Instructional Framework

Bioscience

41.0100.00

This Instructional Framework identifies, explains, and expands the content of the standards/measurement criteria, and, as well, guides the development of multiple-choice items for the Technical Skills Assessment. This document corresponds with the Technical Standards endorsed in July 2021.

Domain 1: Essential Lab Skills **Instructional Time: 30 – 40%**	
STANDARD 7.0 DEMONSTRATE BASIC LAB SKILLS IN THE USE OF EQUIPMENT AND INSTRUMENTATION	

7.1 Use software for scientific analyses and documentation (e.g., spreadsheet, presentation, and word processing)	• Scientific analyses and documentation
	  ○ Spreadsheet
	  ○ Presentation
	  ○ Word processing

7.2 Identify and demonstrate proper use of laboratory glassware	• Proper use of laboratory glassware
	  ○ Beaker
	  ○ Graduated cylinder
	  ○ Flask

7.3 Identify and demonstrate proper use of laboratory balances	• Proper use of laboratory balances ○ Analytical balances
7.4 Identify and demonstrate proper use of micropipettes	• Proper use of micropipettes
7.5 Identify and demonstrate proper use of spectrophotometers, including creating a standard curve relating absorbance and concentration	• Proper use of spectrophotometers, including creating a standard curve
7.6 Identify, balance, and operate centrifuges	• Balance centrifuge • Operate centrifuge

7.7 Describe the purpose of and how to operate an autoclave	• Autoclave
	  ○ Purpose
	  ○ Operation

7.8 Describe the purpose of and how to operate fume and laminar flow hoods	● Purpose and operation ○ Fume hood ○ Laminar flow hoods
7.9 Prepare microscopic specimens and interpret results using appropriate microscopes (i.e., dissecting, compound, digital, etc.)	● Microscopic specimens ○ Prepare ○ Interpret results ● Microscope selection ○ Dissecting ○ Compound ○ Digital
7.10 Identify and demonstrate proper use of hot plate/stirrers	● Proper use of hot plate/stirrers
7.11 Identify and demonstrate proper use of incubators, including shaking incubators	● Proper use of incubators ● Proper use of shaking incubators
7.12 Identify and demonstrate proper use of water baths and heat blocks	● Proper use of water baths ● Proper use of heat blocks
7.13 Use a pH meter and explain the logarithmic nature of the pH scale	● Proper use of pH meter ● Logarithmic nature of the pH scale
STANDARD 10.0 DEMONSTRATE MATERIAL PREPARATION AND STORAGE	
10.1 Calculate and prepare solutions and buffers (e.g., mass/volume, %, molarity, and pH)	● Calculate and prepare solutions and buffers ○ Mass/volume ○ % ○ Molarity ○ pH ● Dimensional analysis, conversion factors
10.2 Calculate and prepare dilutions, including serial dilutions	● Calculate and prepare dilutions ○ C1V1=C2V2 ○ Serial dilution
10.3 Calculate the molar mass of a given compound using a Periodic Table of Elements	● Molar mass of a given compound using a Periodic Table of Elements

10.4 Label and store solutions and buffers (e.g., ingredients, preparer's initials, dates, concentration, lots, storage conditions, sterility, hazards, and special directions)	● Label and store solutions and buffers ○ Ingredients ○ Preparer's initials ○ Dates ○ Concentration ○ Lots ○ Storage conditions ○ Sterility ○ Hazards ○ Special directions
10.5 Use scientific sources to find appropriate solution preparation protocols	● Scientific sources to find appropriate solution preparation protocols
10.6 Explain the control inventory process for materials and supplies	● Control inventory process for materials and supplies
STANDARD 13.0 DEMONSTRATE SCIENTIFIC MEASURE	
13.1 Perform calculations and solve problems using scientific notation	● Perform calculations ● Solve problems using scientific notations
13.2 Utilize appropriate SI (International System of Units) base units and prefixes for all measurements (e.g., milli, micro, and nano)	● Utilize appropriate SI (International System of Units) base units ● SI Prefixes for all measurements ○ Milli ○ Micro ○ Nano
13.3 Construct, interpret, and apply graphs using software tools (e.g., spreadsheets)	● Construct, interpret, and apply graphs using software tools ○ Spreadsheets
13.4 Calculate appropriate statistics (e.g., mean, median, mode, range, standard deviation, and linear regression)	● Calculate appropriate statistics ○ Mean ○ Median ○ Mode ○ Range ○ Standard deviation ○ Linear regression

