1.2 ureides and nucleic acids

1.2.1 ureides classification - pyrimidines - thymine - uracil and cytosine - purine. Adenine and guanine - synthesis (structural elucidation not necessary).

What are ureides? Acyl derivatives of urea are called ureides and may be called acylureas. For example, urea react with acetyl chloride (or) acetic anhydride to give acetyl derivative of urea (acetyl urea). the ureide of acetic acid.

$$NH_2CONH_2 + CH_3COCl \longrightarrow CH_3CONHCONH_2 + HCl$$

urea — acetyl chloride — acetyl urea

These are compounds formed by condensation of urea with acids and contain the amide type (CO-NH) of linking:

Classification: ureides have been classified in two different ways

(i) Mono ureides
(ii) diureides

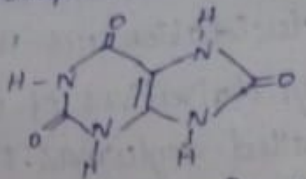
According to structure in depend - classified in two types

(i) cyclic ureides (or) closed chain ureides.
(ii) acyclic ureides (or) open chain ureides.

Mono ureides:

It containing one urea residue are termed as mono ureides. For example : $CH_3CONHCONH_2$
Acetyl urea.

Diureides:
It contain two urea residue are called as
For example:

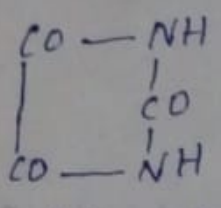


uric acid (diureide)

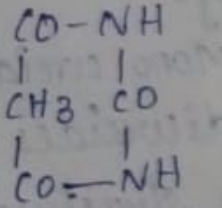
Acyclic ureide:
Acyclic ureide (or) open chain ureide if it has open chain structure that means a molecule has open chain structure

$CH_3CONHCONH_2$
acetyl urea (acyclic ureide)

Cyclic ureides:
A cyclic ureide if its molecule has a closed chain structure. For example



oxayl urea (or)
Parabanic acid

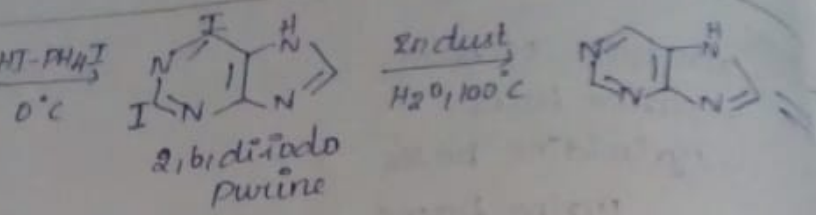


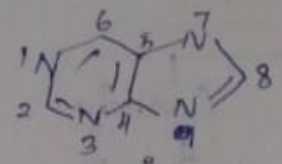
Malonyl urea (or)
barbituric acid

Preparation:

$CH_3COCl + NH_2CONH_2 \longrightarrow CH_3CONHCONH_2$

acetyl chloride — urea — acetyl urea.





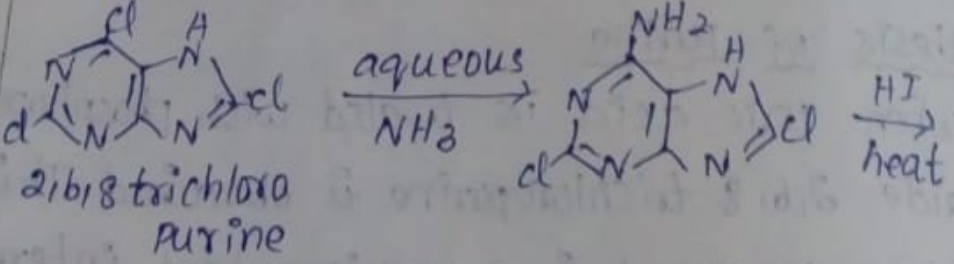
purine

catalytic reduction of trichloropurine (H_2-Pd + sodium acetate) gives purine.

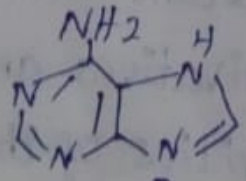
Adenine (6 amino purine)

This occurs in the pancreas of cattle and in extract. Its general reaction showed that adeni was a purine and its structure was established synthesis.

