

MOLECULAR BASIS OF INHERITANCE



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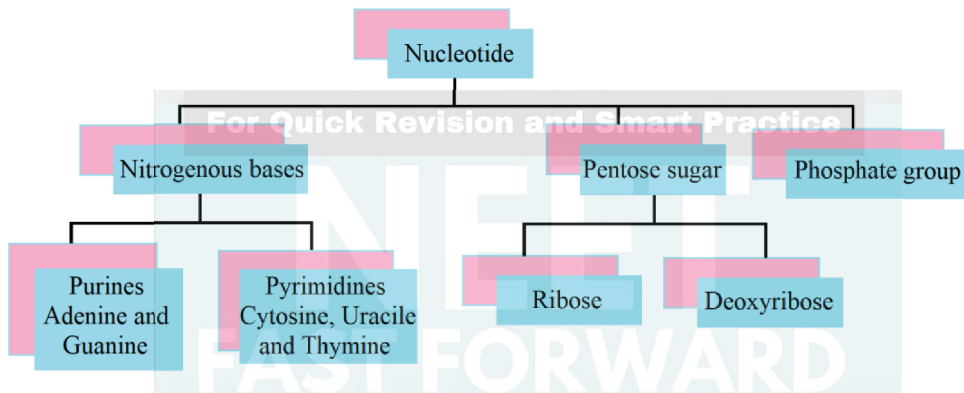
MOLECULAR BASIS OF INHERITANCE

The DNA:

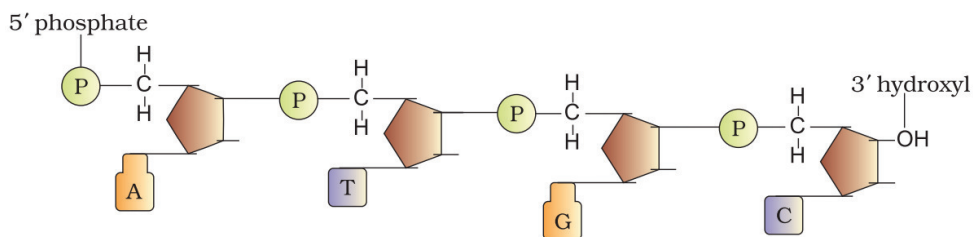
DNA (Deoxyribonucleic Acid) and RNA (Ribonucleic Acid) are two types of nucleic acid found in living organisms. DNA acts as genetic material in most of the organisms. RNA also acts as genetic material in some organisms as in some viruses and acts as messenger. It functions as adapter, structural, and in some cases as a catalytic molecule.

The DNA it is a long polymer of deoxyribonucleotides. A pair of nucleotides is also known as base pairs. Length of DNA is usually defined as number of nucleotides present in it. Escherichia coli have 4.6×10^6 bp and haploid content of human DNA is 3.3×10^9 bp.

Structure of Polynucleotide Chain:



A nucleotide has three components – a nitrogenous base, a pentose sugar (ribose in case of RNA, and deoxyribose for DNA), and a phosphate group. There are two types of nitrogenous bases – Purines (Adenine and Guanine), and Pyrimidines (Cytosine, Uracil and Thymine). Cytosine is common for both DNA and RNA and Thymine is present in DNA. Uracil is present in RNA at the place of Thymine.



A polynucleotide chain:

A nitrogenous base is linked to pentose sugar with N-glycosidic linkage to form to form a nucleoside. When phosphate group is linked 5'-OH of a nucleoside through phosphoester linkage nucleotide is formed. Two nucleotides are linked through 3'-5' phosphodiester linkage to form dinucleotide. More nucleotide joins together to form polynucleotide. In RNA, nucleotide residue has additional -OH group present at 2'-position in ribose and uracil is found at the place of Thymine.

DNA & RNA

Structure differences:

DNA	RNA
The sugar present in DNA is 2-deoxy-D – (-) - ribose.	The sugar present in RNA is D- (-) - ribose.
DNA contains cytosine and thymine as pyrimidine bases and guanine and adenine as purine bases.	RNA contains cytosine and uracil pyrimidine bases and guanine and adenine as purine bases.
DNA has double strand α -helix structure.	RNA has a single stranded α -helix structure.
DNA molecules are very large their molecular mass may vary from $6 \times 10^6 - 16 \times 10^6 \mu$	RNA molecules are comparatively much smaller with molecular mass ranging from 20,000 – 40,000.

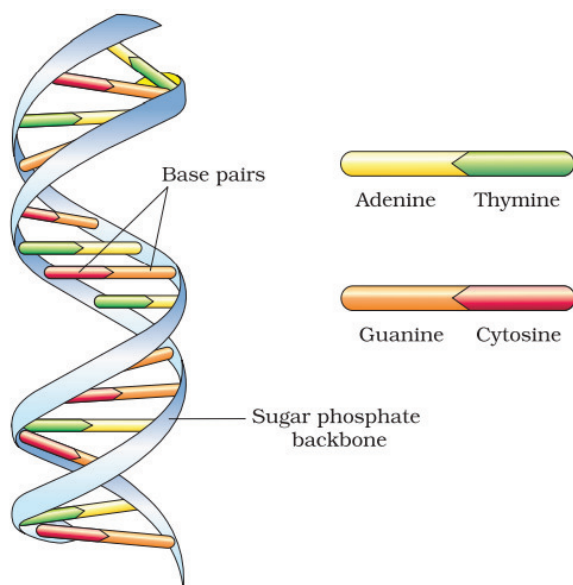
Functional differences:

DNA: DNA has unique property of replication. DNA controls the transmission of hereditary effects. **For Quick Revision and Smart Practice**

RNA: RNA usually does not replicate. RNA controls the synthesis of proteins.

