**Topic:**

Proteins Classification

**Proteins Classification**

**Proteins are classified as follows:**

1. On the basis of Structure
2. On the basis of Composition
3. **Classification on the basis of Structure:**

Proteins are classified into two classes on the basis of its structure which are given below:

1. Fibrous Proteins
2. Globular Proteins
3. **Fibrous Proteins:**
* They consist of molecules having polypeptide chains in the form of an elongation or fibrils.
* Secondary structure present.
* They are insoluble in aqueous media.
* They are non-crystalline and elastic in nature.
* They have structural roles in cells and organisms
* **Scleroproteins** or **fibrous proteins** is one of the three main classification of protein structure (alongside globular and membrane proteins).
* Scleroprotein are made up by elongated or fibrous polypeptide chains which form filamentous and sheet like structure. These kind of protein can be distinguished from globular protein by its low solubility in water. The roles of such proteins include protection and structural role by forming connective tissue, tendons, bone matrices, and muscle fiber.
* Scleroprotein consist of many super families including keratin, collagen, elastin, and fibroin. Collagen is the most abundant protein which exists in vertebrae animal as tendon, cartilage and bone

.

**Biomolecular Structure:**

* Scleroprotein forms long protein filaments, which are shaped like rods or wires. Scleroproteins are structural proteins or storage proteins that are typically inert and water-insoluble. A scleroprotein occurs as an aggregate due to hydrophobic side chains that protrude from the molecule.
* A scleroprotein's peptide sequence often has limited residues with repeats; these can form unusual secondary structures, such as a collagen helix. The structures often feature cross-links between chains (e.g., cys-cys disulfide bonds between keratin chains).
* Scleroproteins tend not to denature as easily as globular proteins.
* Miroshnikov et al. (1998) are among the researchers who have attempted to synthesize fibrous proteins.
* **Example:**

Keratin (Hair, skin, nails), Fibrin (of Blood Clot), Collagen, Myosin (muscle cells), Silk Fiber (Silk form and Spider's web)

**Keratin:**

 **Keratin** is one of a family of fibrous structural proteins known as scleroproteins.  α- Keratin is a type of keratin found in vertebrates. It is the key structural material making upscale, hair, nails, feathers, horns, claws, hooves, calluses, and the outer layer of skin among vertebrates. Keratin is an important protein in the **epidermis**. Keratin has two main functions: to adhere cells to each other and to form a protective layer on the outside of the **skin**. In epithelial cells, keratin proteins inside the **cell** attach to proteins called desmosomes on the surface.

**Fibrin:**

 **Fibrin**, an insoluble protein that is produced in response to bleeding and is the major component of the blood clot. When tissue damage results in bleeding, **fibrinogen** is converted at the wound into **fibrin** by the action of thrombin, **a clotting** enzyme. **Fibrin** molecules then combine to form long **fibrin** threads that entangle platelets, building up **a** spongy mass that gradually hardens and contracts to form the **blood clot**.

**Collagen:**

The name *collagen* comes from the Greek, meaning "glue", and denoting "producing". This refers to the compound's early use in the process of boiling the skin and tendons of horses and other animals to obtain glue.

Collagen is the main structural protein in the extracellular matrix in the various connective tissues in the body. As the main component of connective tissue, it is the most abundant protein in mammals, making up from 25% to 35% of the whole-body protein content. Collagen consists of amino acids bound together to form a triple helix of elongated fibril known as a collagen helix. It is mostly found in connective tissues such as cartilage, bones, tendons, ligaments, and skin.

Depending upon the degree of mineralization, collagen tissues may be rigid (bone), compliant (tendon), or have a gradient from rigid to compliant (cartilage). It is also abundant in corneas, blood vessels, the gut, intervertebral discs, and the dentin in teeth. In muscle tissue, it serves as a major component of the endomysium. Collagen constitutes one to two percent of muscle tissue and accounts for 6% of the weight of strong, tendinous, muscles. The fibroblast is the most common cell that creates collagen. Gelatin, which is used in food and industry, is collagen that has been irreversibly hydrolyzed. Collagen has many medical uses in treating complications of the bones and skin.

1. **Globular Proteins:**
* **Globular proteins** or **spheroproteins** are spherical ("globe-like") proteins and are one of the common protein types (the others being fibrous, disordered and membrane proteins). Globular proteins are somewhat water-soluble (forming colloids in water), unlike the fibrous or membrane proteins. There are multiple fold classes of globular proteins, since there are many different architectures that can fold into a roughly spherical shape.
* The term globin can refer more specifically to proteins including the globin fold
* **Globular proteins** are spherical in shape
* Tertiary structure present.
* They soluble in aqueous media.
* They can be crystallized.
* They disorganize with the changes in physical environment.