(i) Fischer

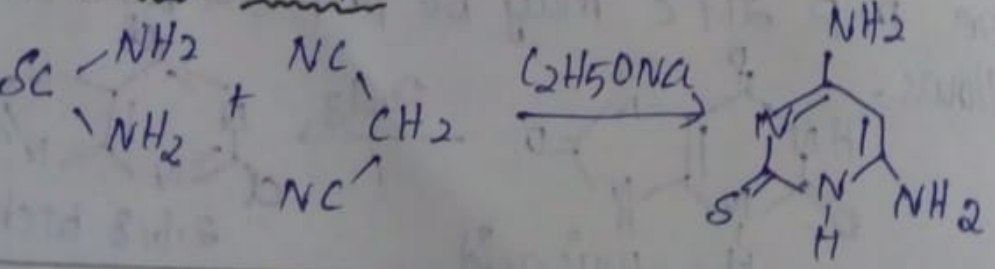


2,6,8 trichloro purine



adenine

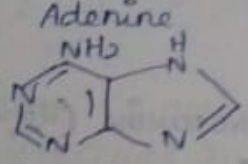
(ii) Traube (1904)



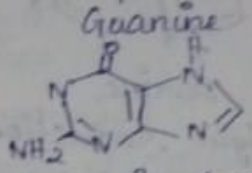
Bases:

Two types of bases
→ purine bases
→ Pyrimidine bases

Purine bases

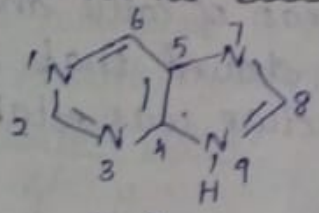


6-amino purine



2-amino 6-oxo purine

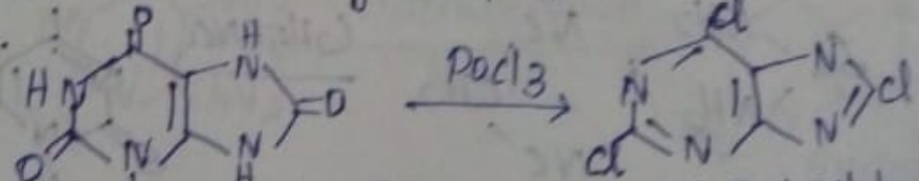
Structure of Purine



Purine

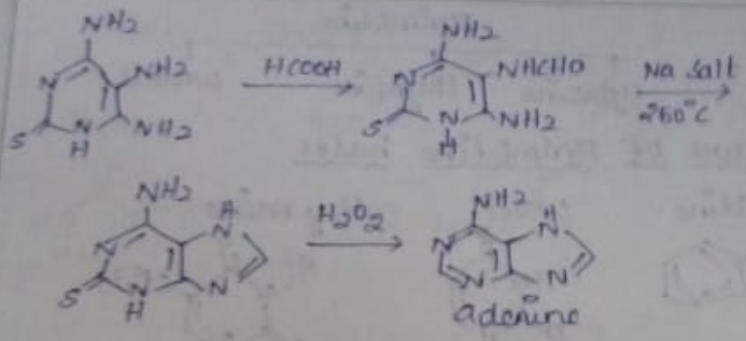
Synthesis of Purine

When uric acid is treated with phosphoxyl chloride 2,6,8 trichloropurine is obtained. This trichloro compound is a very important intermediate in the synthesis of purine derivatives and a point worth noting is that the reactivities of the chlorine atoms towards nucleophilic reagents are 6>2>8. Purine m.p 217°C may be prepared from uric acid as follows.



