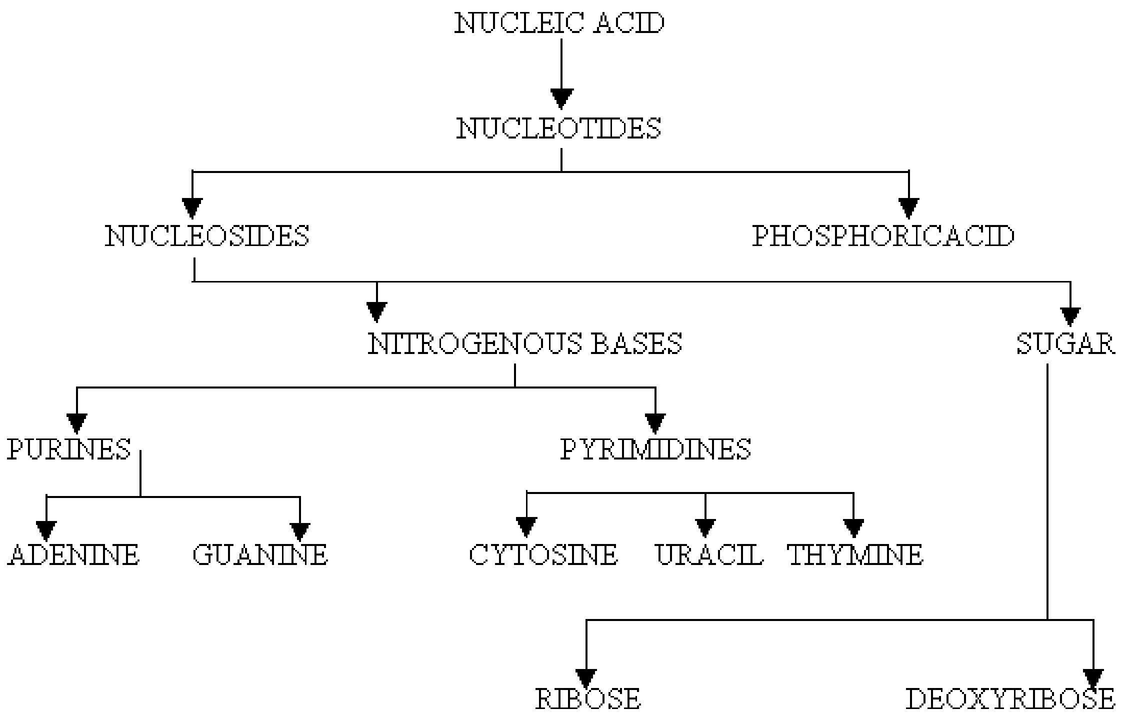
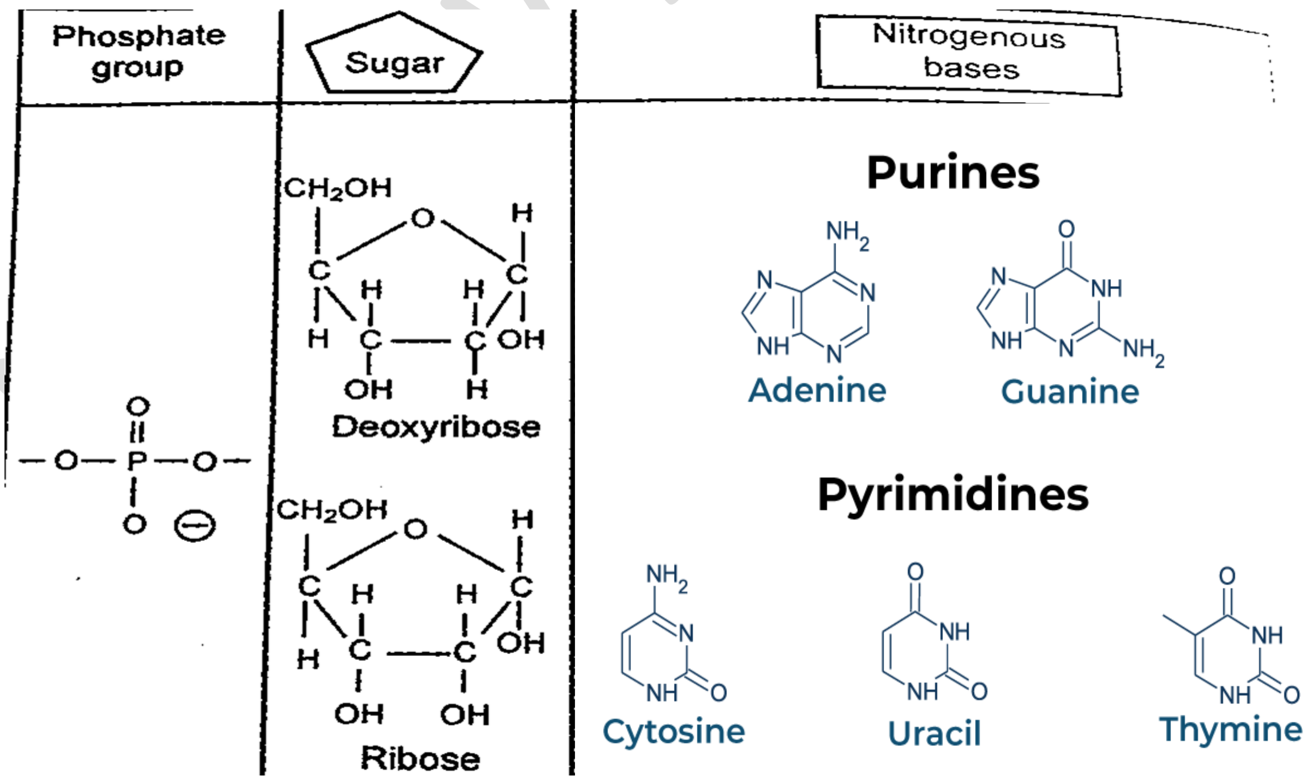
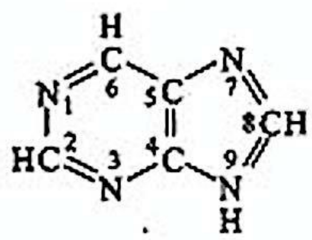
Molecular Basis of Inheritance

