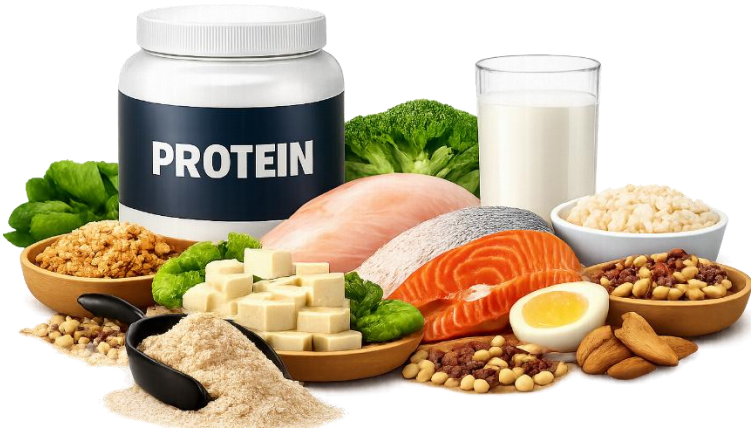
Proteins

Introduction to Proteins

Definition of Proteins

- Proteins are large, complex biomolecules composed of one or more long chains of amino acids.
- These chains are linked by peptide bonds, forming polypeptides, which fold into specific three-dimensional structures necessary for their biological function.

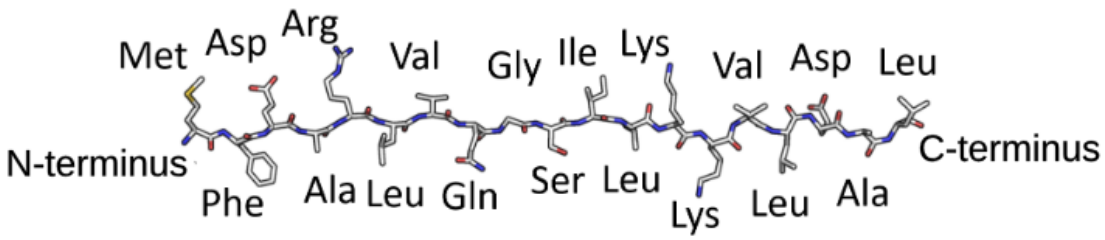


- Proteins are macromolecules, meaning they are made up of thousands of atoms and have high molecular weights, typically in the range of 5,000 to several million Daltons.
- **Chemically, a protein contains:**
  - Carbon (C)
  - Hydrogen (H)
  - Oxygen (O)
  - Nitrogen (N)
  - Sulfur (S) (sometimes present, especially in amino acids like cysteine and methionine)
- The general formula of an amino acid is: **NH_2–CHR–COOH**
- Where R is a variable side chain that defines each amino acid.

Protein Structure

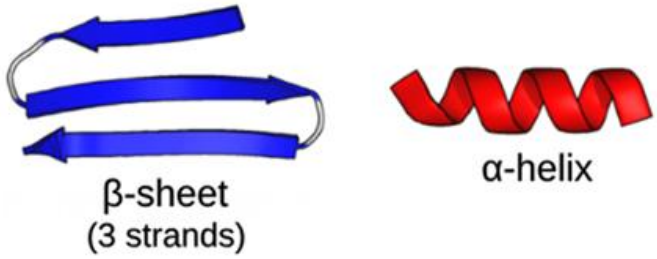
- The function of a protein is directly related to its structure, which is hierarchical and categorized as follows:

1. Primary Structure



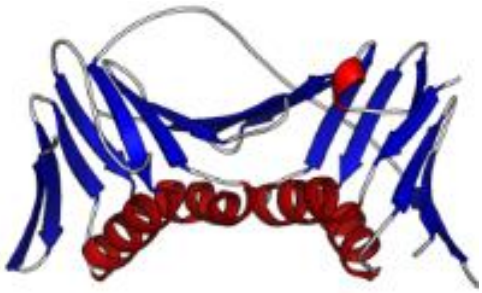
- The linear sequence of amino acids in a polypeptide chain.
- Determined by the gene encoding the protein.
- Peptide bonds form between amino acids.

2. Secondary Structure



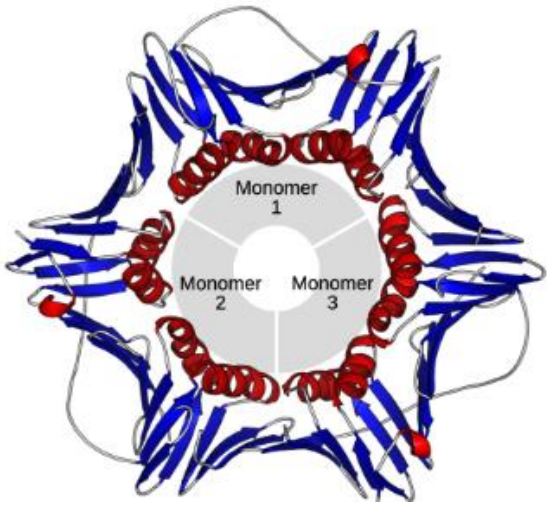
- Local folding patterns within the polypeptide chain.
- Includes α-helices and β-pleated sheets stabilized by hydrogen bonds.

