NUCLEIC ACIDS (DNA, RNA)

Every cell has a unique property of transmitting characters to the offsprings which helps in maintaining the phenotypes and genotype of organisms generation after generation.

The molecule which is responsible for genetic identity resides in DNA (De oxy ribo nucleic acid) which makes the chromosomes found in the nucleus of a cell.

Chemical analysis of chromosomes shows presence of two nucleic acids DNA (De oxy ribose nucleic acid) and RNA (Ribose Nucleic acid) Nucleic acids were first discovered by a Swiss biochemist Friedrich Miescher (1869) who called them nucleic due to their acidic nature.

Nucleic acid is a macromolecule made of many monomeric units, called nucleotides. Each nucleotide consists of a nucleoside and a phosphate group. Thus the nucleotide is a phosphoric ester of nucleoside. Each nucleoside consists of sugar molecule and a nitrogenous base.

Nucleic acid = many nucleotides
Nucleotide - nucleosides + Phosphate
Nucleoside - Sugar + nitrogenous base
Nucleic acid = Phosphate + Sugar + nitrogenous bases

Different components of Nucleic acid —

1) Phosphoric Acid - The acidic nature of nucleic acid is due to presence of phosphoric acid. Sugar of nucleotide combines with phosphoric acid by a phosphoester bond formed at 5th or 3rd carbon of the sugar.

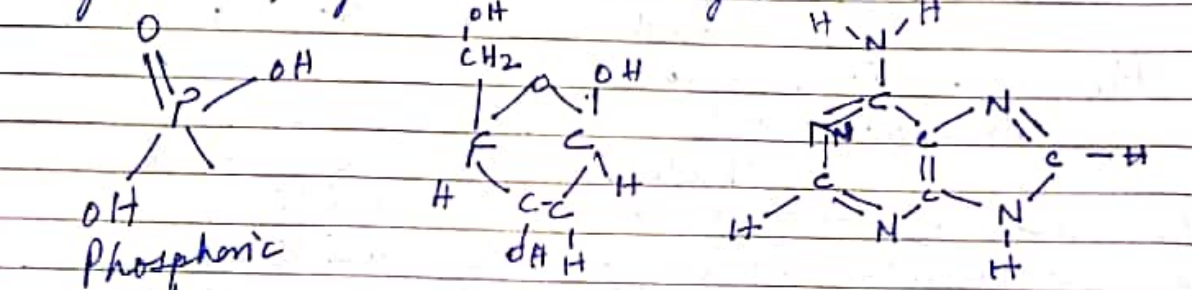
Sugar – It is a five carbon (Pentose) sugar. Ribose sugar is present in RNA while Deoxyribose sugar is present in DNA.

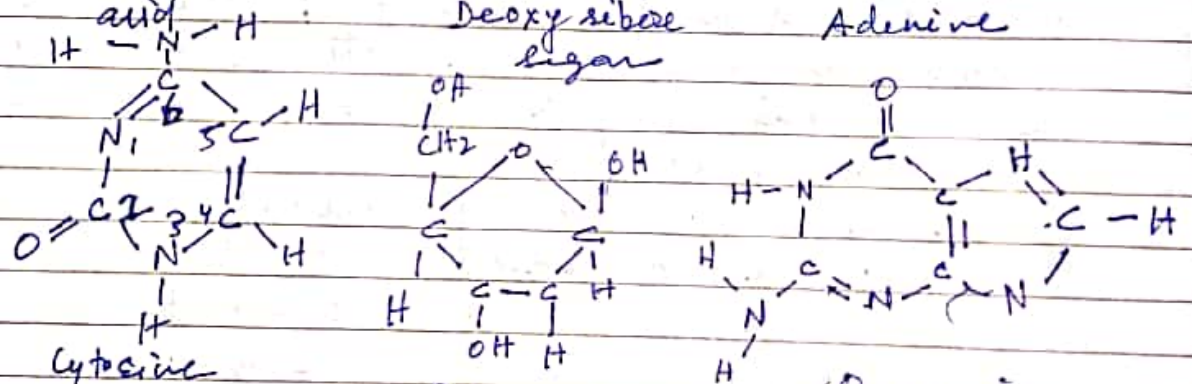
3) Nitrogenous bases – There are ~~two~~ total five bases belonging to two types

i) Purines – The two purines are adenine and guanine having double rings of Carbon and nitrogen.

ii) Pyrimidines – These includes cytosine, thymine and uracil pyrimidines are made up of only one ring of carbon.