**Globular Structure and Solubility:**

The term globular protein is quite old (dating probably from the 19th century) and is now somewhat archaic given the hundreds of thousands of proteins and more elegant and descriptive structural motif vocabulary. The globular nature of these proteins can be determined without the means of modern techniques, but only by using ultracentrifuges or dynamic light scattering techniques.

The spherical structure is induced by the protein's tertiary structure. The molecule's a-polar (hydrophobic) amino acids are bounded towards the molecule's interior whereas polar (hydrophilic) amino acids are bound outwards, allowing dipole-dipole interactions with the solvent, which explains the molecule's solubility because the free energy released when the [[1]](https://en.wikipedia.org/wiki/Globular_protein#cite_note-:0-1)protein folded into its native conformation is relatively small. This is because protein folding requires entropic cost. As a primary sequence of a polypeptide chain can form numerous conformations, native globular structure restricts its conformation to a few only. It results in a decrease in randomness, although non-covalent interactions such as hydrophobic interactions stabilize the structure.

Although it is still unknown how proteins fold up naturally, new evidence has helped advance understanding. Part of the protein folding problem is that several non-covalent, weak interactions are formed, such as hydrogen bonds and Van der Waals interactions. Via several techniques, the mechanism of protein folding is currently being studied. Even in the protein's denatured state, it can be folded into the correct structure.

Globular proteins seem to have two mechanisms for protein folding, either the diffusion-collision model or nucleation condensation model, although recent findings have shown globular proteins, such as PTP-BL PDZ2, that fold with characteristic features of both models. These new findings have shown that the transition states of proteins may affect the way they fold. The folding of globular proteins has also recently been connected to treatment of diseases, and anti-cancer ligands have been developed which bind to the folded but not the natural protein. These studies have shown that the folding of globular proteins affects its function.

By the second law of thermodynamics, the free energy difference between unfolded and folded states is contributed by enthalpy and entropy changes. As the free energy difference in a globular protein that results from folding into its native conformation is small, it is marginally stable, thus providing a rapid turnover rate and effective control of protein degradation and synthesis.

**Role:**

Unlike fibrous proteins which only play a structural function, globular proteins can act as:

* Enzymes, by catalyzing organic reactions taking place in the organism in mild conditions and with a great specificity. Different esterases fulfill this role.
* Messengers, by transmitting messages to regulate biological processes. This function is done by hormones, i.e. insulin etc.
* Transporters of other molecules through membranes
* Stocks of amino acids.
* Regulatory roles are also performed by globular proteins rather than fibrous proteins.
* Structural proteins, e.g., actin and tubulin, which are globular and soluble as monomers, but polymerize to form long, stiff fibers
* **Example:**

 Enzymes, Antibodies, Hormones and Hemoglobin.

**Enzymes**:

Enzymes are proteins that act as biological catalysts. Catalysts accelerate chemical reactions. The molecules upon which enzymes may act are called substrates, and the enzyme converts the substrates into different molecules known as products.

**Antibodies:**

Antibodies are secreted into the blood and mucosa, where they bind to and inactivate foreign substances such as pathogens and toxins (neutralization).  Antibodies activate the complement system to destroy bacterial cells by lysis (punching holes in the cell wall).Antibody, also called immunoglobulin, a protective protein produced by the immune system in response to the presence of a foreign substance

**Hormones**:

Hormones are chemical substances that affect the activity of another part of the body (target site). In essence, hormones serve as messengers, controlling and coordinating activities throughout the body. Adrenaline is an example of a hormone that is under the control of the nervous system. Pancreas– an organ of digestion which is inside the abdomen. It makes insulin, which controls the amount of sugar in the bloodstream

**Hemoglobin**:

Hemoglobin contains the prosthetic group known as heme. Each heme group contains an iron ion (Fe2+) which forms a co-ordinate bond with an oxygen molecule (O2), allowing hemoglobin to transport oxygen through the bloodstream. As each of the four protein subunits of hemoglobin possesses its own prosthetic heme group, each hemoglobin can transport four molecules of oxygen.

1. **Classification on the basis of Composition:**

Proteins are classified into two classes on the basis of their composition which are given below:

1. Simple Proteins
2. Conjugated Proteins
3. **Simple Proteins:**
* The proteins which composed of entirely amino acids only or yield amino acids on hydrolysis are called simple proteins.
* **Example:**

 Albumin, Globulin, Histones etc.