Uric acid

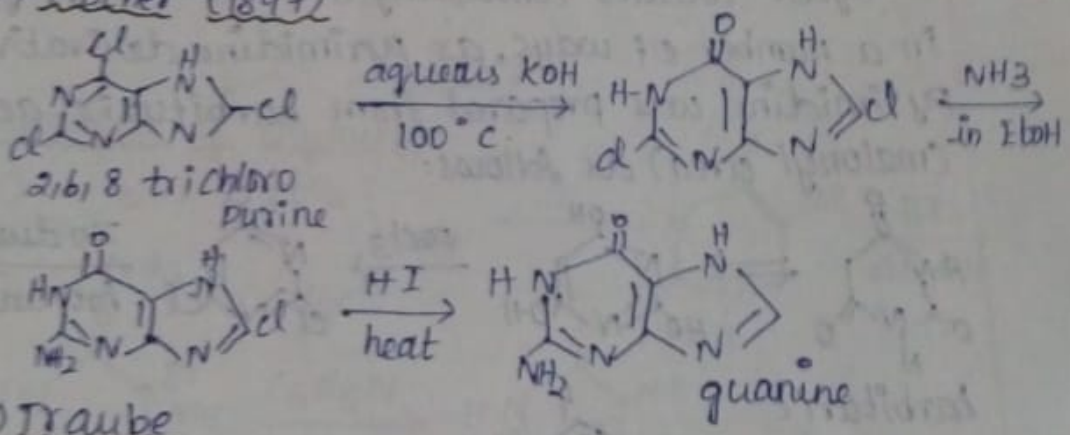
2,6,8 trichloro pur



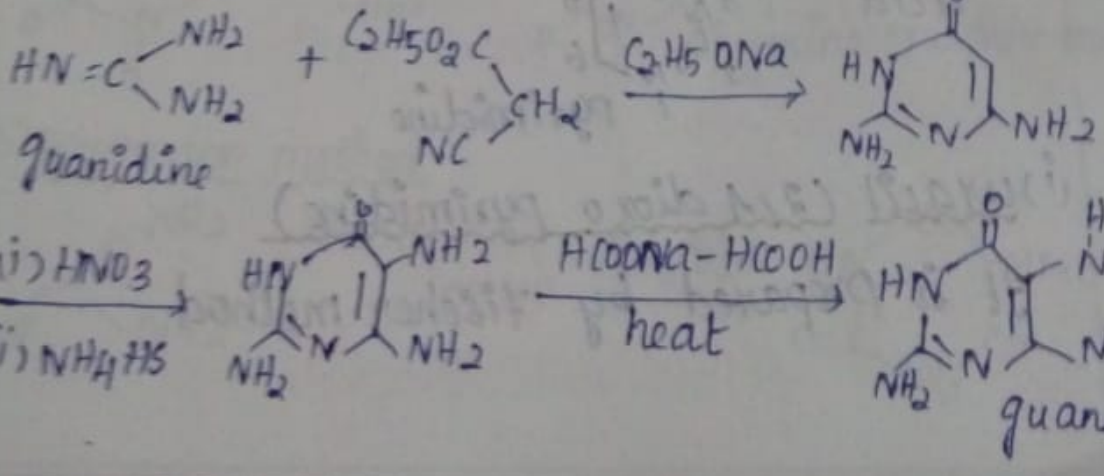
Guanine : (2 amino 6-hydroxy purine)

This occurs in the pancreas of cattle in guano and in certain fish scales. Its structure is shown by the fact that it gives xanthine on treatment with nitrous acid this conversion is also effected by boiling guanine with 25 percent hydrochloric acid.

(i) Fischer (1897)



(ii) Traube

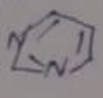


Pyrimidine

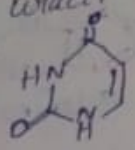
cytosine thymine uracil

structure of pyrimidine bases

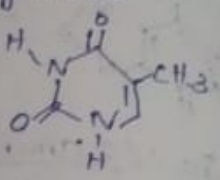
pyrimidine



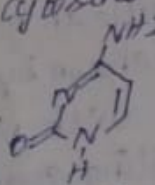
uracil



thymine

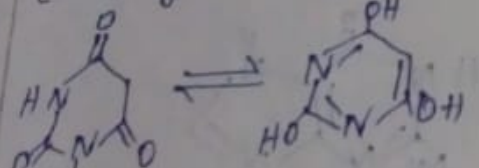


cytosine

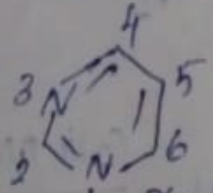


preparation of pyrimidine

Cyclic ureides containing six member ring in a number of ways, as pyrimidine derivative. Pyrimidine was prepared from barbituric acid (malonyl urea) as follows:



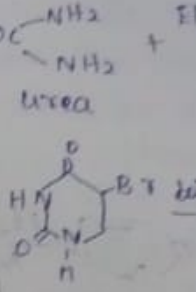
barbituric acid



pyrimidine

(i) uracil (2,4 dioxo pyrimidine)

It is prepared by Fischer method.



b) COOH
CH2
CHOH
COOH

Malic a
deriva

Synthe

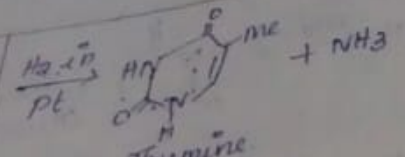
a)

CO

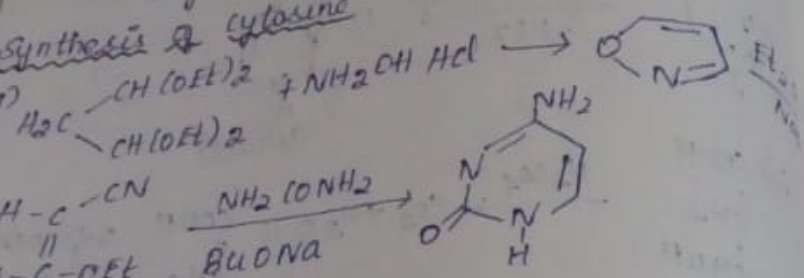
HN

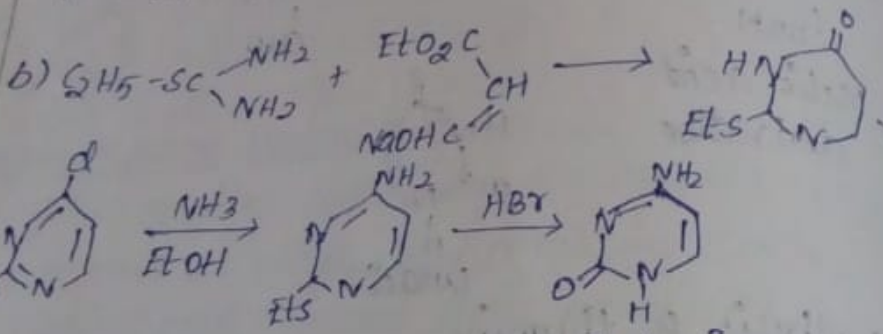
O

b)