The pyrimidine Uracil is absent in DNA. It contains only adenine guanine, cytosine and thymine





Purines

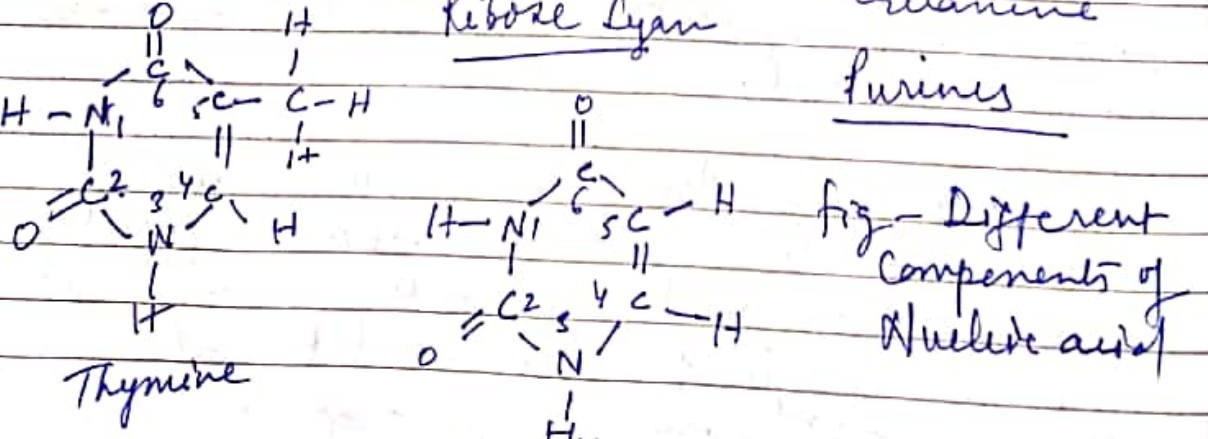


fig – Different components of Nucleic acid

Lecture - 1

BSC Part III

Paper II

STRUCTURE OF DNA (Deoxyribonucleic acid)

In 1953 J.D. Watson and F.H.C. Crick proposed double helical structure of DNA based on the X-Ray Photographs obtained by M.H.F. Wilkins and co-workers. All these three persons were awarded Nobel Prize in 1962 for this work.

Following are the characteristic features of double helical structure of DNA -

1/ Each nucleotide is made up of Sugar, Phosphate and a nitrogenous base. Many such nucleotides are linked by Phosphodiester bonds to form a polynucleotide chain or strand.

2/ Phosphodiester bonds are formed between 5' carbon of Sugar of one nucleotide and 3' carbon of Sugar of the next nucleotide

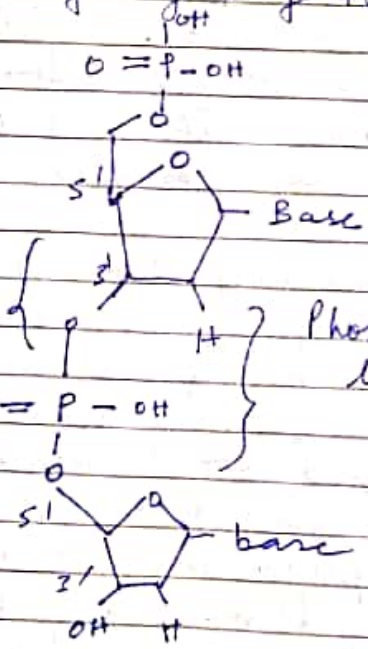


fig - Nucleic acid - Two molecules joined by phosphodiester bonds between them.

3/ Nitrogenous base is attached to 1' carbon of Sugar at this place purine base

attached by its 5' position and pyrimidine by 3' position.

4/ Polynucleotide strand is made of backbone of sugar and phosphate forming its long axis and bases right angle to it.

5/ Chargaff's rule states that in natural DNA's the base ration Adenine and Thymine is always close to unity and Guanine Cytosine ratio is always close to unity indicating that A always pairs with T and G pairs with C.

