MODULE 13

AIM

The aim of this module is to provide students with an introduction to amino acids and proteins.

CONTENTS AND OBJECTIVES

- Introduction
- Amino Acids
- Structure of Proteins

AMINO ACID, PEPTIDE AND PROTEINS

Introduction

- Proteins are the most abundant organic molecules in all the living organisms.
- They are known to play an important role in cell structure and function.
- Proteins are polymers of **amino acids** which determine their physical and chemical properties.
- Individual amino acids are linked to the adjacent ones by amide linkages, also commonly known as peptide bonds. Peptide bonds are essentially covalent bonds.

Amino Acids

- Amino acid means any molecule which contains both an amino group as well as an acidic group.
- Every amino acid consists of an amino group, a carboxylic group, a hydrogen atom and a side-chain (R-group), all attached to a central carbon atom (CŬ).
- The simplest amino acid is glycine which has only a hydrogen atom in place of the R-group.

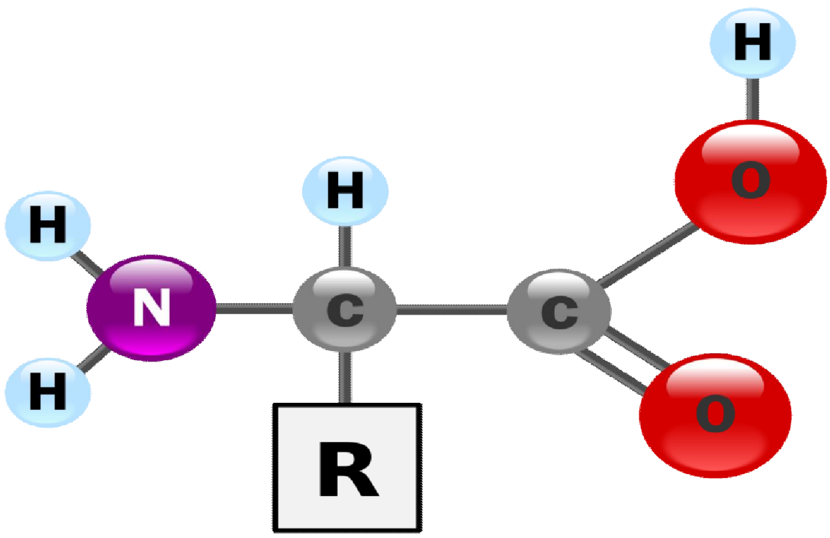
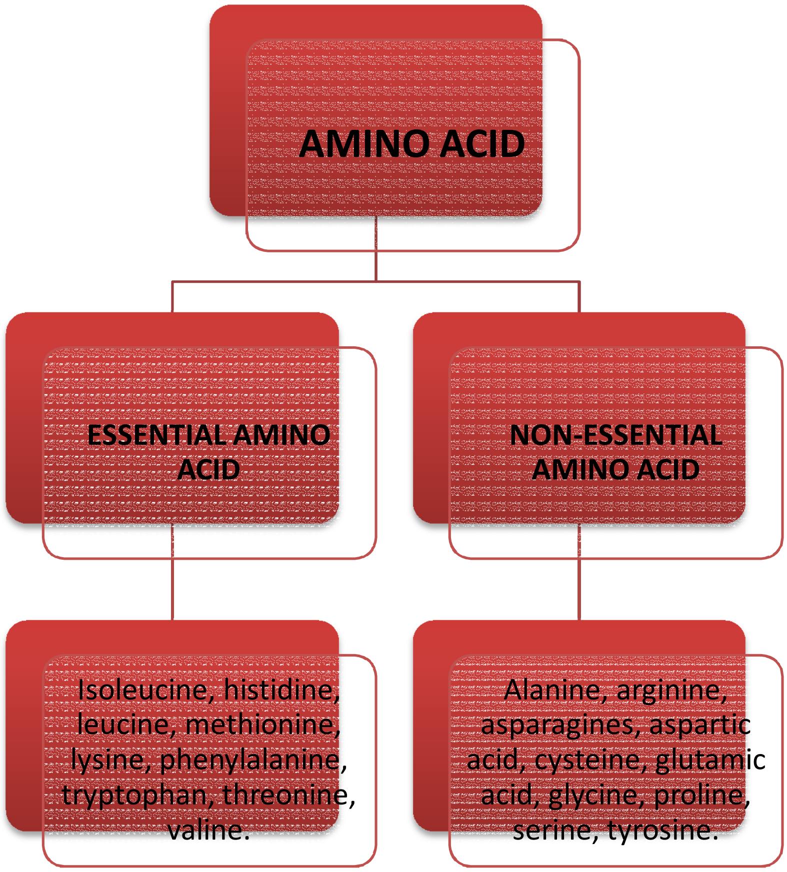