Synthesis of cytosine

a)


b)


1.2.2 Nucleic acids - structure of ribose and deoxy ribose - DNA and RNA their components. Biological functions of nucleic acids - elementary on replication and protein synthesis

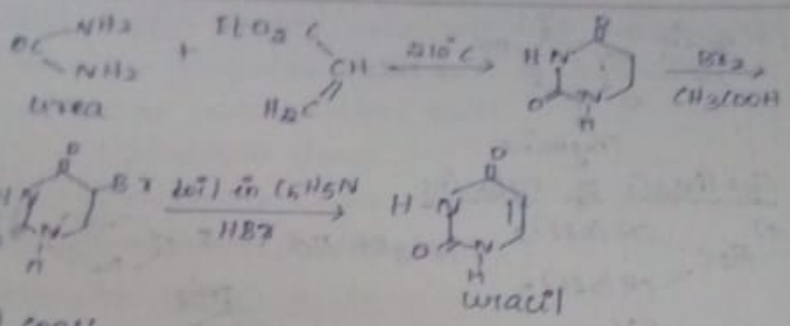
nucleic acids

↓

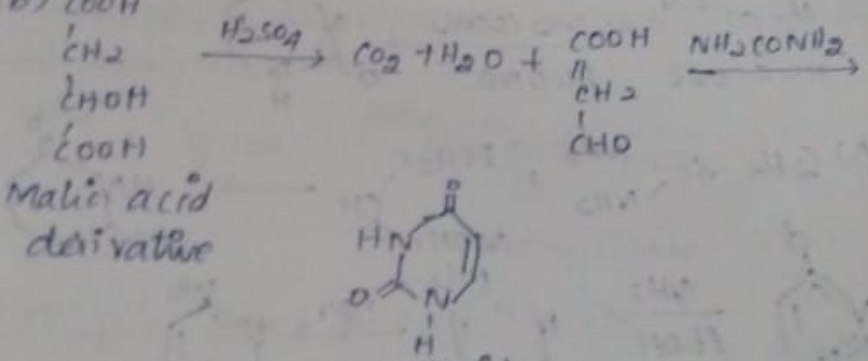
poly nucleotides

↓

nucleoside + phosphate

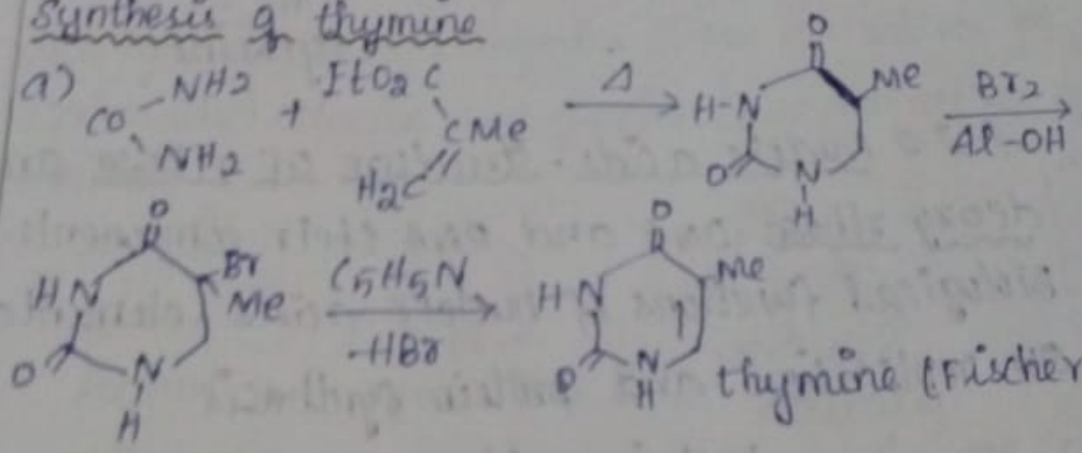


b) Malic acid derivative



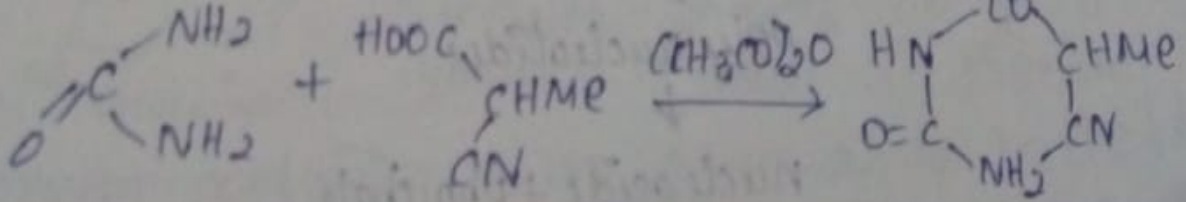
Synthesis of thymine

a)