Domain 2: Applied Lab Skills **Instructional Time: 25 – 35%**	
STANDARD 6.0 EXAMINE THE ROLE OF LIVING ORGANISMS IN BIOSCIENCE RESEARCH	
6.1 Discuss the benefits, limitations, and ethics of using model organisms and cell lines in research (e.g., C. elegans, Arabidopsis, fruit flies, yeast, E. coli, mice, and, as well, HeLa and CHO cells)	● Benefits, limitations, and ethics of using model organisms and cell lines ○ C. elegans ○ Arabidopsis ○ Fruit flies ○ Yeast ○ E. coli ○ Mice ○ HeLa and CHO cells
6.2 Compare and contrast standards of practice for treatment, care, maintenance, and propagation of different living organisms (i.e., invertebrate, vertebrate, cell lines, etc.)	● Standards of practice for different living organisms ○ Treatment ○ Care ○ Maintenance ○ Propagation ● Living Organism ○ Invertebrate ○ Vertebrate ○ Cell lines
STANDARD 8.0 DEMONSTRATE MICROBIOLOGY SKILLS	
8.1 Demonstrate sterile technique (i.e., maintain lab and equipment hygiene, etc.)	● Sterile technique ○ Maintain lab and equipment hygiene
8.2 Identify, prepare, sterilize, dispense, and store culture media	● Culture media ○ Prepare ○ Sterilize ○ Store
8.3 Identify, propagate, and quantify microorganisms and cells	● Propagate microorganisms and cells ● Quantify microorganisms and cells

8.4 Identify techniques for short- and long-term cultures (e.g., stabs, slants, liquid nitrogen, and glycerol stocks)	● Short-term culture techniques ○ Stabs ○ Slants ● Long-term cultures techniques ○ Liquid nitrogen ○ Glycerol stocks
8.5 Isolate, maintain, and store pure cultures	● Pure cultures ○ Isolate ○ Maintain ○ Store
8.6 Transform and maintain bacteria (e.g., E. coli)	● Transform E. coli ● Maintain E. coli culture
8.7 Decontaminate and dispose of equipment, glassware, and biologicals, including disinfection with 0.5% sodium hypochlorite solution and sterilization using the autoclave	● Decontaminate and dispose equipment, glassware, and biologicals ○ 0.5% sodium hypochlorite solution ○ Sterilization via autoclave
8.8 Identify bacteria types (i.e., gram staining, catalase activity, DNA sequencing)	● Identify bacteria types ○ Gram staining ○ Catalase activity ○ DNA sequencing
STANDARD 9.0 DEMONSTRATE PROTEIN TECHNIQUES	
9.1 Compare and contrast methods to detect proteins (e.g., Western Blot, ELISA, and immunohistochemical methods)	● Compare and contrast methods to detect proteins ○ Western Blot ○ ELISA ○ Immunohistochemical methods
9.2 Extract proteins	● Extract proteins
9.3 Separate and characterize proteins (e.g., column chromatography and SDS-PAGE)	● Separate and characterize proteins ○ Column chromatography ○ SDS-PAGE ● Characterize proteins via structure

9.4 Perform protein assays and compare to protein standards (i.e., Bradford and Lowry methods, etc.)	• Protein assays and compare to protein standard
	  ○ Bradford method
	  ○ Lowry method