Figure 1 General Structure of an Amino Acid

- Thus, all the amino acids differ in their side chains.
- All the amino acids, except glycine, have a chiral carbon to give stereoisomers as all of them have four different groups attached to the central carbon atom.
- Amino acids are classified into three groups based on the nature of R-groups:
  - **Nonpolar, aliphatic**- These amino acids consist of hydrophobic R-groups. Eg- Glycine, alanine, valine, leucine, isoleucine, methionine and proline.
  - **Aromatic amino acids**- They have aromatic rings which make them hydrophobic. Eg- Phenylalanine, tryptophan and tyrosine.
  - **Polar, Uncharged**- The R-groups for these amino acids carry no charge which makes them more polar than the non-polar amino acids. Eg- Serine, threonine, cysteine, asparagines and glutamine.
  - **Positively charged**- These contain a positively charged R-group. Eg- Lysine and arginine.
  - **Negatively charged**- They have a negatively charged R-group. Eg- Glutamate and aspartate.
- Amino acids are also classified on the basis of the ability of body to synthesize them:
  1. Essential amino aicds- These amino acids cannot be synthesized by the body and thus, have to be acquired through the diet.

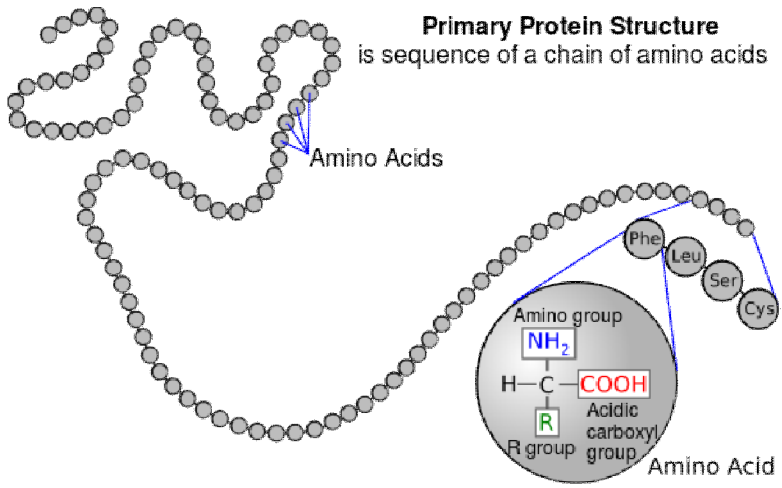
     Eg- Isoleucine, histidine, leucine, methionine, lysine, phenylalanine, tryptophan, threonine and valine.
  2. Non-essential amino acids- Alanine, arginine, asparagines, aspartic acid, cysteine, glutamic acid, glycine, proline, serine and tyrosine.



STRUCTURE OF PROTEINS

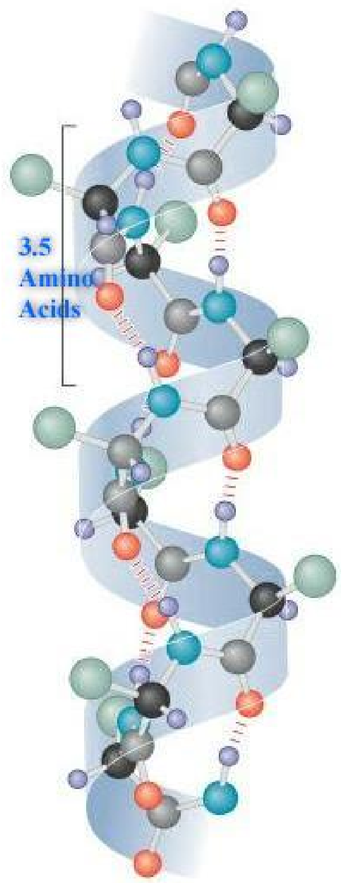
- A cell uses 20 different amino acids (discussed above) for the construction of proteins.
- Being macromolecules, proteins show four different levels of structural organizations: primary, secondary, tertiary and quaternary.

Primary structure- The sequence of amino acids in a polypeptide chain is known as its primary structure. The amino acids in a primary structure are linked to each other by peptide linkages.

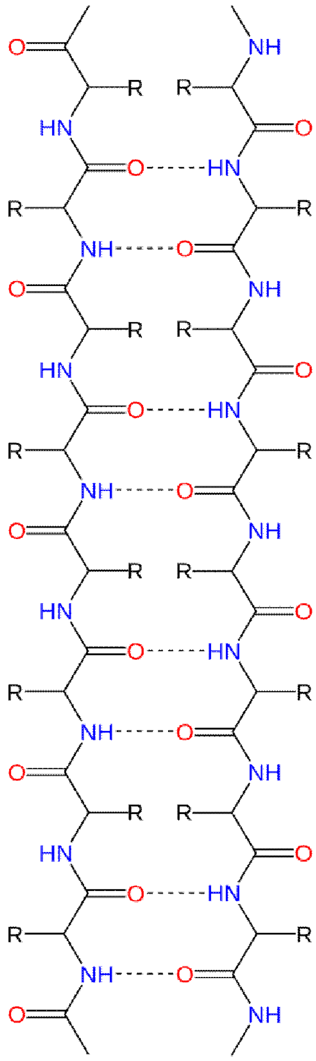


<u>Secondary structure-</u> It is the local folded structure of the polypeptide chains held in shape by the hydrogen bonds. The two most common types of secondary structures are:

<u>Ŭ Helix</u>- It is the most common secondary structure of proteins found in nature.. It consists of a polypeptide chain coiled in a right-handed way. The side-chains of the amino acids tend to extend outward from the core in Ŭ Helix. This allows the helix to maintain its helical conformation.

