# PUC 1st Year-Semester-II

## Unit II: Chemical constituents of Living cells

## Module No 10: Proteins- Structure, classification and funcitons

### Structure of Protein molecules

Proteins are natural polymers that are ranked first amongst the chemical substances essential for the growth and maintenance of life. These are the compounds of carbon, oxygen, hydrogen and nitrogen. Some proteins contain additional elements such as phosphorus, iron, zinc and copper. The proteins are very large compact molecules often referred to as macro molecules. Each protein is made up of numerous simpler units called the amino acids which are joined together by peptide bonds. When many amino acids are linked together, the combination is called polypeptide. The polypeptide chains unite to form very large molecule called proteins.

### Structure of Proteins

Four basic structural levels are assigned to proteins. These are primary, secondary, tertiary and quaternary structures.

### 1.Primary structure:

The primary structure of a protein refers to the linear sequence of amino acids in the polypeptide chains and location of disulphide bridges, if there are any. The amino acids are linked with each other by peptide bonds only. The primary structure is thus a complete description of the covalent connection of a protein. **[**Primary structure of the protein hormone insulin contain two chains, α and β, joined together by two disulphide bonds. α – chain contains 21 and β chain contain 30 amino acids.**]**

**1. Secondary structure:**

All protein molecules are not simple long polymeric chains. Instead the chains are coiled into a spiral called an α – helix and β-pleated sheet . The folding of a linear polypeptide chain into a specific coiled structure is referred to as the secondary structure of a protein. Such coiling or folding is produced or maintained by hydrogen bonds formed between the CO and NH groups of adjacent coils. Each turn of α – helix contains 3.6 amino acids and travels a distance of 0.54 nm. The spacing of each amino acid is 0.15 nm. The right handed α – helix is more stable than left handed helix.

The secondary structure of protein is a characteristic of fibrous and contractile proteins such as keratin of hair, fibrin of blood clots, myosin of muscle, collagen and elastin of connective tissue.

**2. Tertiary structure:**

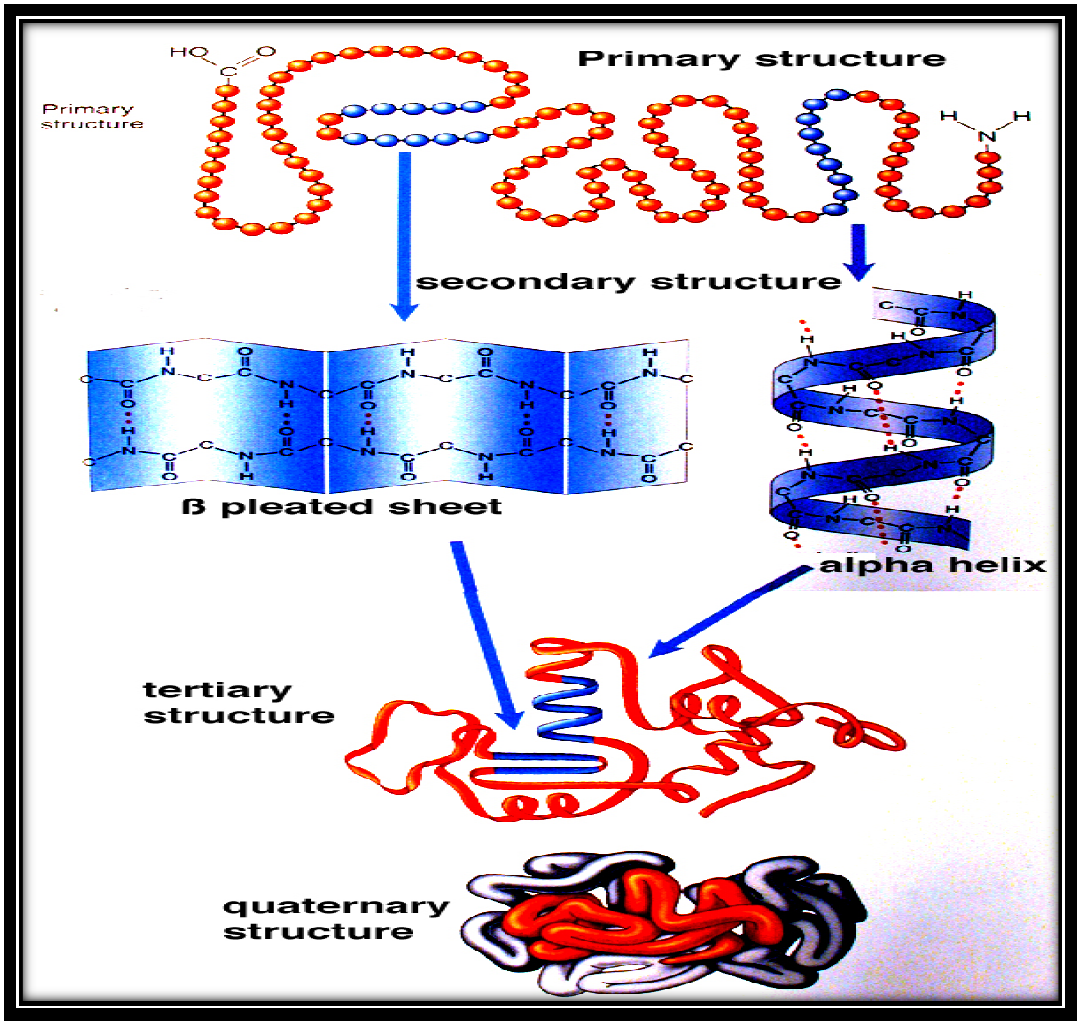
The tertiary structure of a protein results when a helix folded in specific fashions to give three dimensional or tertiary structure. It is a compact structure with hydrophobic side chains held interior while the hydrophilic groups are on the surface of the protein molecule. This type of arrangements ensures stability of the molecule. Tertiary structure is maintained chiefly by 4 kinds of bonds – Hydrogen bonds, Ionic bonds, Hydrophobic bonds and Disulphide bonds.

