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BCM 201:

Amino Acids Chemistry: Protein Biological  
Functions and Classification

## INTRODUCTION

- Proteins are the **most abundant macromolecules in living systems**, constituting well over 50% of the cell's dry weight
- Their diversity and abundance are reflected in their roles in virtually all aspects of cell structure and function.
- Proteins **are the agents of biological function**. They are also the expressions of genetic information encoded in DNA
- Their functions are numerous and are essential in virtually all spheres of biological processes.

## Important Biological Properties of Protein

1. Proteins are **linear polymers** built of monomer units called amino acids.
  2. Proteins contain a **wide range of functional groups** that account for their broad spectrum of activities
  3. Proteins can interact with one another and with other biological macromolecules to **form complex assemblies**
  4. Some proteins are quite **rigid**, whereas others display **limited flexibility**
- Chemically, proteins are unbranched polymers of amino acids (AAs). The AAs in protein are linked head to tail, via **covalent peptide bonds** from the carboxyl group to the amino group,
  - Peptide bonds are a type of **amide linkage**, and their formation results in the release of  $H_2O$ . The peptide “backbone” consists of the repeated sequence  $-N - C_{\alpha} - C-$  where: N is the amide nitrogen,  $C_{\alpha}$  is the  $\alpha$ -carbon atom of an amino acid in the polymer chain, and C is the carbonyl carbon of the amino acid,

# BIOLOGICAL FUNCTIONS OF PROTEINS

- Proteins perform several roles in the human body, including:
  1. Structural function: e.g alpha keratin, collagen, elastin, fibroin, proteoglycans
  2. Regulatory functions: e.g insulin, thyrotropin, somatotropin, *lac* repressor, nuclear factor 1 (NF 1), catabolite activator protein (CAP)
  3. Transport function: involved in the transport of substances in the blood and across cell membranes e.g. Glucose transporters, serum albumin, haemoglobin
  4. Defence. This is also called protective function. Examples include immunoglobulins, fibrinogen, thrombin

5. Enzymatic functions. They speed up rate of chemical reactions e.g. Alpha amylase, transferases, peptidases, carboxylase, etc
  
6. Signal transduction. Some proteins can simultaneously bind 2 or more other proteins especially during signal transduction. These proteins are called adaptor or scaffold proteins. E.g. IRS-, crk, stat, Grb, shc
  
7. Storage functions e.g casein, zein, phaseolin, ferritin, ovalalbumin

## CLASSIFICATION OF PROTEIN

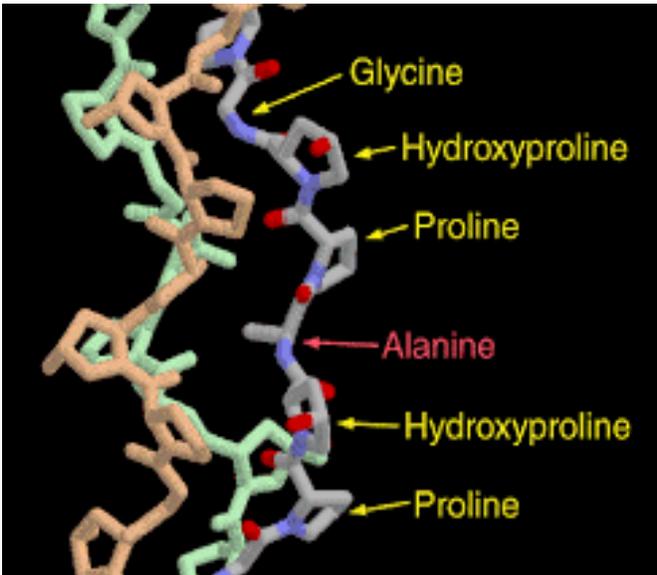
- Based on 2 important criteria, namely **shape** and **solubility**, proteins can be grouped into: Fibrous, Globular or Membrane proteins
- **FIBROUS PROTEINS:**
  - Tend to have relatively **simple**, regular **linear** structures.
  - These proteins often serve **structural roles** in cells.
  - Typically, they are **insoluble in water** or in dilute salt solutions.
  - Example: **collagen** (has 3 polypeptide chains intertwined )

## **GLOBULAR PROTEINS:**

- Are roughly **spherical** in shape.
- Their polypeptide chains are compactly folded - with the hydrophobic A.A side chains in the interior of the molecule & the hydrophilic side chains in contact with the aqueous environment
- Thus, usually very **soluble in aqueous solutions**.
- They often serve **metabolic functions**
- Examples : **myoglobin** and **cytosolic enzymes**.

## MEMBRANE PROTEINS:

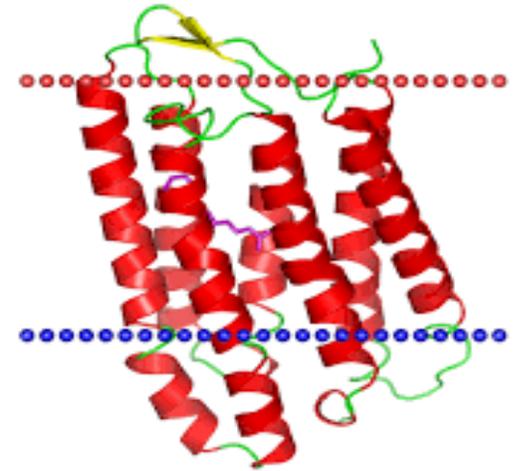
- They are found in association with the various **membrane systems** of cells.
- They **fold** such that their hydrophobic amino acid side chains orient outward (exposed) in their membrane –associated regions
- They are **insoluble in aqueous solutions** but **soluble in a solution of detergent**.
- Membrane proteins characteristically have fewer hydrophilic amino acids than cytosolic proteins.
- **Example:** bacteriorhodopsin



Collagen: a fibrous protein



Myoglobin: globular protein



Bacteriorhodopsin:  
membrane-bound protein