**Albumin:**

 **Albumin** is a water soluble **(**Albumins in general are transport proteins) keeps fluid from leaking out of blood vessels, nourishes tissues, and transports hormones, vitamins, drugs, and substances like calcium throughout the body.

**Globulins**:

(The normal concentration of globulins in human blood is about 2.6-4.6 g/dL.) make up the remaining 40% of proteins in the blood.

**Histones:**

In biology, **histones** are highly basic proteins found in eukaryotic cell that pack and order the [DNA](https://en.wikipedia.org/wiki/DNA) into structural units called nucleosomes. Histones are abundant in [lysine](https://en.wikipedia.org/wiki/Lysine). Lysine is a building block for protein. It's an essential amino acid because your body cannot make it, so you need to obtain it from food. It's important for normal growth and muscle turnover and used to form carnitine, a substance found in most cells of your body and arginine. Arginine is an essential amino acid in juvenile humans, Arginine is a complex amino acid, often found at active site in proteins and enzymes due to its amine-containing side chain. Histones are the chief protein components of chromatin acting as spools around which DNA winds, and playing a role in gene regulation. Chromatin is a complex of DNA and proteins found in eukaryotic cells.[[1]](https://en.wikipedia.org/wiki/Chromatin#cite_note-1) Its primary function is packaging long DNA molecules into more compact, denser structures. This prevents the strands from becoming tangled and also plays important roles in reinforcing the DNA during cell division, preventing DNA damage, and regulating gene expression and DNA replication. A nucleosome is the basic structural unit of DNA packaging in eukaryotes. The structure of a nucleosome consists of a segment of DNA wound around eight histone protein and resembles thread wrapped around a spool. The nucleosome is the fundamental subunit of chromatin.

1. **Conjugated protein**
* A **conjugated protein** is a protein that functions in interaction with other chemical groups attached by covalent bonding or weak interactions
* These proteins yield some other chemical component in addition to amino acids on hydrolysis.
* The non-amino part of a conjugated protein is usually called its Prosthetic group. Most Prosthetic group are formed from vitamins.
* Conjugated proteins are classified on the basis of the chemical nature of their prosthetic groups.
* **Examples**:

Lipoproteins, Glycoproteins, Phosphoproteins, Hemoproteins, Flavoproteins, Metalloprotein, Phytochromes, Cytochromes, Opsins and Chromoproteins.

**Lipoprotein:**

They consist of lipids (fat) and proteins.

**Glycoproteins:**

Glycoproteins are proteins which contain oligosaccharide chains covalently attached to amino acid side-chains. The carbohydrate is attached to the protein in a cotranslational or posttranslational modification. This process is known as glycosylation

**Multiple Choice Questions**

**1. Which of the following factors is not responsible for the denaturation of proteins?**

(a) Heat

(b) Charge

(c) PH change

(d) Organic solvents

**Sol: (b) Charge**

**2. \_\_\_\_\_\_\_\_is not a classified form of conjugated proteins.**

(a) Lipoproteins

(b) Glycoproteins

(c) Metalloproteins

(d) Complete proteins

**Sol: (d) Complete proteins**

**4. Which of the following proteins was first sequenced by Frederick Sanger?**

(a) Myosin

(b) Insulin

(c) Myoglobin

(d) Haemoglobin

**Sol: (b) Insulin**

**5. Which of the following is true about enzymes?**

(a) Proteins

(b) Nucleic acids

(c) Carbohydrates

(d) DNA molecule

**Sol: (a) Proteins**

**6. Myoglobin is:**

(a) Protein with primary structure

(b) Protein with secondary structure

(c) Protein with tertiary structure

(d) Protein with quaternery structure

**Sol: (c) Protein with tertiary structure**

**7. Tertiary structure is maintained by**

(a) Peptide bond

(b) Hydrogen bond

(c) Di-sulphide bond

(d) All of the above

**Sol: (d) All of the above**

**8. Histones are rich in**

(a) Lysine

(b) Arginine

(c) Histidine

(d) Lysine and Arginine

**Sol: (d) Lysine and Arginine**

**9**. **Which of the following is obtained by heating bones and tendons in the water?**

(a) Gelatin

(b) Enzyme

(c) Amylase

(d) Lactase

**Sol: (a**) **Gelatin**

**10**. **Which structural organization is most common in globular proteins?**

(a) Primary

(b) Secondary

(c) Tertiary

(d) Quaternary

**Sol: (c) Tertiary**