**3. Quaternary structure:**

In proteins that are made up of two or more polypeptide chains, the quaternary structure refers to the specific orientation of these chains with respect to one another and the nature of the interactions that stabilize this orientation.

Many proteins contain more than one polypeptide chain. The individual polypeptides fold to yield secondary and tertiary structures but also bind to

one another in precise ways through hydrogen bonds, vander waals forces, ionic bonds, disulphide bridges and hydrophobic interaction. The organization of two or more polypeptide chains into one unit is called the quaternary structure of protein.




# Different Levels of Structural Proteins

**Classification of Proteins**

Proteins are mainly classified into two

1. Simple proteins
2. Conjugated proteins

I. **Simple proteins:** Simple proteins on hydrolysis yield only amino acids. These are of two types.

A. Fibrous proteins
B. Globular proteins

**A. Fibrous proteins:** Fibrous proteins are insoluble in aqueous media, which have a supporting or protective function in the animals. This group includes the proteins of silk, wool, skin, hair, horn, nails, hoofs, quills, connective tissue and bone. The fibrous proteins can be subdivided into- collagens, Elastins, Keratins, myosin, ossein.

**B. Globular Proteins**

The globular proteins are soluble in aqueous media and are easily denatured. These are spherical or ovoid in shape. This group includes enzymes, oxygen carrying proteins and protein hormones. These are subdivided into

**a. Albumins:** They are soluble in water and are easily coagulated by heat. Ex: Egg albumin

**b. Globulins:** These proteins are insoluble in water, but soluble in dilute neutral salt solutions, such as Nacl**.** Ex: Serum globulin, fibrinogen, myosin of muscle.

**c. Histones:** These are water soluble proteins. They are found in thymus, pancrease, spleen, nucleic acids, Globulin of Haemoglobin

**d. Protamines:** They are soluble in Ammonium hydroxide solution. They are found in nucleic acids, sperm cell of fish.

**e. Glutelins:** They are insoluble in distilled water or alcohol but soluble in dilute acid or base solutions Ex: Glutenin from wheat, oryzenin from rice.

f. **Prolamines:** They are insoluble in absolute alcohol and water but soluble in 70 to 80% alcohol. Ex: zein from maize, gliadin from wheat

**II. Conjugated Proteins:**

Simple proteins bound to a non protein group or a prosthetic group aer called conjugated proteins. They are further classified on the basis of the nature of the prosthetic group.

a. **Nucleoproteins:** These are combinations of proteins with nucleic acids
b. **Mucoproteins:** They contain carbohydrate bound to protein molecules ( more than 4% of carbohydrates) ex: Ovomucoid α from egg white
   Orosomucoid from blood serum
c. **Glycoproteins:** The carbohydrate percentage is less than 4% in glycoproteins. Ex: mucin of saliva
d. **Lipoproteins:** These are compounds of lipid and proteins. Ex: cholesterol, lipovitelline of egg yolk.
e. **Chromoproteins:** These are compounds of proteins plus a coloured pigment. Ex: Haemoglobin, Haemocyanin
f. **Metallo proteins:** These are metal binding proteins.Ex: Transferrin, carbonic anhydrase
g. **Flavoproteins:** The prosthetic group of flavin component remains permanently attached to the proteins. Ex: Succinic dehydragenase, Xanthine oxidase.
h. **Phosphoproteins:** These are proteins united with a phosphoric group. Ex: casein of milk

**III. Derived proteins:** Derived proteins are not present in nature as such. They are obtained as a result of partial hydrolysis of natural proteins. Ex: Proteoses, Peptones, Poly peptides, etc

**Functions of Proteins:**

Proteins are indispensable for life and perform a number of functions

1. Some proteins serve as structural materials.

   Ex: Myosin of muscles

   Keratin of skin and hair

   Collagen of connective tissue

2. Actine and myosin are directly involved in the contraction of muscle through which mechanical work is performed
3. The blood contains number of proteins. *Serum albumins* control the osmatic pressure and the pH of the blood. *Fibrinogen* plays a vital role in blood coagulation. *Haemoglobin* transports oxygen from the lungs to all tissues of the body. *g-globulins* of our blood functions as the antibodies
4. The most striking characteristic feature of proteins is their ability to function within living cells as reaction- catalyzing enzymes
5. Many hormones are proteins and play important role in metabolic reactions. Ex: Insulin, oxytocin etc
6. Proteins of our food serves as a source of the aminoacids. These essential amino acids are readily synthesized in plants and in some animals and are ingested as proteins by man

7. The visual purple, rhodopsin is made up of retinene an aldehyde derivative of vitamine A and a protein, opsin.

8. Melanin, the pigment of skin, hair and choroid layer of eye is derived from the amino acid tyrosine.

9. In ureotelic animals, the amino acids ornithine, citrulline and arginine participate in the formation of urea by a cyclic process

**Short Answer Questions:**

1. Explain the quaternary structure of proteins?

2. Describe the tertiary structure of proteins?

**Long Answer Questions:**

1. Describe the structure of protein molecules?
2. Write the classification of Proteins
3. Explain the function of Proteins