huntington's, Parkinson's, and Alzheimer's.

17.2.47 Fluorescent chain-terminating dideoxynucleotide

The development of fluorescent dideoxynucleotides was a crucial step in the launch of automated capillary electrophoresis, which greatly accelerated the pace of genome sequencing in the latter stages of the Human Genome Project.

17.2.48 Free availability of human genome sequence

A key principle of the public Human Genome Project was the free deposition of data into the public domain every 24 hours.

17.2.49 Free-living organism

A free-living organism is any organism that is able to live on its own and is not dependent on another organism for survival.

17.2.50 Fugu rubripes (pufferfish)

Fugu is a species of pufferfish. The sequencing of the Fugu genome was completed and published in 2002. Its small genome is useful as a reference for finding genes and studying other aspects of genomics.

17.2.51 Functional element

The International ENCODE Project concluded that large tracts of the human genome possessed some biochemical or functional activity.

17.2.52 Functional genomics (discipline)

Functional genomics is a term that arose midway through the Human Genome Project that addressed the need to assay and identify the functional properties of the gene catalogue.

17.2.53 Gene

A gene is a distinct section of DNA that represents the code or "instructions" for a specific protein product. Genes are composed of specific sequences of bases (nucleotides) of varying length.

17.2.54 Gene/genome mapping

Gene/genome mapping is determining the chromosomal location of genes, through either physical or genetic approaches.

17.2.55 Gene-based designer drug

Identification of disease genes gives hope to rationally designed drugs. Gleevec, which counters the BRC-ABL gene fusion in leukemia, is a good example. Gene therapy is showing signs of promise after a major setback in the Gelsinger case.

17.2.56 Gene count

Analysis of the reference genome revealed that human possess about 20,000 genes. This is far fewer than the oft-quoted 100,000 estimate that was widely used until the draft sequence came into view.

17.2.57 Gene expression

Gene expression is the pattern of gene regulation and activity, which varies by cell type and at different stages of development. The advent of DNA microarrays provided a huge leap in our understanding of gene expression in development and diseases such as cancer.

17.2.58 Gene patent

Newly isolated genes were widely patented by biotech companies and non-profit organizations throughout the 1990s, often stirring controversy. A high-profile lawsuit filed by the American Civil Liberties Union against diagnostics company Myriad Genetics led to the U.S. Supreme Court's overturning gene patents in 2013.

17.2.59 Genetic code

The genetic code refers to the rules that determine which codons (triplet sequences of nucleotides) code for which proteins in DNA.

17.2.60 Genetic linkage map

A genetic linkage map shows the position of genes on a chromosome based on their recombination frequency. This is done by identifying close association or linkage to random polymorphic markers of known chromosomal location.

17.2.61 Genetic mapping

Genetic mapping is a method of building a recombination map of DNA markers by performing systematic linkage studies of genes and random polymorphic DNA markers.

17.2.62 Genetics

Genetics is the branch of biology that studies genes, genetic information, and heredity.

17.2.63 Genetic screening

Genetic screening refers to the analysis of human DNA for medical purposes, especially in testing for genetic features or mutations that may bring about disease.

17.2.64 Genome

A genome is the total genetic material of an organism.

17.2.65 Genome maintenance

Genome maintenance refers to biological mechanisms and processes that preserve the genome's integrity. These include mechanisms for preventing cancer like DNA repair and cell division cycle control.

17.2.66 Genome project

A genome project is the research effort to sequence the entire DNA of any organism.

17.2.67 Genomics

Genomics is the study of whole genomes. This includes sequencing and mapping as well as analysis of their structure and function.

17.2.68 Germline

Germline refers to cells that pass the genetic information from generation to generation.

17.2.69 Haemophilus influenzae (glossary)

Heamophilus influenzae is a bacterium that was the first free-living organism to have its genome sequenced. The sequence was published in 1995 and demonstrated the viability of the then-new whole-genome shotgun sequencing method.

17.2.70 HeLa (definition)

HeLa is the cancer cell line derived from the African-American woman Henrietta Lacks (also known by the pseudonym Helen Lane) without her knowledge in the 1950s. It is now the most widely used cancer cell line in research.

