BIOCHEMISTRY- BP203T

UNIT: 4 **NUCLEIC ACID METABOLISM AND GENETIC INFORMATION TRANSFER**

CLASS:1

TOPIC: INTRODUCTION TO NUCLEIC ACID METABOLISM AND GENETIC INFORMATION TRANSFER

INTRODUCTION TO NUCLEIC ACID METABOLISM AND GENETIC INFORMATION TRANSFER:

Nucleic acid metabolism and genetic information transfer are fundamental biological processes that govern how genetic information is stored, maintained, expressed, and transmitted in living organisms, particularly in complex organisms like mammals.

1. Nucleic Acid Metabolism

Nucleic acid metabolism refers to the synthesis, modification, and degradation of nucleic acids—DNA and RNA. It encompasses:

- DNA replication: The accurate copying of genetic material before cell division.
- DNA repair: Correction of errors or damage to maintain genomic stability.
- RNA synthesis (transcription): Production of RNA molecules from DNA templates.
- RNA processing and turnover: Maturation and degradation of RNA to control gene expression.
- Nucleotide metabolism: Biosynthesis and recycling of nucleotides, the building blocks of DNA and RNA.

These processes ensure the cell has a ready and accurate supply of genetic material for function and division.

2. Genetic Information Transfer

Genetic information transfer refers to the flow of information from DNA to RNA to protein, as described by the central dogma of molecular biology:

DNA → RNA → Protein

This includes:

- Transcription: Transfer of genetic information from DNA to messenger RNA (mRNA).
- RNA processing: Modifications like splicing, capping, and polyadenylation to form mature mRNA.
- Translation: Decoding of mRNA to synthesize proteins by ribosomes.

This flow is tightly regulated to ensure proteins are produced at the right time, location, and amount.

3. Importance in Cellular and Organismal Function

These processes are essential for:

- Growth and development (e.g., through cell division and differentiation)
- Gene regulation and response to stimuli
- Maintenance of genome integrity
- Inheritance of traits across generations

Errors in nucleic acid metabolism or information transfer can lead to mutations, genetic diseases, or cancer.

There are two types of nucleic acids, namely deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). Primarily, nucleic acids serve as repositories and transmitters of genetic information.

BRIEF HISTORY:

DNA was discovered in 1869 by Johann Friedrich Miescher, a Swiss researcher. The demonstration that DNA contained genetic information was first made in 1944 by Avery, Macleod, and MacCary.

FUNCTIONS OF NUCLEIC ACIDS:

DNA is the chemical basis of heredity and may be regarded as the reserve bank of genetic information.

DNA is exclusively responsible for maintaining the identity of different species of organisms over millions of years. Further, every aspect of cellular function is under the control of DNA. The DNA is organized into genes, the fundamental units of genetic information.

The genes control protein synthesis through the mediation of RNA. The interrelationship of these three classes of biomolecules (DNA, RNA, and proteins) constitutes the central dogma of molecular biology, or more commonly, the central dogma of life.

COMPONENTS OF NUCLEIC ACIDS:

Nucleic acids are the polymers of nucleotides (polynucleotides) held by 3' and 5' phosphate bridges.

In other words, nucleic acids are built up by the monomeric units—nucleotides (It may be recalled that protein is a polymer of amino acids).

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NUCLEOTIDES:

Nucleotides are composed of a nitrogenous base, a pentose sugar, and a phosphate.

Nucleotides perform a wide variety of functions in living cells, besides being the building blocks or monomeric units in the nucleic acid (DNA and RNA) structure.

These include their role as structural components of some coenzymes of B-complex vitamins (e.g., FAD, NAD+), in the energy reactions of cells (ATP is the energy currency), and in the control of metabolic reactions.

STRUCTURE OF NUCLEOTIDES:

As already stated, the nucleotide essentially consists of nucleobase, sugar, and phosphate. The term nucleoside refers to base + sugar. Thus, nucleotide is nucleoside + phosphate. Purines and pyrimidines.

The nitrogenous bases found in nucleotides (and, therefore, nucleic acids) are aromatic heterocyclic compounds.

The bases are of two types—

Purines

Pyrimidines.

Purines are numbered in the anticlockwise direction, while pyrimidines are numbered in the clockwise direction.

DNA and RNA contain the same purines, namely adenine (A) and guanine (G). Further,

The pyrimidine cytosine (C) is found in both DNA and RNA. However, the nucleic acids differ with respect to the second pyrimidine base.

DNA contains thymine (T), whereas RNA contains uracil (U). Thymine and uracil differ in structure by the presence (in T) or absence (in U) of a methyl group