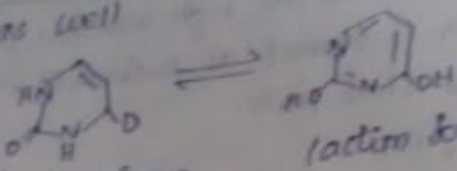


thymine (Fischer meth

b) Bergmann method



as well

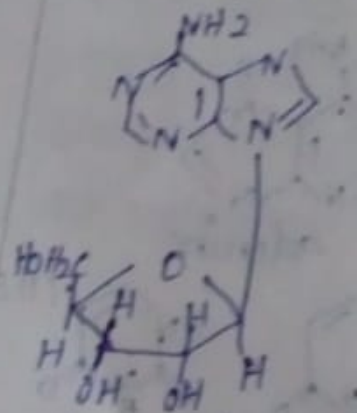


lactam form lactim form

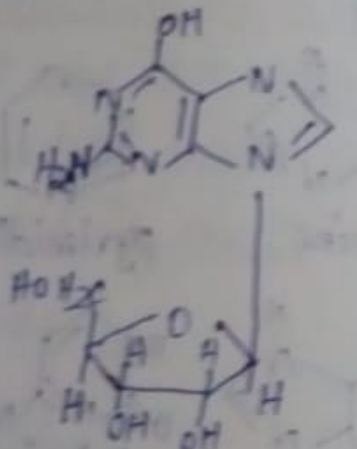
However, the resonance energy of the amide present in the lactam form is generally greater than the resonance stabilisation of the aromatic ring in the lactim form. The base joined to sugar in a nucleoside is therefore, present in the lactam form and also predominates at pH ~ 7

Nucleosides:

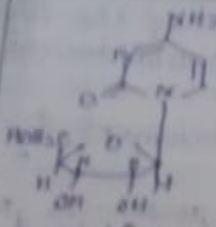
A base joined to a sugar molecule is known as nucleoside. The base sugar molecules are so named as the reflect the names of the base and sugar. For example adenosine (ribose + adenine) guanosine (ribose + guanine), cytidine (ribose + cytosine) and uridine (ribose + uracil)



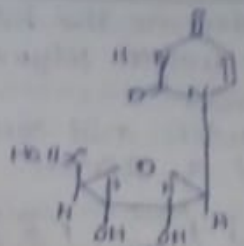
adenosine
(ribose + adenine)



Guanosine
(ribose + guanine)



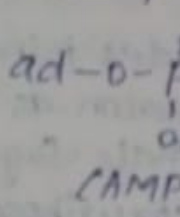
cytidine
(ribose + cytosine)



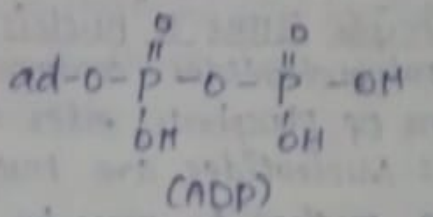
uridine
(ribose + uracil)

Nucleotides:

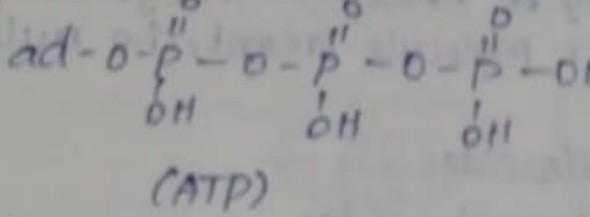
Nucleoside phosphates are called nucleotides these may be mono, di (or) triphosphate for example adenosine gives adenosine monophosphate (AMP), adenosine diphosphate (ADP) and adenosine triphosphate (ATP)



(AMP)



(ADP)



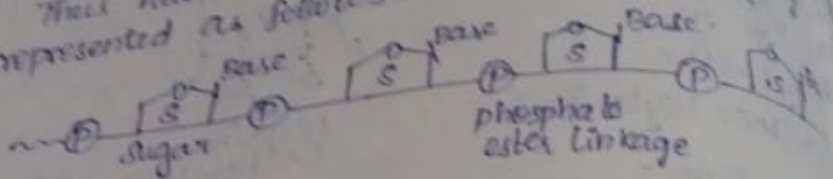
(ATP)

(ad is an abbreviation for adenosine)

The P-O-P bonds are high energy phosphate bond is on account of these bonds that some nucleotides act as energy carrier.