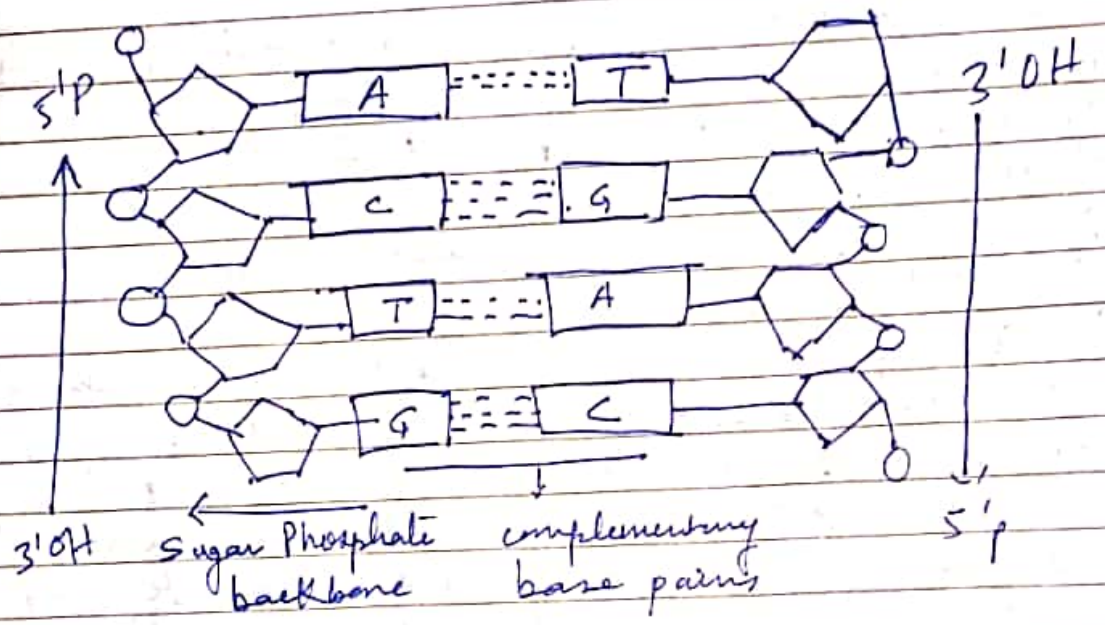
A and T and G and C are complementary base pairs. Thus if in DNA strand has A the will have T and if it is G then other would be C. Thus if base sequence of one strand is CAT.TAGGAC the base sequence of other strand will be GTA ATC CTG, hence the two polypeptide strands are called complementary to each other.

6/ Two such complementary strands are joined with one another by hydrogen bonds between their complementary nitrogenous bases. There are three hydrogen bonds between Cytosine and guanine and two hydrogen bonds between adenine and thymine.

7/ The two polypeptide chains are helically wired around the same axis in such a way that these can seperate from one another only by unwiling. Helical wiling is supposed to the right handed. This right handed form of DNA is called B DNA.

8) The two chains or strands are anti parallel, ie they run in opposite

directions in relation to their sugar molecules.
The 5'p - 3'OH phosphodiester links are in opposite direction.
9/ Double stranded DNA molecule has a diameter of 20 A° i.e distance between two polynucleotide strands is 20 A°.
10/ The helix makes one complete turn every 34 A° along its length. This also called diameter of helix.
11/ There are 10 nucleotides per turn of helix Thus the distance between two base pairs is 3.4 A°



Structure of DNA double strand showing antiparallel nature of DNA.

Since the discovery of B DNA, some other forms of DNA have been also recognized These forms have classified on the basis of
(1) number of base pairs per turn of helix
11) The distance of base pairs along the helical co axis, Accordingly besides commonly known B DNA have been identified A, C, and Z DNA

Differences between B DNA and Z DNA

B DNA	Z DNA
1/ The two helix and antiparallel	Here also the two helix and antiparallel.
2/ Helix coiling is right handed	helix coiling is left handed.
3/ Course of helix is regular	Zig-Zag.
4/ Orientation of adjacent nucleotides is same	opposite orientation.
5/ 10 base pairs per helix	12 base pairs per helix
6/ Diameter 34°A	45°A
7/ Distance between two BP is 3-4A°	~~45°~~ 3-7A°
8/ Diameter of DNA molecule is 20 A°	Diameter 18 A°

DNA is a genetic material that can recombine and Mutate it fulfills following functions –

1/ It contains all biologically useful materials in the form of triplet code the genetic code.
2/ It can be replicated and a complete copy of it is transferred to next generation.
3/ It has the capacity for variation, mutations and recombinations which is stable and inheritable.
4/ It can produce a copy like it.

Bibha Verma
Dept of Zoology