17.2.71 Heritable mutations

Heritable mutations are mutations that are passed down from generation to generation, rather than acquired spontaneously or somatically.

17.2.72 High throughput biology

The term "high throughput" refers to using automation to conduct large numbers of experiments and therefore produce large quantities of data. For instance, in drug discovery, high-throughput screening means the use of automation to assess the biological activity of many different compounds. High-throughput sequencing refers to sequencing large amounts of DNA in short amounts of time.

17.2.73 Hybridization

Hybridization is a method by which complementary DNA strands can anneal together. It is a critical component of gene mapping, linkage mapping, and DNA amplification through the polymerase chain reaction.

17.2.74 Informatics

Informatics is the computational analysis of information. It includes sub-specialties such as bioinformatics and cheminformatics.

17.2.75 Junk DNA (glossary)

Junk DNA is the nickname given to DNA that does not code for proteins. The term "junk" was used for many years to imply the DNA had no function; now, many scientists believe it may serve to regulate the coding regions.

17.2.76 Marker

A marker is a genetic landmark representing a specific location on a chromosome. Markers in the Human Genome Project were typically polymorphic DNA sequences such as RFLPs and STSs.

17.2.77 Marker spacing

Marker spacing is the interval between adjacent DNA markers. The shorter the average distance between markers, the higher the resolution of the genetic map.

17.2.78 Megabase (Mb)

A megabase (Mb) is a unit of measurement for DNA length. It is equal to 1 million bases or nucleotides.

17.2.79 Mendelian inheritance

Mendelian inheritance refers to genes or traits that follow the rules of classical genetics, established by Gregor Mendel in the 1860s.

17.2.80 Messenger RNA (mRNA)

Messenger RNA is the intermediary molecule on which the DNA code is "transcribed" and then brought from the cell nucleus to the ribosome for protein synthesis.

17.2.81 Microarray

A microarray is a genetic profiling technique used to analyze gene expression – that is, which genes are turned on and which are turned off.

17.2.82 Microbial genome

A microbial genome is a bacterial genome sequence. The first was sequenced and published in 1995 by J. Craig Venter and colleagues at The Institute for Genomic Research (TIGR).

17.2.83 Microbiome

The microbiome is the collection of microbial life in a particular ecosystem. This could refer to a location or a part of the human body, such as the gut microbiome or the skin microbiome. It is a rapidly growing aspect of genomic research, given growing evidence of the sheer volume of microbes that live in and on humans and their positive and negative role in human health.

17.2.84 Mitochondrial DNA

Mitochondrial DNA is DNA found within a cell's mitochondria. Mitochondria take the energy from food and make it usable to the cell.

17.2.85 Model organism

A model organism is a relatively simple organism scientists study to understand biological processes in more complex living things.

17.2.86 Molecular biology (discipline)

Molecular biology is the study of biology and biological processes at the molecular level by examining the structure and function of essential molecules such as DNA and RNA.

17.2.87 Molecular genetics

Molecular genetics is a term referring to the modern study of genetics at the molecular level. The term is redundant since there is no field of contemporary research using a non-molecular approach to genetics.

17.2.88 Moore's Law

In technology, Moore's Law refers to the doubling of the number of transistors on integrated circuits every two or so years, pointing to the increasing complexity of computer processors. The law's logic has been applied to molecular biology both in the analysis of the complexity of life and in the area of genome sequencing. For instance, as sequencing technology has become "miniaturized" (that is, as the working parts of automated sequencers have shrunk) the process has become cheaper.

17.2.89 Mouse genetics

Mouse genetics is the study of genetics in inbred strains of mice, providing crucial discoveries and understanding of genetic phenomena. The mouse is an important model organism, with close genetic similarilty to humans but significant advantages in the ability to cross, develop inbred strains, etc. The mouse genome was mapped and sequenced in parallel with the human genome.

17.2.90 Mutagen

A mutagen is any compound that causes mutations in DNA.