Depending upon the type of pentose (ribose (or) deoxy present, the nucleotides can be of two types. ribonucleotides and deoxyribonucleotides.

Nucleotides are the building blocks of the high molecular weight polymers, poly nucleotides of nucleic acids.
Thus nucleic acid can be diagrammatically represented as follows:



Functions of nucleotides:
Three crucial functions of nucleotides present in the cells are:
→ some of these are energy carriers.
→ some others are co-enzymes.
→ some of them are carrier of hereditary information - the genetic code.

Principle types of nucleic acids:
polynucleotides composed of nucleotides joined by means of phosphate ester linkage are known as nucleic acids. Nucleotides are nucleaside phosphate. Sugar in the nucleaside may be ribase (or) deoxyribose. Depending the nature of sugar molecule present, the nucleic acids are two types.

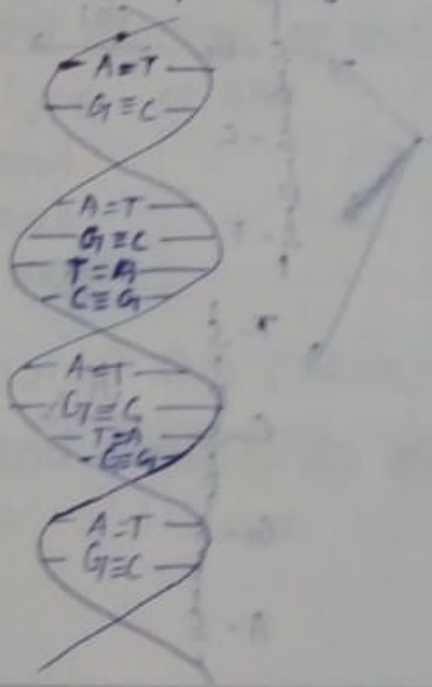
Ribo nucleosides
Deoxyribonucleosides.

Their phosphates (nucleotides) are called ribonucleotide and deoxyribonucleotide. respectively - corresponding these two types of nucleotides, nucleic acid are

(i) those containing of ribonucleotides are called ribonucleic acids
(ii) those consisting of deoxyribonucleotides are known as deoxyribo nucleic acids