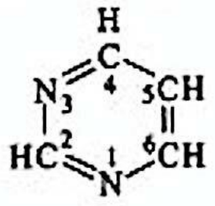
1. After Mendel, genetic material was investigated, resulting in DNA being genetic material in majority of organisms, whereas RNA acts as a genetic material in some viruses
2. Deoxyribonucleic acid (DNA) and Ribonucleic acid (RNA) are the two types of nucleic acid found in living systems.
4. RNA mostly functions as messenger. Also functions as adapter, structural or as a catalytic molecule.
5. DNA & RNA are polynucleotide chain or polymer consisting of millions of nucleotides.



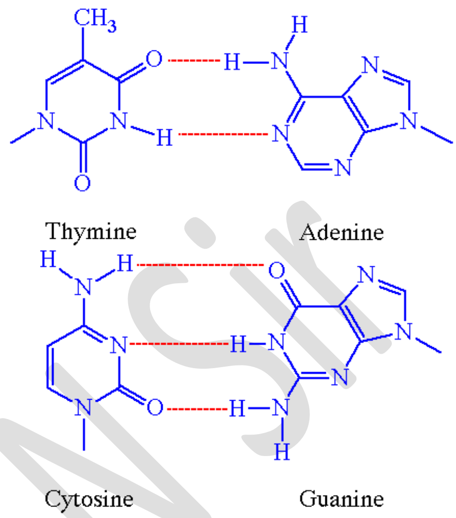




(Purine)



(Pyrimidine)

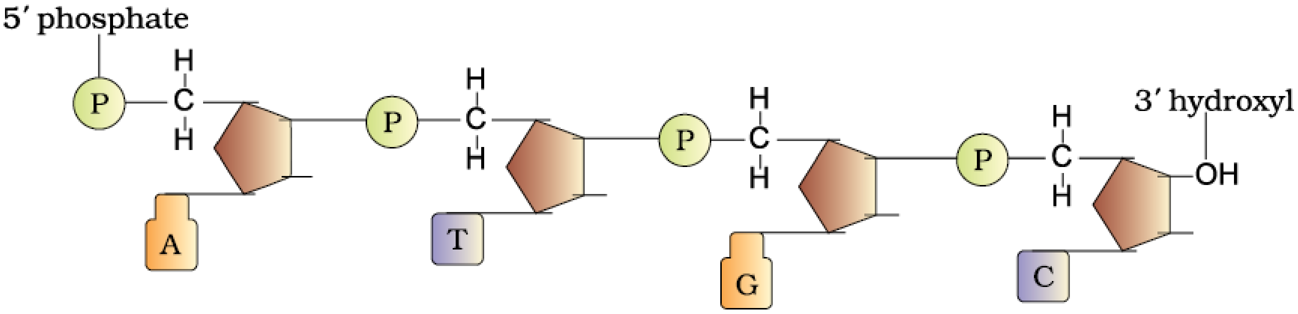


6. Cytosine is common for both DNA and RNA and thymine is present in DNA. Uracil is present in RNA at the place of thymine.
7. A nitrogenous base link to the pentose sugar at 1′ C through **N-glycosidic linkage** form Nucleoside.
8. A phosphate group link to 5′ —OH of a nucleoside through **phosphodiester linkage** forms Nucleotide.
9. In case of RNA, every nucleotide residue has an additional—OH group present at 2-position in the ribose. Also, the uracil is found at the place of thymine (5-methyl uracil).
10. Two Strands of DNA are complementary to each other i.e. if we know the sequence of one strand we can predict sequence of another strand.
11. Length of DNA is defined as number of nucleotide/ Base pairs. Number of Nucleotides in different organism:

SN	Organism	Nucleotide/Base pair
(i)	Bacteriophage / ϕ×174	5386 nucleotides
(ii)	Bacteriophage lambda	48502 base pairs
(iii)	Escherichia coli	4.6×10^6 bp
(iv)	Haploid Human DNA	3.3×10^9 bp
(v)	Diploid Human DNA	6.6×10^9 bp

Nitrogenous Base		Genetic Material	Nucleoside	Nucleotide
Adenine	6 amino Purine	DNA	Deoxyadenosine	Deoxyadenylic acid / Deoxyadenylate
		RNA	Adenosine	Adenylic acid / adenylate
Guanine	2 Amino, 6- Oxo Purine	DNA	Deoxyguanosine	Deoxyguanylic acid / Deoxyguanylate
		RNA	Guanosine	Guanylic acid / guanylate
Cytosine	4 Amino, 2-oxo Pyrimidine	DNA	Deoxycytidine	Deoxycytidylic acid/ Deoxycytidylate
		RNA	Cytidine	Cytidylic acid/ Cytidylate
Thymine	5- methyl, 2,4 di-oxo Pyrimidine **Or** 5-methyl uracil	DNA	Deoxythymidine	Deoxythymidylic acid/ Deoxythymidylate
Uracil	2,4 di-oxo Pyrimidine	RNA	Uridine	Uridylic acid/ Uridylate

A Polynucleotide Chain



Discoveries Related to Structure of DNA

(i) Friedrich Meischer in 1869, first identified DNA as an acidic substance present in the nucleus and named it as 'nuclein'.

(ii) Maurice Wilkins and Rosalind Franklin- had obtained high-resolution X-ray images of DNA fibers that suggested a helical, corkscrew-like shape.

(iii) James Watson and Francis Crick, proposed a very simple double helix model for the structure of DNA in 1953 based on X-ray diffraction data.

(iii) Erwin Chargaff -For a double-stranded DNA, the ratios between adenine and thymine and guanine and cytosine are constant and equals to one i.e. $\frac{A}{T} = \frac{G}{C}$

Salient Features of Double-helix Structure of DNA

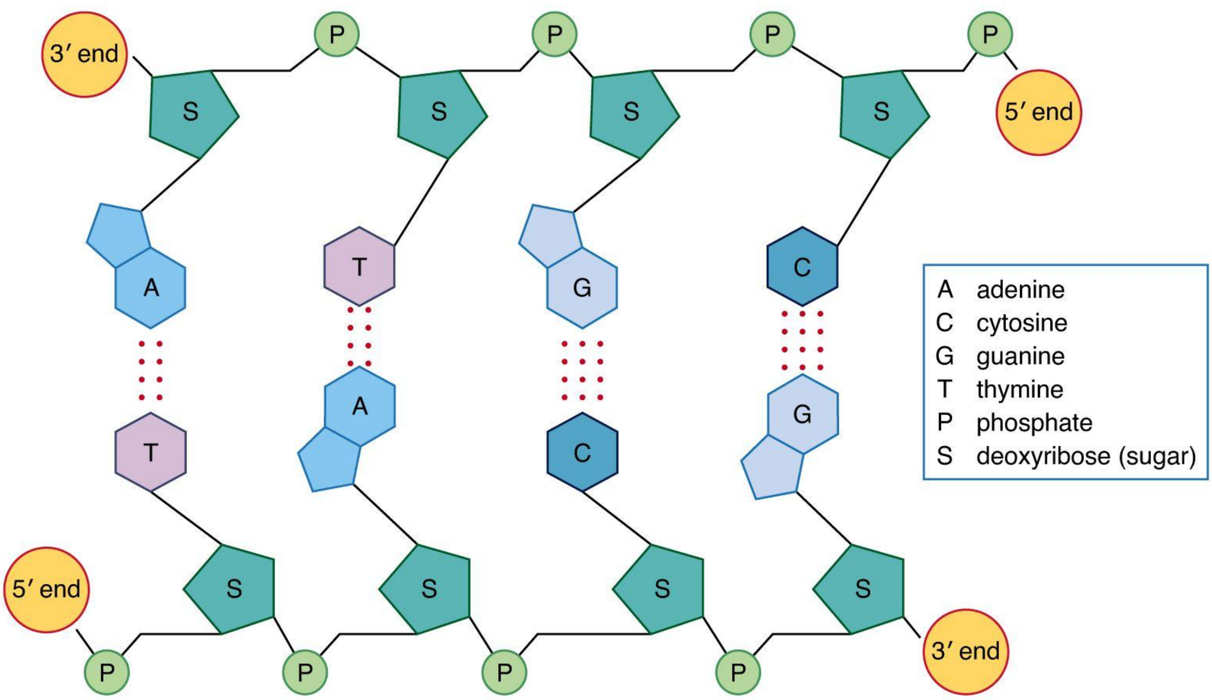
(i) The two chains have anti-parallel polarity, i.e. 5′ to 3′ for one, 3′ to 5′ for another. (At 5′ end phosphate group attached to 5′ C and at 3′ end OH group attached to 3′ C).