3. Tertiary Structure



- The overall three-dimensional shape of a single polypeptide chain.
- Stabilized by interactions between side chains (R groups), such as:
  - Hydrophobic interactions
  - Hydrogen bonding
  - Ionic bonds
  - Disulfide bridges (S–S bonds)

4. Quaternary Structure



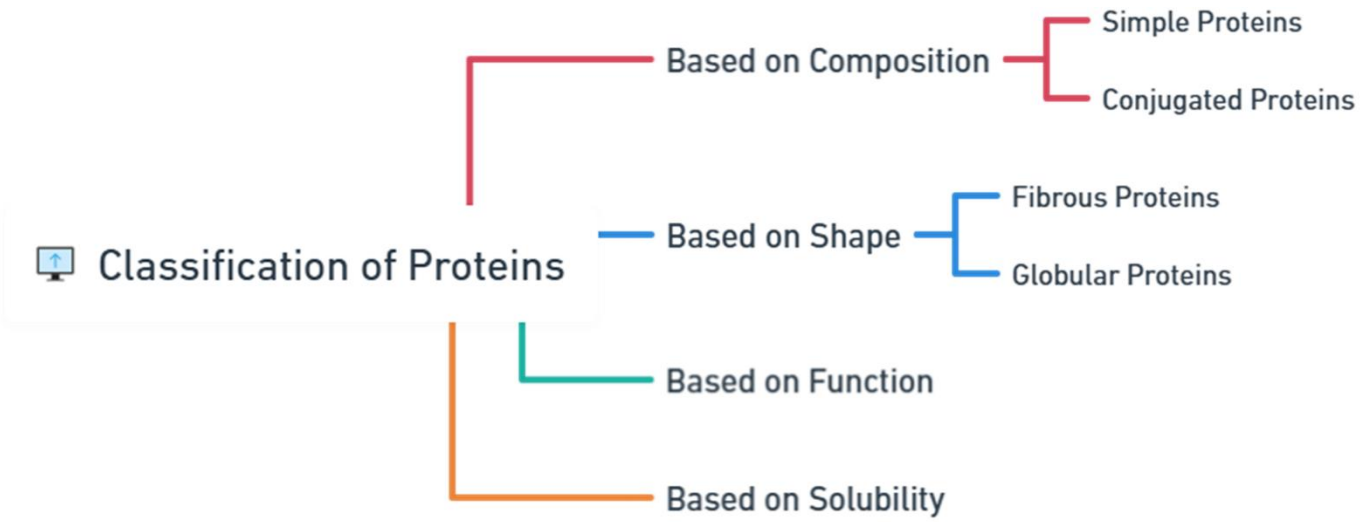
- The association of multiple polypeptide subunits into a larger functional complex.
- **Example:** Hemoglobin is a tetramer composed of four subunits.

Biochemical Importance of Proteins

- Proteins perform a vast array of functions in biological systems:
  - **Enzymes**: Catalysts in biochemical reactions (e.g., amylase, lipase).
  - **Structural Components**: Keratin in hair, collagen in connective tissue.
  - **Transport**: Hemoglobin carries oxygen in the blood.
  - **Regulatory**: Hormones like insulin are proteins.
  - **Immune Defense**: Antibodies are specialized proteins.
  - **Storage**: Ferritin stores iron in the body.
  - **Movement**: Actin and myosin in muscles.
- Proteins are crucial both as targets of natural products and as bioactive agents themselves (e.g., plant-derived enzymes, therapeutic proteins, and monoclonal antibodies).

Classification of Proteins

- Proteins can be classified based on composition, shape, function, and solubility.



A. Based on Composition

1. Simple Proteins:

- Yield only amino acids upon hydrolysis.
- Examples: Albumin, Globulin, Histones, Protamines.

2. Conjugated Proteins:

- Contain non-protein components called prosthetic groups.
- Types:

- **Glycoproteins**: Carbohydrate + protein (e.g., mucins)
- **Lipoproteins**: Lipid + protein (e.g., HDL, LDL)
- **Phosphoproteins**: Phosphate group (e.g., casein)
- **Chromoproteins**: Pigment group (e.g., hemoglobin)
- **Metalloproteins**: Metal ions (e.g., ceruloplasmin)

B. Based on Shape

1. Fibrous Proteins:

- Long, rod-like, structural function, insoluble in water.
- Examples: Collagen, Keratin, Elastin.

2. Globular Proteins:

- Spherical, soluble in water, functional roles.
- Examples: Enzymes, hormones, antibodies.

C. Based on Function

1. **Structural Proteins** – Collagen, elastin.
2. **Catalytic Proteins** – Enzymes like pepsin, trypsin.
3. **Transport Proteins** – Hemoglobin, transferrin.
4. **Defense Proteins** – Immunoglobulins.
5. **Regulatory Proteins** – Hormones such as insulin.
6. **Storage Proteins** – Ferritin, casein.
7. **Contractile Proteins** – Myosin, actin.

D. Based on Solubility

1. **Albumins** – Soluble in water (e.g., serum albumin).
2. **Globulins** – Insoluble in water, soluble in dilute salt solutions.
3. **Glutelins** – Soluble in dilute acids or bases.
4. **Prolamines** – Soluble in 70–80% ethanol.
5. **Histones** – Basic proteins, soluble in water.

Chemistry of Proteins

Amino Acid Composition

- Proteins are made up of 20 standard amino acids, which are α-amino acids, each with:
  - An amino group ($–NH_2$)

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