Course- B.Sc. (Botany Honours), Part -3

Paper-VI (Group-B), Molecular Biology

Topic- Structure and Function of DNA.

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Structure and Function of DNA

1. DNA is made up of subunits which scientists called nucleotides.

2. Each nucleotide is made up of a sugar, a phosphate and a base.

3. There are 4 different bases in a DNA molecule: adenine (a purine) cytosine (a pyrimidine) guanine (a purine) thymine (a pyrimidine)

4. The number of purine bases equals the number of pyrimidine bases

5. The number of adenine bases equals the number of thymine bases

6. The number of guanine bases equals the number of cytosine bases

7. The basic structure of the DNA molecule is helical, with the bases being stacked on top of each other Components of DNA DNA is a polymer. The monomer units of DNA are nucleotides, and the polymer is known as a "polynucleotide". Each nucleotide consists of a 5-carbon sugar (deoxyribose), a nitrogen containing base attached to the sugar, and a phosphate group.

The Double Helical structure of DNA is given by Watson and Crick

The double helix of DNA has these features:

- It contains two polynucleotide strands wound around each other.
- The backbone of each consists of alternating deoxyribose and phosphate groups.
- The phosphate group bonded to the 5' carbon atom of one deoxyribose is covalently bonded to the 3' carbon of the next.
- The two strands are "**antiparallel";** that is, one strand runs 5′ to 3′ while the other runs 3′ to 5′.
- The DNA strands are assembled in the 5′ to 3′ direction and, by convention, we "read" them the same way.
- The purine or pyrimidine attached to each deoxyribose projects in toward the axis of the helix.
- Each base forms hydrogen bonds with the one directly opposite it, forming base pairs (also called nucleotide pairs).
- **3.4 Å separate** the planes in which adjacent base pairs are located.
- The double helix makes a complete turn in just over **10 nucleotide** pairs, so each turn takes a little more (35.7 Å to be exact) than the 34 Å
- There is an average of 25 hydrogen bonds within each complete turn of the double helix providing a stability of binding about as strong as what a covalent bond would provide.
- The diameter of the **helix is 20 Å**.

- The helix can be virtually any length; when fully stretched, some DNA molecules are as much as 5 cm (2 inches!) long.
- The path taken by the two backbones forms a **major** (wider) groove (from "34 A" to the top of the arrow) and a **minor** (narrower) groove (the one below).

FUNCTIONS OF DNA

DNA carries the genetic information of a cell and consists of thousands of genes. Each gene serves as a recipe on how to build a protein molecule.

Proteins perform important tasks for the cell functions or serve as building blocks. The flow of information from the genes determines the protein composition and thereby the functions of the cell.

The DNA is situated in the nucleus, organized into chromosomes. Every cell must contain the genetic information and the DNA is therefore duplicated before a cell divides (replication).

When proteins are needed, the corresponding genes are transcribed into RNA (transcription).

The RNA is first processed so that non-coding parts are removed (processing) and is then transported out of the nucleus (transport). Outside the nucleus, the proteins are built based upon the code in the RNA (translation).

Types of DNA

DNA can be classified in various ways based on

All the four forms of DNA viz A, B, C and D are **right handed**.

The Z DNA has **left handed** double helical structure. This DNA is considered to be associated with gene regulation.

Structure of RNA: It contains ribose sugar, nitrogen bases and phosphate group. The nitrogen bases include adenine, guanine, cytosine and uracil. **In DNA thymine is present in place of uracil and deoxyribose sugar is found in place of ribose sugar.** In RNA, the pairing occurs between adenine and uracil. It has usually single strand. However, some viruses have double stranded RNA. The DNA molecule that Watson and Crick described was in the B form. It is now known that DNA can exist in several other forms. The primary difference between the forms is the direction that the helix spirals.

A, B, C = right-handed helix Z = left-handed helix (found in vitro under high salt) B is the major form that is found in the cell. Z-DNA was initially found only under high salt conditions, but the cellular environment is actually a low-salt environment. The question then is whether

type Z exist under cellular conditions. Several features have been discovered that can stablize Z-DNA under in a low salt environment. Differences between DNA and RNA

MODES OF REPLICATION There are three possible modes of DNA replication:

(1) Dispersive

(2) Conservative

(3) Semiconservative

1. In dispersive replication, the old DNA molecule would break into several pieces, each fragment would replicate and the old and new sesgments would recombine randomly to yield progeny DNA molecules. Each progeny molecule would have both old and new segments along its length.

2. According to the conservative scheme, the two newly synthesized strands (following the replication of a DNA molecule) would associate to form one double helix, while the two old strands would remain together as one double helix.

3. In contrast, in the semi conservative mode of DNA replication, each newly synthesized strand would remain associated with the old strand against which it was synthesized. Thus each progeny DNA molecule would consist of one old and one newly synthesized strand.