STANDARD 12.0 DEMONSTRATE NUCLEIC ACID TECHNIQUES	
12.1 Explain the structure of DNA (e.g., DNA miniprep/plasmid and genomic DNA)	• DNA structure • DNA miniprep/plasmid • Genomic DNA • DNA extraction and purification • Linear vs. Circular (plasmids and mitochondrial)
12.2 Perform and analyze restriction digests	• Specificity of restriction enzymes • Identification of restriction sites and their relationship to the number of bands and the size of bands
12.3 Perform and explain gel electrophoresis (e.g., electrolysis, buffer selection and preparation, and gel concentration preparation)	• Electrolysis • Buffer selection, concentration, and preparation • Gel concentration preparation • Differentiate between horizontal and vertical gel electrophoresis and how to choose (DNA/RNA vs. Protein) • Choice and calculation of gel concentration anode vs. cathode end of box • Choosing a voltage
12.4 Identify and troubleshoot common gel electrophoresis errors (e.g., punctured well during loading, overloaded well, nuclease contamination, and poor separation of bands)	• Punctured well during loading reduced by not inserting tip too far down • Overloaded well reduced by loading over 15uL • Nuclease contamination reduced by aseptic technique • Poor separation of bands reduced by longer runs at lower voltage

12.5 Describe DNA sequencing methods, including Sanger and next-generation sequencing, and compare the advantages and disadvantages of each method	• Compare sequencing methods
	  ○ Sanger
	  ○ Next generation

12.6 Compare and contrast PCR method to the cellular process of DNA replication	• Stages of PCR • Types of enzymes utilized in DNA replication

12.7 Optimize and perform PCR protocols	● Thermocycler set up ● Optimized cycles ○ Number ○ Temperature ○ Time
12.8 Perform basic molecular biology techniques. (e.g., cloning, gene expression, and protein production)	● Molecular biology techniques ○ Cloning ○ Gene expression ○ Protein production
12.9 Explain gene structure and regulation (e.g., lac operon and trp operon, introns and exons, and alternative splicing)	● Gene structure and regulation ○ Lac operon and trp operon ○ Introns and exons ○ Alternative splicing
12.10 Design PCR primers	● Melting temperature ● GC clamp ● Self-complementary potential ○ Hairpin and primer dimer formation
12.11 Prepare a standard curve based on a DNA ladder to estimate DNA size	● Generate a standard curve on log graph paper from the migration distance of bands in standard ○ Based on migration distance of DNA bands in relation to ladder
Domain 3: Safety and Regulatory Practices **Instructional Time: 20 – 30%**	
STANDARD 1.0 MAINTAIN A SAFE WORK ENVIRONMENT	
1.1 Identify and wear appropriate lab attire and personal protective equipment (e.g., safety glasses or goggles, lab coat, gloves, and closed-toe shoes)	● Safety glasses or goggles ● Lab coat/apron ● Gloves ● Closed-toe shoes ● Hair tied back ● Face mask/face shield

1.2 Identify emergency contacts and practice emergency protocols (e.g., fire procedure, shower safety, eyewash practice, and evacuation procedure)	● Fire procedure ● Shower safety ● Eyewash practice ● Evacuation procedure ● Application of First Aid Kit ● Chemical Spill Kit
1.3 Identify and follow handling instructions/information and usage of chemicals as identified in the safety data sheets (SDSs)	● SDS ○ Document format ○ 16 sections ○ Location of resource
1.4 Identify and explain the importance of routine maintenance of equipment and reporting unsafe or nonfunctioning equipment	● Maintenance ○ Importance ○ Assess proper functionality before use ● Reporting procedures ○ Broken equipment
1.5 Maintain equipment log (i.e., eyewash, autoclave, laminar flow hood, etc.)	● Log components ○ Date ○ Service completed ○ Person responsible ○ Updated weekly or monthly as required ○ Example equipment: eyewash, autoclave, laminar flow hood
1.6 Identify biological, biohazardous, and chemical materials and explain appropriate handling (i.e., body fluids, ethidium bromide, sodium hypochlorite, etc.)	● Appropriate handling ○ Body fluids ○ Ethidium bromide ○ Sodium hypochlorite ○ E.coli
1.7 Identify and comply with safety signage and the significance of SDS symbols	● Pictograms ● Hazard classification and category ● Descriptors ● Regulatory agencies of safety signage ○ OSHA’s HCS (Hazard Communications Standard) ○ GHS (Globally Harmonized System) ○ NFPA Safety Diamond and colors