(ii) Sugar & phosphate group forms the backbone of DNA/RNA and the bases project inside.

(iii) The bases in two strands are paired through hydrogen bond (H—bonds) forming base pairs (bp). Adenine forms two hydrogen bonds with thymine. Guanine bonds with cytosine by three H—bonds.

(iv) Purine always comes opposite to a pyrimidine. This forms a uniform distance between the two strands.

(iv) The two chains are coiled in a right-handed fashion. The pitch of the helix is 3.4 nm or 34 A°, diameter 2nm or 20 A°, and there are roughly 10 bp in each turn. The distance between a base pair is 0.34 nm.



(v) The plane of one base pair stacks over the other in double helix. This confers stability to the helical structure in addition to H—bonds.

9. The length of a Diploid Human DNA double helix is about 2.2 meters (6.6×10^{9} bp x 0.34×10^{-9} m/bp)

10. The length of DNA of E Coli is 1360 micron.

Central Dogma- proposed by Francis Crick

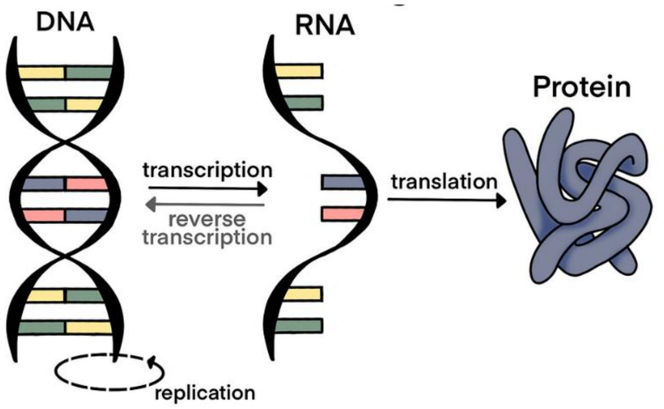
Genetic information flows from **DNA** → **RNA** → **Protein.**

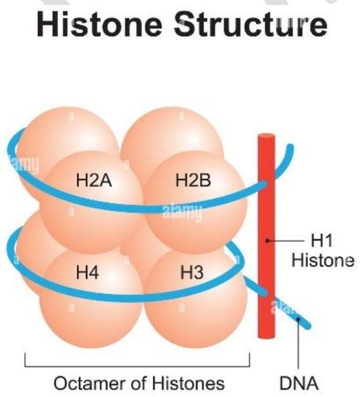
Replication: The process of producing two identical copies of DNA from one original DNA molecule. Enzyme involved DNA polymerases.

Transcription: The process of making an RNA (called mRNA) copy of a gene's DNA sequence. Enzyme involved RNA polymerases.

Reverse Transcription: In some viruses flow of information is reverse i.e. from DNA to RNA in which an enzyme reverse transcriptase makes a copy of DNA from RNA.

Translation: The process by which messenger RNA (mRNA) directs protein synthesis.





Packing of DNA Helix

(i) In prokaryotic cells such as E.coli, DNA (negatively charged) held with some proteins (positive charges) in a region called as **Nucleoid.** The DNA in nucleoid is organised in large loops held by proteins.

(ii) In eukaryotes positively charged proteins called histones organised to form a unit of eight molecules called histone octamer, that are rich in basic amino acid residues, lysines and arginines (both positive). DNA wrapped around histone octamer form a structure called **Nucleosome.**

(iii) A typical **nucleosome contains 200 bp** of DNA helix.

Nucleosomes in chromatin can be seen as **beads-on-string.** Chromatin fibres further coils and condense to form chromosomes at metaphase stage.

(iv) No. of beads/ nucleosome in a mammalian cell are 30 million approx.

(v) The packaging of chromatin at higher level requires additional set of proteins which are collectively called **Non-Histone Chromosomal (NHC) proteins**.

(vi) Euchromatin: transcriptionally active areas, wherein chromatin is loosely packed and they take up the light stain.

(vii) Heterochromatin: transcriptionally inactive areas, wherein chromatin is densely packed and takes up the dark stain.