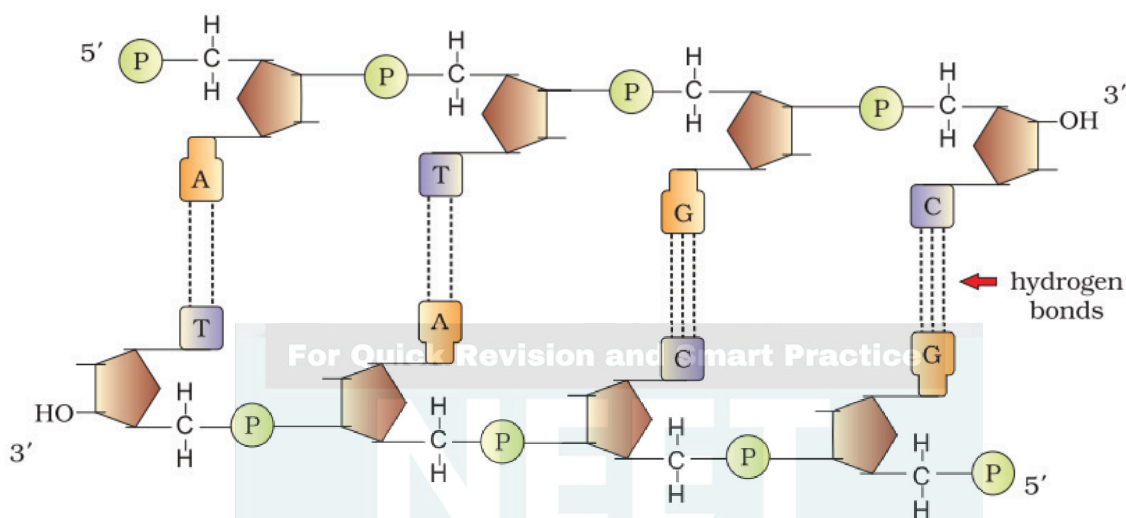
DNA double helix:

In 1953 that James Watson and Francis Crick, based on the X-ray diffraction data produced by Maurice Wilkins and Rosalind Franklin, proposed a very simple but famous Double Helix model for the structure of DNA, the ratios between Adenine and Thymine and Guanine and Cytosine are constant and equals one. The base pairing confers a very unique property to the polynucleotide chains. They are said to be complementary to each other, each strand from a DNA act as a template for synthesis of a new strand, the two double stranded DNA produced would be identical to the parental DNA molecule.

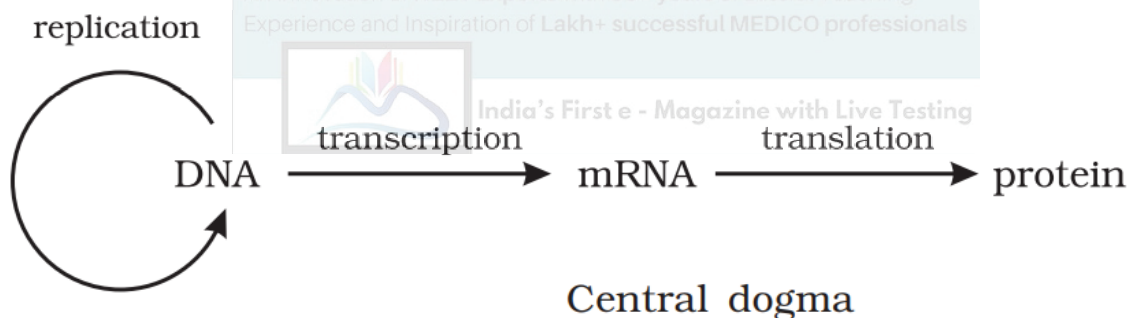


The silent features of this model are:

- DNA is made of two polynucleotide chains in which backbone is made up of sugar-phosphate and bases projected inside it.
- Two chains have anti-parallel polarity. One $5' \rightarrow 3'$ and with $3' \rightarrow 5'$.
- The bases in two strands are paired through H-bonds. Adenine and Thymine forms double hydrogen bond and Guanine and Cytosine forms triple hydrogen bonds.
- Two chains are coiled in right handed fashion. The pitch of helix is 3.4 nm and roughly 10 bp in each turn.
- The plane of one base pair stacks over the other in double helix to confer stability.



Francis Crick proposed the Central dogma in molecular biology, which states that the genetic information flows from DNA \rightarrow RNA \rightarrow Protein.



Packing of DNA helix:

In prokaryotes, well defined nucleus is absent and negatively charged DNA is combined with some positively charged proteins called nucleoids.

In eukaryotes, histones, positively charged protein organized to form 8 molecules unit called histone octamer. Negatively charged DNA is wrapped around the histone octamer to form nucleosome. Histones are rich in the basic amino acid residues lysine's and arginine's. Both the amino acid residues carry positive charges in their side chains. Single nucleosome contains about 200 base pairs. Chromatin is the repeating unit of nucleosome.

In nucleus, some region of chromatin are loosely packed (and stains light) and are



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