Biology for Engineers

PROTEINS:

Proteins are large and complex biomolecules made up of long chains of amino acid residues that play a crucial role in cells. They are essential in our day-to-day life for good health and benefit in growing something faster. Proteins are made up of smaller units called amino acids. The protein consists of hydrogen, carbon, oxygen, sulfur, and nitrogen.

Proteins are very complex molecules involved in some chemical processes that are important for life. Protein is made of small units of amino acids. These proteins help in metabolism, communication, and movement in our body

Importance of Protein

- Protein helps in maintaining good shape and fit for our body.
- Protein repairs the body's damaged tissues.
- Protein is used to build bones, skin, and muscles.

Classification of Protein

Classification of proteins is based on the

- Based on the shape
- Based on Constitution
- Based on the Nature of molecules

Based on shape

- Fibrous protein
- Globular proteins

Based on the constitution

- Simple proteins
- Conjugated proteins

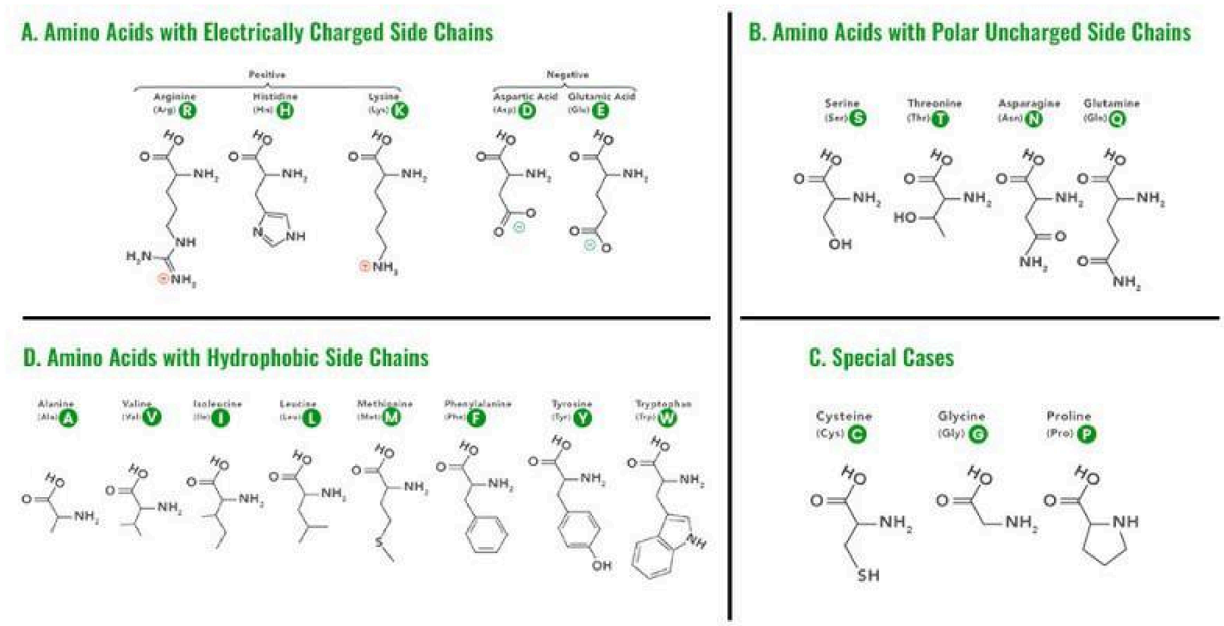
Based on nature of molecules

- **Acidic proteins:** They exist as anion and contain acidic amino acids. Example of acidic protein is **Alpha-synuclein**.
- **Basic proteins:** They exist as cations and are rich in basic amino acids. Example of acidic protein are lysine, arginine etc.

The Basic Unit of Protein – Amino Acids:

Amino acids are the basic structural unit of protein. Amino acids consist of the carbon atom, a carboxyl group (COOH), and a hydrogen atom.

Amino acids are classified as follows:



- **Aromatic**: Tyrosine, Tryptophan, Phenylalanine.
- **Positively charged**: Lysine, Arginine, Histidine.
- **Negatively charged:** Aspartate, Glutamate.
- **Nonpolar**, aliphatic: Leucine, Methionine, Isoleucine.

Function of Protein

Enzymatic protein

The function of enzymatic protein:

- It accelerates the metabolic process in our cells.
- It also accelerates the metabolic process in stomach digestion, liver functions, and blood clotting.

Hormonal protein

The function of hormonal protein

- Hormonal proteins are protein-based chemicals secreted by endocrine glands.
- By using hormonal protein each hormone affects particular cells in the body.

Structural protein

The function of structural protein

- Structural proteins are very important for the body because they are fibrous proteins.
- It helps in developing muscles, bones, skin, and cartilage.

Defensive protein

The function of defensive protein

- These defensive proteins help in developing antibodies for attacking.
- These antibodies are developed in white blood cells to attack bacteria.

Storage protein

The function of storage protein

- Storage protein stores minerals like potassium.
- Storage protein contains ovalbumin and casein found in milk, and egg whites.

Transport protein

The function of transport protein

- Transport protein called calbindin which is useful for absorption of calcium from intestinal walls.
- Transport proteins carry important materials to the cells of the body.

Receptor protein

The function of **receptor protein**

- It controls the substances which enter and leave the cells.

Contractile protein

The function of contractile protein

- It helps in regulating the strength, speed of the heart, and muscle contractions.
- Contractile proteins cause heart complications if the heart produces severe contractions.

