# Quadrant II – Transcript and Related Materials

**Programme: Bachelor of Science (Third Year)**

**Subject: Botany**

**Course Code: BOC 106**

**Course Title: Cell Biology and Biochemistry**

**Unit: 4 – Biomolecules**

**Module Name: Proteins - Classification, structure (primary, secondary, tertiary and quaternary)**

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Protein is a macromolecule made up of building blocks called amino acids. They are polymers of amino acids. Each protein has a unique, precisely defined amino acid sequence which is genetically determined.

The term protein was first proposed by Berzelius (1838). Greek word *Proteios* means pre- eminent or first. Protein is the essential constituents of living cells and play crucial roles in all biological processes. As enzymes they catalyse reactions. As carrier proteins - transport molecules across membranes, etc. Proteins make up 12% of the protoplasm. Chemically proteins are made up of carbon, nitrogen, hydrogen, oxygen and sometimes sulphur, phosphorus, iron, zinc, iodine, etc.

Plant sources of proteins are pulses, nuts, cereals, etc.

Some biologically important proteins are Glutenin in wheat, Oryzenin in rice, flavoprotein , nucleoproteins, cytochrome.

**Classification of Proteins**

Proteins are classified as:

a) **Simple proteins** – Chemically have only amino acids.

b) **Conjugated proteins** – Non amino acid components are associated with the protein molecule.

c) **Derived proteins** – Degradation products of proteins.

**Simple Proteins**

Simple proteins are also known as Holoproteins. These are globular type only scleroproteins which are fibrous. This group include proteins containing only amino acids.

- **Albumins -** Soluble in water.Coagulated by heat. Example - Leucosin in cereals
- **Globulins -** Insoluble in water. Soluble in neutral salts. Coagulated by heat. Example -Tuberin in potato
- **Glutelins** - Insoluble in water, neutral salts. Coagulated by heat. Example Glutenin in Wheat
- **Prolamines** - Insoluble in water, alcohol & neutral solvents but soluble in ethyl alcohol. Not coagulated by heat. Example – Zein in Maize
- **Scleroproteins** - Insoluble in water, acids, bases, salts and ethyl alcohol.
- **Protamines & Histones** - Soluble in water. Not coagulated by heat

**Conjugated Proteins**

Also called Complex proteins or Heteroproteins. These are proteins linked with a separable non protein portion called prosthetic group. Based on the nature of the prosthetic group present classified as:

- **Nucleoproteins** - Containing nucleic acid as the prosthetic group
- **Glycoproteins** - Containing carbohydrate
- **Chromoproteins** - Coupled with a coloured pigment
- **Lipoproteins** - Containing phospholipids or cholesterol
- **Metalloproteins** - Linked with metals
- **Phosphoproteins** - Containing phosphoric acid as the prosthetic group

**Derived Proteins**

These are derivatives of proteins resulting from the action of heat, enzymes or chemical reagents. This group also includes the artificially produced polypeptides. Derived proteins are of two types:

**Primary Derived Proteins** – derivatives of proteins in which the size of protein molecule is not altered materially.

- Proteans - produced by action of acids, enzymes or water on protein.

- Metaproteins - produced by further action of acid or alkali on protein.
- Coagulated - produced by action of heat or alcohol on protein.

**Secondary Derived Proteins** - derivatives of proteins in which the hydrolysis has certainly occurred. The molecules are smaller than the original proteins.

- Proteoses - prolonged hydrolysis of metaproteins yield proteoses.
- Peptones - obtained by continued hydrolysis of proteoses.
- Polypeptides - prolonged hydrolysis of natural proteins yield peptides.

## Structure of Proteins

Four basic structural levels are assigned to proteins:

- **Primary structure -** sequence of amino acid.
- **Secondary structure -** amino acids linked by hydrogen bonds.
- **Tertiary structure -** 3D folding of polypeptide chain.
- **Quaternary structure -** Consists of more than one polypeptide chain.

### Primary Structure

The linear sequence of amino acid residues making up its polypeptide chain. The proteins are **linear, unfolded** and formed of one or more polypeptide chains.

The amino acid residues are linked by repeating peptide bonds.The adjacent polypeptide chains are linked by disulfide bonds. Most of the structural proteins which are in the form of fibres exhibit primary structure. Eg. Fibroin of silk.

### Secondary Structure

Refers to the helical nature of the proteins.Based on the nature of hydrogen bonding two types:

**Alpha helix -** Helical structure
The helix is formed by a series of amino acid residues woven into a spiral chain. The helical chain has a screw like symmetry. A hydrogen bond is formed

between the peptide group of every first and fourth amino acid residues. The regular appearance of hydrogen bonds determines the regularity of turns in the polypeptide chain.

**Beta pleated -** Pleated sheet structure
Formed from hydrogen bonding between two peptide chains. This bonding leads to the formation of sheets of parallel chains in the form of pleated sheets. The chains may be
Parallel – the N- terminal end of the polypeptide chains point in the same direction.
Antiparallel - the N- terminal end of the polypeptide chains point in opposite direction.

**Tertiary Structure** Is exhibited by proteins having only one polypeptide chain. Refers to the folding of polypeptide chains caused by the formation of bonds or weak association between amino acid side chains.

Four different types of side chain interactions are involved covalent bonds, ionic interactions, hydrogen bonds and hydrophobic interactions

The tertiary structure is attained by globular proteins. Ribonuclease is example of a protein with tertiary structure

**Quaternary Structure**

Two or more polypeptide chains associate together to produce a quaternary structure. It is formed by the combination of primary, secondary and tertiary structures.

Depending on the nature of the polypeptide chains quaternary structure are of two types:

**Homogeneous Quaternary Structure**

Polypeptide chains are identical e.g. Phosphorylase.

**Heterogenous Quaternary Structure**

Polypeptide chains are non-identical e.g. Haemoglobin, keratin, etc.