17.2.91 Naturally occurring DNA

Naturally occurring DNA is DNA that occurs in nature, as opposed to that which is synthesized or assembled artificially.

17.2.92 Next-generation sequencing (definition)

Next-generation sequencing refers to methods of DNA sequencing developed in the early 2000s that replaced Sanger sequencing for high-throughput genome sequencing. This was commercially developed by companies like Solexa, 454 Life Sciences, and Pacific Biosciences.

17.2.93 Oncogene

An oncogene is a gene that has the potential to convert normal cells into cancerous ones.

17.2.94 Personal genome

Personal genome is a term for the partial or full sequencing and analysis of individual genomes, made possible by rapid advances in DNA sequencing technology. The first published personal genomes were those of J. Craig Venter and James Watson in 2007-08.

17.2.95 Personalized medicine

Personalized medicine is an approach to medicine that seeks to individualize a patient's treatment based on his or her genetic information.

17.2.96 Phenome

The phenome is the set of all observable properties of an organism.

17.2.97 Physical map

A physical map is a structural map of genes and other DNA landmarks using physical mapping techniques, such as fluorescence in situ hybridization or radiation hybrid mapping, in contrast to genetic mapping approaches.

17.2.98 Plant genome

A plant genome is the total genetic material of a plant. Arabidopsis thaliana was the first model plant organism to be sequenced. The rice genome is perhaps the best known and arguably the most important plant genome sequenced to date.

17.2.99 Polymerase

Polymerase is an enzyme used to synthesize polymers, specifically chains of nucleic acids such as DNA and RNA. DNA polymerases specifically create DNA molecules and are an essential tool of molecular biology.

17.2.100 Polymerase chain reaction (PCR) (method)

Polymerase chain reaction is a revolutionary laboratory technique in which a piece of DNA can be amplified many times over, creating thousands or even millions of copies.

17.2.101 Population-scale sequencing

Population-scale sequencing is the ability to sequence large communities, or even entire populations or countries, thanks to the plummeting price of next-generation sequencing.

17.2.102 Positional cloning

Positional cloning refers to a method for identifying genes, especially disease genes.

17.2.103 Post-genomic world

Post-genomic world is a disputed term sometimes used to refer to the era of biology and medicine following the completion of the Human Genome Project. Some argue, however, that this is merely the genomic era.

17.2.104 Prenatal genetic testing

Prenatal genetic testing is genetic screening and testing before birth. Screening is increasingly being performed non-invasively using new methods to detect small quantities of fetal DNA in the maternal blood.

17.2.105 Protein sequencing (glossary)

Protein sequencing is the process of determination the sequence of amino acids that compose a protein molecule.

17.2.106 Pulsed field electrophoresis

Pulsed field electrophoresis was an important gel-based method developed by Charles Cantor and colleagues to separate large fragments of DNA. It was widely used in the early phase of the Human Genome Project.

17.2.107 Recombinant DNA

Recombinant DNA is DNA molecules formed by the splicing together of genetic material from different sources.

17.2.108 Regulatory region

A regulatory region is a section of the genome that contains sequences (such as promoters) that regulate the activity of genes. These genes may be adjacent to the regulatory region or far removed.

17.2.109 Research and development (R&D)

Research and development, or R&D, is the collective term for basic and applied research, as used in corporate and government organizations.

17.2.110 Restriction fragment length polymorphism (RFLP)

A restriction fragment length polymorphism (RFLP) is a DNA fragment produced by restriction enzymes that differs in length across genetically related organisms. As a technique, they are used in the diagnosis of hereditary disorders.

17.2.111 Sanger chain termination method, DNA sequencing

The Sanger method is a manual DNA sequencing method. It was developed by Frederick Sanger and published in 1977. It was one of the earliest sequencing methods devised and soon became the standard in the field.

17.2.112 Sequence-tagged site (STS)

A sequence-tagged site (STS) refers to a short DNA sequence that can be easily located and amplified using the polymerase chain reaction (PCR) laboratory technique. The purpose of an STS is to serve as a genetic marker when mapping. They supplanted the use of restriction fragment length polymorphisms (RFLPs) during the Human Genome Project.