1.8 Distinguish the characteristics of biosafety levels (e.g., BSL-1 to BSL-4)	● BSL-1 to BSL-4 ○ Description ○ PPE ○ Pathogen type ○ Equipment
1.9 Identify standard operating procedures (SOPs) for monitoring, using, storing, and disposal of biological, biohazardous, and chemical materials	● Standard Operating Procedures (SOPs) ○ Procedural expectations for completing a task safely ○ Locate SOP resource for a particular task
1.10 Identify standard operating procedures (SOPs) for biological, biohazardous, and chemical spills, including broken glass	● Standard Operating Procedures (SOPs) ○ Procedural expectations for responding to a spill or broken glass ○ Locate SOP resource for a particular task
STANDARD 2.0 DEMONSTRATE STANDARD OPERATING PROCEDURE (SOPS) IN THE LABORATORY	
2.1 Discuss the importance of state, local, and industry regulations (i.e., EPA, FDA, OSHA, NIH, AZDEQ, etc.)	● Agencies ○ EPA ○ FDA ○ OSHA ○ NIH ○ AZDEQ
2.2 Set up, maintain, and practice lab documentation (research approaches and observations) according to standard operating procedures (SOPs) (e.g., paper and/or electronic notebook)	● Paper and/or electronic notebook ● Scientific inquiry process ○ Observations ○ Questions ○ Methods/procedures
2.3 Describe protocols for securing the integrity of samples and data	● Verification process ○ Signature in lab notebook ○ Follow SOPs
2.4 Explain the impact of social media and mobile communications technology on confidentiality, risks, and disclosures of information	● Social media and mobile communication impact ○ Confidentiality ○ Risk ○ Disclosure of information

2.5 Practice recording all research approaches and observations	● Paper and/or electronic notebook ● Scientific inquiry process ○ Observations ■ Consent for use of pictures and videos ○ Questions ○ Methods/procedures
STANDARD 3.0 DEMONSTRATE QUALITY CONTROL PROCEDURES	
3.1 Perform and document quality tests on reagents prepared or use in the lab to ensure reproducibility (i.e., pH, conductivity, spectrophotometry, etc.)	● Quality test on reagents and ensure reproducibility ○ Reagent tests ■ pH, conductivity, spectrophotometry
3.2 Describe manufacturing practices pertaining to quality control (e.g., standards and control chart ramifications)	● Manufacturing practices ○ Standards ○ Control chart ramifications ○ Quality control ■ CGMP
3.3 Demonstrate reproducibility from an SOP and characterize variation across samples (i.e., trend analysis)	● Reproducibility ○ Trend analysis
Domain 4: Research Practices **Instructional Time: 15 – 25%**	
STANDARD 4.0 DEMONSTRATE CRITICAL THINKING AND PROBLEM-SOLVING SKILLS	
4.1 Identify and access scientific and technical literature (i.e., patents, peer-reviewed articles, white papers, and technical bulletins), including databases (i.e., Google Scholar, PubMED), assess the scientific merit, and create a literature review)	● Scientific Merit and Literature Review ○ Patents ○ Peer-reviewed articles ○ White papers ○ Technical bulletins ○ Databases ■ Google Scholar ■ PubMed
4.2 Identify and use observational methods and skills (i.e., records, checklists, frequency count, work samples, etc.)	● Observational methods and skills ○ Records ○ Checklists

	○ Frequency count ○ Work samples
4.3 Design a research question with attention to relevant prior knowledge and develop a testable hypothesis	● Research question ○ Relevant/relate to prior knowledge ● Hypothesis ○ Testable
4.4 Design an experiment or a series of experiments based on prior research that is/are suitable to the hypothesis	● Gather prior research ● Create hypothesis ● Types of research
4.5 Test the hypothesis using appropriate experimental design (analytical and statistical), distinguishing between control and experimental variables	● Experimental design ○ Analytical ○ Statistical ● Experimental variable ○ Independent ○ Dependent ● Control variables ● Constants
4.6 Collect, record, and analyze data and analysis procedures	● Recording of data i.e., notes, observations, tables, data, facts, figures, evidence, etc. ● Analysis of data i.e., qualitative and quantitative
4.7 Develop conclusions based on evidence	● Conclusions based on evidence
4.8 Communicate results of scientific investigations in oral, written, digital, and graphical form using relevant technology and terminology	● Communicate results using relevant technology and terminology ○ Oral ○ Written ○ Digital ○ Graphical
STANDARD 5.0 DEMONSTRATE ETHICAL AND LEGAL CONDUCT	
5.1 Discuss codes of ethics and ethical protocols that apply to confidentiality and security in bioscience research, development, and manufacturing	● Codes of ethics and ethical protocols ○ Confidentiality and security in bioscience research, development, and manufacturing