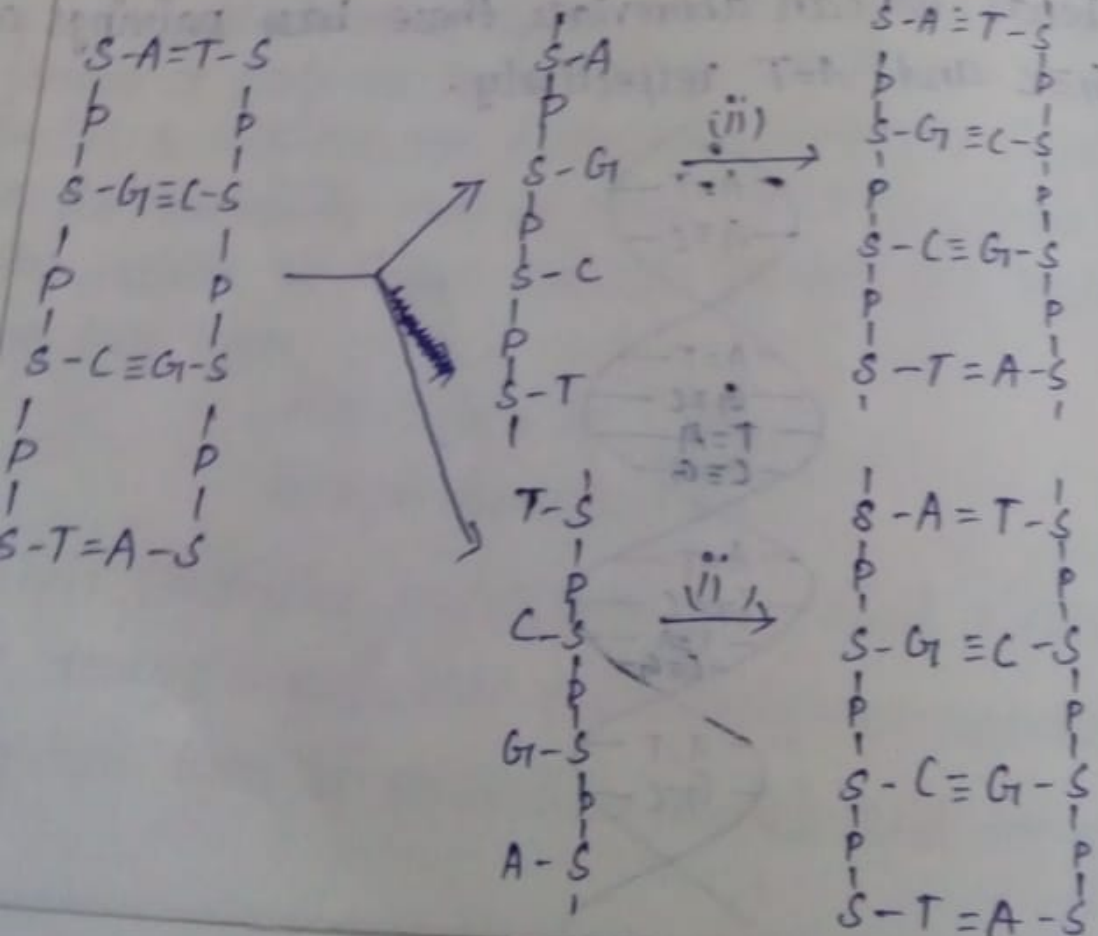
Structure of DNA

Based on the chemical and physical evidence, DNA molecule is believed to be a double right handed helix made up of two polynucleotides chain wound round the same axis like a spiral staircase. The two chains of the double helix are held in position by hydrogen bonds between base residue in one chain and appropriate base residue in the neighbouring chain. It has been suggested specifically that guanine (G) is linked to cytosine (C) by three hydrogen bonds and adenine (A) is linked to thymine (T) by two hydrogen bonds. We can abbreviate these base pairings as G≡C and A=T respectively.



Replication of DNA

DNA molecule has the unique property of making/building up another identical molecule. During this the double stranded helix of DNA seperates into two single strands. Each single strand then gets its appropriate complementary strand resulting in formation two double stranded DNA molecules. By the unique specificity of the G≡C and A=T base pairings, the newly synthesized complementary DNA in each case is carbon copy of the strand originally seperated from it. Thus in each resulting double-stranded DNA molecule, one of the strand comes from the parent DNA molecule, and the other is newly synthesized. Further each resulting molecule is an exact replica of the parent DNA



Functions

DNA
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Functions of DNA:

DNA is often oft referred to as the master molecule because the key role it plays in the living cell three important function performed by DNA are

i. It sends information and instruction to the cell for the manufacture of specific protein.

ii. Due to its unique property of self replication it is responsible for maintaining heredity traits from generation to generation

iii. under certain conditions eg when exposed to x-rays or ultra violet light or under the action of certain chemicals, DNA may undergo mutation, ie its base sequence may undergo slight alteration. These changes are passed on the near replicated molecules which bring about changes in the structure and functioning the cell. This brings about certain changes in the animal and its progeny.

Structure and functions of RNA:

Three types of RNA

(1) mRNA
ii, rRNA
iii, tRNA

rRNA: Ribosomal RNA (rRNA) is present in ribosomes and constitutes about 80% of the

of the total RNA the molecular mass is ...
and it is metabolically stable

Transfer RNA (tRNA)

Transfer RNA (or) soluble RNA (sRNA) occurs in the cytoplasm and constitutes about 10% of the total RNA. Its molecular mass is ~ 2.5 × 10⁴ and it is important in amino acid transport

Messenger RNA (mRNA)

mRNA occurs in ribosomes, cytoplasm and constitutes about 5% of total RNA, Its molecular mass is 50 × 10⁴ and has a very short life. It is complementary copy of a segment of one strand of DNA for example, if the base sequence in the strand is

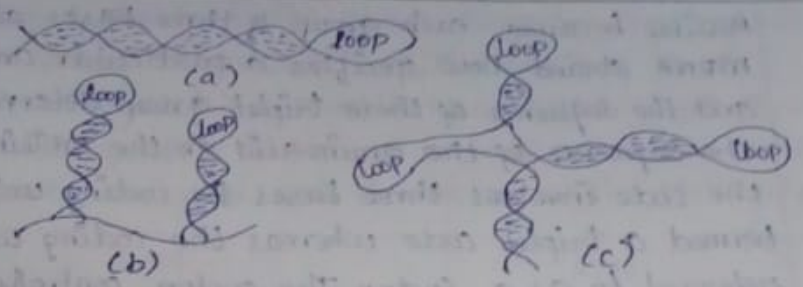
—A-T-C-G-A-A-T—

the base-sequence in the mRNA would be

—U-A-G-C-U-U-A—

In RNA, uracil (U) is used in place of thymine present in DNA.

RNA is believed to be a single stranded molecule looped back on itself to form a helical structure. In the helical portion the base pairing is possible but the bases present along the chain cannot be paired. RNA molecules vary in the number of loop and helix units.