17.2.113 Sequencing

Sequencing refers to the process of determining the sequence of nucleotide bases in a DNA strand.

17.2.114 Sequencing dye

Sequencing dyes are dyes, typically fluorescent, that are used to track DNA nucleotides and fragments in sequencing methodologies.

17.2.115 Sequencing strategy

A sequencing strategy is the choice of sequencing system, platform or approach used for a project. For de novo genome sequencing, shotgun sequencing strategies have become almost ubiquitous since the conclusion of the Human Genome Project.

17.2.116 Single nucleotide polymorphism (SNP)

A single nucleotide polymorphism is a point of variation among DNA sequences in which the difference is one nucleotide base.

17.2.117 Somatic cell hybridization

Somatic cell hybridization is a classic method used to map genes using somatic cell hybrids containing varying compositions of human chromosomes on a mouse background.

17.2.118 Structural variation

Structural variation refers to a tier of genetic variation in humans and other organisms involving deletions, duplications and rearrangements of variably sized segments of DNA. Structural variation impacts the copy number of scores of genes, and growing evidence points to the role of structural variation in many genetic disorders. It is also known as copy number variation.

17.2.119 Synthetic biology

Synthetic biology refers to a 21st century version of genetic engineering. Specifically, it is the ability to synthesize long stretches of DNA and to cut and paste DNA modules to engineer new functions and properties into cells and organisms.

17.2.120 Systems biology

Systems biology is a conceptual approach to the study of biology that stresses viewing biological phenomena as part of a larger picture. Specifically it is the computational analysis of complex biological systems, whether molecules, cells, organs, or entire organisms.

17.2.121 Technology transfer

Technology transfer is the process by which products, devices, and technologies developed in universities or non-profit laboratories is licensed and commercialized.

17.2.122 Telomere

A telomere is a DNA fragment that serves as the "tip" or "cap" at the ends of a chromosome. They are made of a repeating sequence of DNA and are responsible for protecting the chromosome's physical integrity.

17.2.123 Therapeutics

Therapeutics refers to drugs and treatments and their delivery to patients.

17.2.124 Thermostable polymerase

Thermostable polymerase is a heat-stable form of DNA polymerase crucial to the commercial development of polymerase chain reaction (PCR).

17.2.125 Transcriptional regulation

Transcriptional regulation is the regulation of gene activation and RNA transcription by a variety of protein transcription factors, in addition to epigenetic modifications.

17.2.126 Transposon

A transposon, also known as a transposable element, is a small segment of DNA that can transpose, or change position within the genome.

17.2.127 Tumor virus

A tumor virus is any virus that is associated with cellular transformation and cancer.

17.2.128 Vector

Vectors are vehicles used to isolate, propagate and transfer DNA, for example in cloning experiments or in clinical settings using gene therapy.

17.2.129 Viral genome

A viral genome is the total genetic material of a virus. The first genome ever sequence, completed by Fred Sanger and colleagues in the late 1970s, was that of the virus PhiX174.

17.2.130 Whole-genome shotgun method (method)

Whole-genome shotgun sequencing is a sequencing method in which DNA is randomly broken up into smaller pieces, which are sequenced and reassembled by using computer algorithms to look for overlapping regions.

17.2.131 X-ray crystallography

X-ray crystallography is a method of studying the structure of crystals and molecules by measuring the scattering of X-rays through the structure (i.e. X-ray diffraction). Rosalind Franklin's historic Photograph 51, an X-ray of the B form of DNA, was created using the X-ray crystallography method; this was an essential resource in the elucidation of the double helix by James Watson and Francis Crick in 1953.

17.2.132 Y chromosome

The Y chromosome is the male chromosome in humans. It contains only a few dozen functional genes.

17.2.133 Yeast artificial chromosome (YAC)

Yeast artificial chromosomes are chromosomes that have been genetically engineered from yeast DNA. They are an important vehicle for cloning long segments of DNA.

18 INDEX

18.1

End of Book.