	○ Integrity, Objectivity, Professional competence, and Behavior
5.2 Identify laboratory behaviors and practices that could result in liability, negligence, or loss of research integrity (i.e., sample manipulation, data omission/falsification, etc.)	● Sample manipulation ● Data omission/falsification
5.3 Examine implications of bioethical issues (e.g., the use of GMOs and the HeLa privacy issue)	● Implications of bioethical issues ○ Use of GMOs ■ Possible examples/implications • Food resilience • Impact on biodiversity • Consumers rights to know ○ HeLa privacy issue ■ Patient consent ■ Genetic privacy • Genetic databases
5.4 Apply risk management practices and policies to incident reporting	● Risk management practices and policies to incident reporting
5.5 Identify and comply with legal, regulatory, and accreditation standards or codes	● Identification and compilation ○ Legal ○ Regulatory ○ Accreditation standards or codes
5.6 Identify standards for harassment, labor, and employment laws (i.e., OSHA, ADA, DOL, USAGov, etc.)	● Standards ○ Harassment laws ○ Labor laws ■ Department of Labor (DOL) ■ Employment laws ■ OSHA ■ ADA ■ USAGov
5.7 Identify applicable intellectual property protections (e.g., patents, trademark protections, and copyrights)	● Intellectual Property Protections ○ Patents ○ Trademark protections ○ Copyrights ■ Trade Secret

5.8 Discuss privacy and protections of human subjects (i.e., HIPAA rules, IRB-regulated research protocols/informed consent, etc.)	● Privacy and protections of human subjects ○ HIPAA rules ○ Internal Review Board (IRB) -regulated research protocols/informed consent
5.9 Discuss regulations for the ethical treatment and use of living organisms	● Regulations for the ethical treatment and use of living ○ Justification for research ○ Proper care and housing for organisms
5.10 Apply ethical considerations to disclosure regulations (i.e., cancer and smoking research, Tuskegee experiments, etc.)	● Ethical considerations to disclosure regulations ○ Cancer and smoking research ○ Tuskegee experiments ■ Stem cell research
STANDARD 11.0 DEMONSTRATE THE USE OF BIOINFORMATIC RESOURCES	
11.1 Access and analyze gene and genome maps (i.e., FlyBase, NCBI, genome.org)	● Analyze gene and genome maps ○ FlyBase ○ NCBI ○ Genome.org
11.2 Access and evaluate protein structures in PDB (e.g., hemoglobin)	● Evaluate protein structures in Protein Database (PDB) ○ Hemoglobin
11.3 Use BLAST to identify and retrieve homologous/similar DNA or protein sequences from sequence databases (e.g., NCBI)	● Retrieve homologous/similar DNA or protein sequences from sequence databases ○ BLAST ○ NCBI
11.4 Explain the purpose of different BLAST searches including interpreting E-values and Scores (e.g., NCBI)	● Purpose, interpreting E-values and Scores ○ BLAST searches ○ NCBI
11.5 Use PCR primer sequences to perform database searches and determine the nature and size of expected PCR fragments (e.g., NCBI)	● PCR primer sequences to perform ○ Database searches ● Determine the nature and size of expected PCR fragments ○ Electronic PCR ■ NCBI

11.6 Use alignment tools to determine sequence relationships (i.e., DNA Subway, NCBI, MEGA, etc.)	• Determine sequence relationships utilizing alignment tools
	  ○ DNA Subway
	  ○ CBI
	  ○ NCBI
	  ○ MEGA, etc.

11.7 Identify and evaluate genetic variation (i.e., SNPs, inversions, translocations, copy number variations) (e.g., NCBI)	• Evaluate genetic variation
	  ○ SNPs
	  ○ Inversions
	  ○ Translocations,
	  ○ Copy number variations
	  ■ NCBI