Biological Function of RNA: RNA helps in the biosynthesis of proteins. There are indications that RNA may in some way be associated with the process of learning and memory storage.

Biosynthesis of Proteins:

Biosynthesis of proteins in the cell is taking place in the following steps:

i) A chain of DNA, called gene, transmits message to protein factories (ribosomes) in the cytoplasm. DNA in the nucleus serve as a template for the synthesis of an mRNA molecule.

ii) The mRNA so synthesised diffuses out of the nucleus to the cytoplasm and gets attached to a ribosome. There it itself serve as a template for protein synthesis.

The function of mRNA is to direct the synthesis of specific protein synthesis. This is

possible because each group of three bases on mRNA strand now specifies a particular amino acid and the sequence of these triplet group determines the sequence of the amino acid in the protein. The code involves three bases for coding unit termed a triplet code whereas the coding unit referred to as a codon. The codon controls the incorporation of one specific amino acid at a particular position in the protein chain.

iii, The amino acid is first attached to a tRNA which carries it to the correct site on the mRNA template. This tRNA has a base sequence complementary to three base sequence on the mRNA. One amino acid after the other is thus transported to the site. This is followed by formation of amide bonds under the influence of appropriate enzyme and thus the synthesis of a polypeptide chain is completed.

Thus we find that genetic information passes within the same cell from DNA to RNA and then protein similar genetic information passes from parent DNA to a daughter RNA.

(Parent cell) DNA $\xrightarrow{\text{step A}}$ RNA $\xrightarrow{\text{step B}}$ Protein

st.R ↓

(Daughter cell) DNA $\xrightarrow{A}$ RNA $\xrightarrow{B}$ Protein

st generation R ↓

d generation DNA $\xrightarrow{A}$ RNA $\xrightarrow{B}$ protein

Step A shown in the above diagram, (DNA → RNA) is termed "transcription" step whereas step B (RNA → protein) is called "translation step" step R in which genetic information passes from the parent DNA to daughter DNA is known as the "replication step".

DNA	RNA
i) DNA means deoxy ribonucleic acids	i) RNA means ribonucleic acids
ii) Deoxy D-ribose sugar present in DNA	ii) D-ribose sugar present in RNA
iii) Guanine, adenine, cytosine, thymine bases are present in DNA	iii) Guanine, adenine, cytosine, Uracil bases are present in RNA
iv) The molecular mass of DNA is high (10^6-10^9)	iv) The molecular mass of RNA is low (10^4-10^6)
v) Double stranded helix molecule present	v) Single stranded helix present in RNA
vi) There is no type	vi) There are three types i) mRNA ii) t RNA iii) r RNA
vii) It is used to information and instruction to cell	vii) It is very much helpful in biosynthesis of proteins
viii) Adenine linked with thymine	viii) Adenine linked with Uracil.

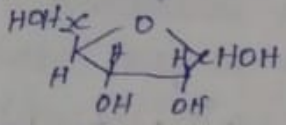
(a) It is power of nucleus of cell	(a) It is present in (cell)
(x) Replication is possible	(x) Replication is

Nucleic acids: Nucleic acids are high molecular weight polymers. The monomer is termed as nucleotide.
A nucleotide consists three parts

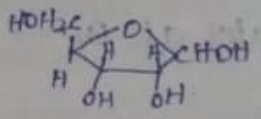
i. phosphate group
ii. a pentose sugar
iii. a heterocyclic base

Sugars in nucleic acids:

The pentose sugar present in nucleic acids are ribose and deoxyribose



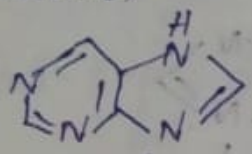
β-ribose



2-deoxyribose

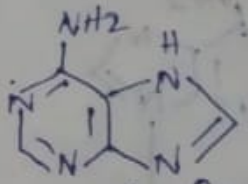
Heterocyclic bases in nucleic acids:

Some of the heterocyclic bases present in nucleic acids are cytosine, uracil, thymine (three derivatives of Pyrimidine) adenine and guanine (two derivatives of Purine)

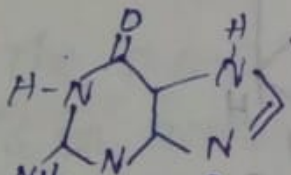


Purine

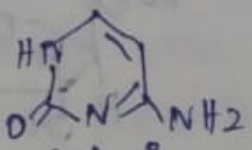
pyrimidine



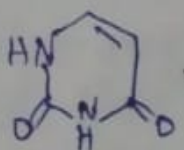
adenine



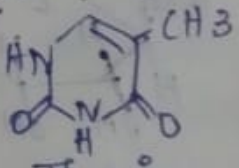
Guanine



Cytosine



Uracil



Thymine

oxygen containing bases given above in the keto (lactam) form exist as the enol (lactim) form.