Proteins are complex biomolecules which are the building blocks of living organisms. The protein consist of amino acids. The proteins are classified on: basis of shape, constitution, and nature of molecule. The protein structure has hierarchy of four levels i.e. primary structure, secondary structure, tertiary and quaternary structure.

Nucleic Acids

Nucleic acids are macromolecules that are found in every living cell, either alone or in conjunction with other substances. End-to-end polymerisation of a vast number of units called nucleotides linked by phosphodiester linkages forms these lengthy strands. The word "nucleic acid" is used to describe specific big molecules found in cells.

Properties of Nucleic Acid:

- Nucleotides are the building blocks of nucleic acid.
- These make up all living things' genetic material.
- In a live cell, deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) are two forms of nucleic acids.
- In 1969, Friedrich Miescher discovered both DNA and RNA.
- A nucleotide is made up of three chemically different components. A heterocyclic base, or nitrogenous base, is one, a monosaccharide pentose sugar is another, and phosphoric acid, or phosphate group, is the third.
- The nitrogenous bases are made up of one or two heterocyclic rings that include nitrogen atoms. Adenine (A), guanine (G), uracil (U), cytosine (C), and thymine (5-methyl uracil) are the five bases (T).
- Adenine and guanine are substituted purines with two heterocyclic rings, whereas uracil, cytosine, and thymine are substituted pyrimidines with three heterocyclic rings (1 heterocyclic ring).
- DNA has the nitrogenous bases A, T, G, and C, whereas RNA has the nitrogenous bases A, U, G, and C.
- Polynucleotides either include beta-ribose sugar (in RNA) or beta 2′ deoxyribose sugar (in DNA) (in DNA).
- Nucleosides: Sugar + Base
- Nucleotides are made up of three parts: base, sugar, and phosphate.
- The backbone of DNA strands is made up of phosphodiester linkages, which are sugar and phosphate residues.
- Due to the presence of phosphate groups, they are acidic and negatively charged.

Functions of Nucleic Acids: Nucleic acids are genetic material for all living cells, meaning they pass on hereditary characteristics from one generation to the next. Nucleic acid can also determine an organism's phenotypic. Some nucleic acids, such as ribozymes, may have enzymatic activity. Nucleic acids play a role in protein production, either directly or indirectly.

Types of Nucleic Acids

Nucleic acids are of two types:

1. Deoxyribonucleic acid (DNA)

2. Ribonucleic Acid (RNA)

DNA

All living species have DNA as their primary genetic material. It's a nucleic acid molecule with two strands.

Occurrence: DNA is mostly present in the chromosomes of plant and animal cells' nuclei. It's found in mitochondria and chloroplasts as well. It's found in circular and supercoiled chromosomes in prokaryotes' cytoplasm. However, it is found in eukaryotes with proteins such as histones and protamine.

Structure: Watson and Crick's double-stranded double-helical model is the most widely accepted structural model of DNA (1953). The structure of DNA, according to the model, is as follows:

- A right-handed helical spiral is formed by each chain of DNA, and two chains coil around each other to form a double helix.
- The phosphodiester bond is the link between the sugar and phosphate molecules, and the bases project inside.
- The chains run in antiparallel directions, with one strand coming from the 5'→3′ direction and the other coming from the 3'→5′ direction.
- The nitrogenous bases on one strand form hydrogen bonds with the bases on the other strand. Adenine forms 2H -bonds with thymine (A-T), and guanine forms 3H -bonds with cytosine (G-C). The helical structure is stabilised by this coupling.
- The chains are complementary because, for every adenine in one chain, there will be thymine in the other; for every guanine in one chain, there will be cytosine in the other, and so on.
- DNA has a 2nm consistent thickness.
- The pitch of the helix is 3.4nm for each round of the double helix.
- Each turn comprises around 10 base pairs. The distance between two neighbouring base pairs is about 0.34 nanometers.
- The helix's backbone is made up of sugar and phosphate, with bases aligned along the axis.

RNA

RNA is a single-stranded nucleic acid found in a few viruses, such as retroviruses and viroids, as genetic material.

Occurrence: The majority of RNA is located in the cytoplasm of cells. The nucleolus and nucleoplasm both contain it. Except for a few viruses that have double-stranded RNA, it is generally found as a single-stranded polynucleotide.

Structure:

1. The single RNA strand is folded back on itself, generating hairpin-like structures fully or in parts.
2. In some plant viruses, the genetic material is double-stranded but non-helical RNA.
3. Each strand of RNA is made up of a large number of ribonucleotides that are bonded together by phosphodiester linkages.
4. Adenine and uracil (A-U) form a pair, and guanine and cytosine form a pair (G-C).
5. Messenger RNA, ribosomal RNA, and transfer RNA are the three kinds of RNA.

Difference between DNA and RNA

DNA	RNA

It contains deoxyribose sugar.	It contains ribose sugar.
It can be present in the nucleus, mitochondria, and chloroplast chromosomes.	It is related to chromosomes and can be found in the cytoplasm, nucleolus, and nucleoplasm.
Double-stranded structure.	Single-stranded structures generally except a few viruses.
Adenine, guanine, cytosine, and thymine are the nitrogenous bases found.	Adenine, guanine, cytosine, and uracil are the nitrogenous bases found.
A long molecule with high molecular weight.	A relatively short molecule with low molecular weight.
Purines and pyrimidines occur in equal proportion	Purines and pyrimidines do not occur in equal proportion.
DNA is the hereditary material.	Only a few viruses and viroids have RNA as their genetic material.