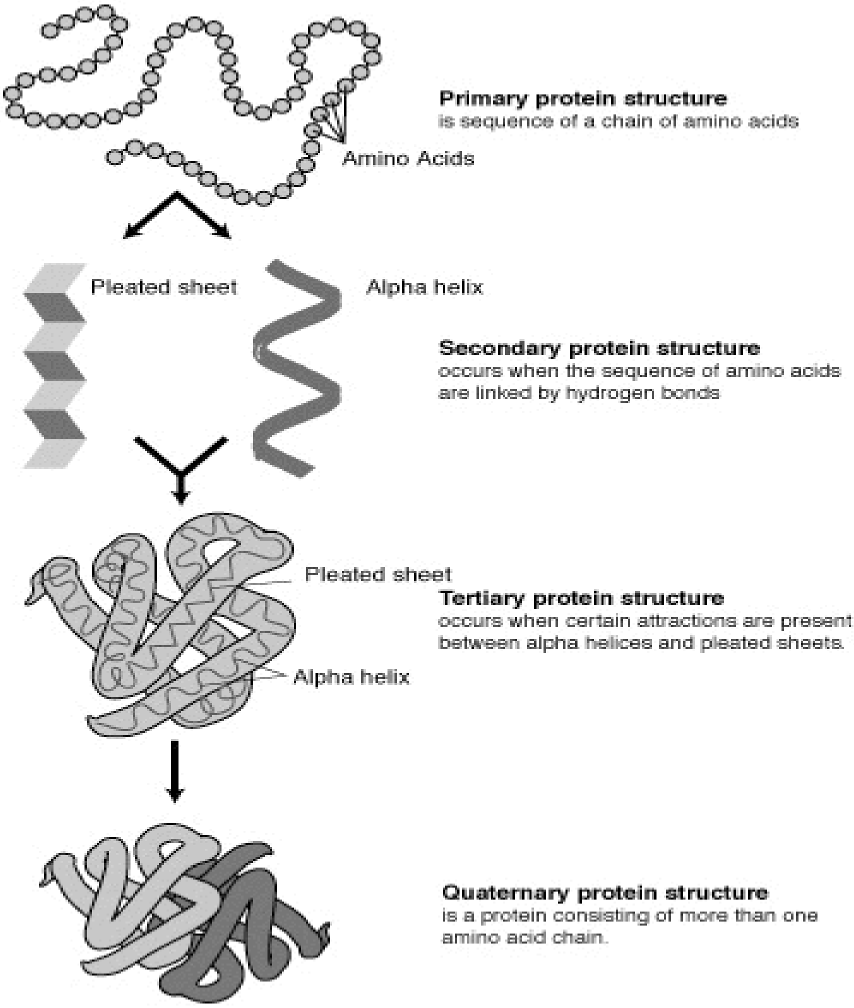


ϐ pleated- It is composed of polypeptide chains lying side-by-side held together by a regular array of hydrogen bond. The polypeptide chains run either parallel or anti-parallel.



Tertiary structure- A tertiary structure refers to the 3-dimensional shape of a protein. A protein molecule generally acquires a 3-D conformation which enables it to achieve maximum stability or lowest energy state. A number of interactions play a major role in stabilizing the tertiary structure or protein, such as- hydrogen bond, covalent bond, electrostatic bonds, disulfide bonds, etc.

Quaternary Structure- Some proteins are made up of multiple polypeptide chains which may be same or different. These are stabilized by various interactions including hydrogen bond, disulfide bridges, etc.



FUNCTIONS OF PROTEINS

Enzymes	• All enzymes are proteins • Speed up the biochemical reactions • Also known as catalysts
Antibodies	• speicalized proteins • Help in defending the body from antigen
Contractile proteins	• Play an important role in muscle contraction and movement
Hormonal proteins	• Also referred to as messenger proteins. • Are involved in coordinating certain bodily activities. • Eg- Thyroxine, oxytocin, insulin.
Storage proteins	• Store amino acids for body to use later. • Eg- Ovalbumiun, caesin
Structural Proteins	• provide support for various body parts. • Eg- Keratin, collagen, elastin
Transport proteins	• Are carrier proteins. • Enable the movement of moilecules from one place to another around the body. • Hemoglobin