



Proteins Classification

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Proteins

Proteins are macromolecules composed of amino acids linked together with peptide bonds

Classification based on the source of proteins

Animal proteins

- ❖ Derived from animal sources such as eggs, milk, meat and fish.
- ❖ Usually called **higher-quality proteins** because they contain adequate amounts of all the essential amino acids.

Plant proteins

- ❖ *Lower-quality proteins* since they have a low content (limiting amount) of one or more of the essential amino acids.
- ❖ The **four most common limiting amino acids are methionine, lysine, threonine and tryptophan.**

Classification based on the shape of protein molecules

Globular Proteins

- ❖ Possessed an axial ratio (length : width) of less than 10 (usually not over 3 or 4)
- ❖ Relatively spherical or ovoid shape.
- ❖ Usually soluble in water or in aqueous media containing acids, bases, salts or alcohol and diffuse readily.
- ❖ Usually associated with tertiary and quaternary structures
- ❖ **Perform a great variety of biological functions and are dynamic rather than static in their activities.**
- ❖ Examples include enzymes, protein hormones, blood transport proteins, antibodies and nutrient storage proteins.
- ❖ A simple functional classification of globular proteins is not possible because of two reasons
 - **These proteins perform a variety of different functions.**
 - **Many widely-differing globular proteins perform almost similar functions.**

Conn and Stumpf (1976) have classified globular proteins into 9 groups

- ❖ **Cytochrome C**
- ❖ **Blood proteins**
- ❖ **Serum albumin**
- ❖ **Glycoproteins**
- ❖ **Antibodies (= Immunoglobulins)**
- ❖ **Hemoglobin**

- ❖ **Hormones**
- ❖ **Enzymes**
- ❖ **Nutrient proteins**

Fibrous or Fibrillar Proteins

- ❖ Axial ratios greater than 10 and, resemble long ribbons or fibers in shape.
- ❖ **Mainly of animal origin and are insoluble in all common solvents** (water, dilute acids, alkalis and salts and also in organic solvents).
- ❖ Extremely strong and possess two important properties (a) **stretchable and later recoil to their original length.** (b) **They have a tendency to creep, i.e., if stretched for a long time, their basic length increases and equals the stretched length but, if the tension on the two ends of the fibril is relaxed, they creep to their shorter and shorter length.**
- ❖ A large scar, for example, creeps to a smaller size if there is no tension on the scar. On the contrary, if the scar is in a region of high tension, the scar becomes larger and larger as happens in the skin of a person gradually becoming obese.
- ❖ Mostly serve a structural or protective role.
- ❖ It includes the proteins of connective tissues, bones, blood vessels, skin, hair, nails, horns, hoofs, wool and silk.

Some of the most abundant animal fibrous proteins are described below

- ❖ **Collagens**
 - ❖ Mesenchymal origin
 - ❖ Major proteins of white connective tissues (tendons, cartilage) and bone.
 - ❖ More than half the total protein in the mammalian body is collagen
 - ❖ Produce soluble gelatins upon boiling in water, dilute acids or alkalis.
 - ❖ Contains high contents (12%) of hydroxyproline.
 - ❖ Poor in sulfur due to lack of cysteine and cystine.
- ❖ **Elastins**
 - ❖ Mesenchymal origin.
 - ❖ Major constituents of yellow elastic tissues (ligaments, blood vessels).
 - ❖ Differ from collagens in not being converted to soluble gelatins.
- ❖ **Keratins**
 - ❖ Ectodermal origin
 - ❖ Major constituents of epithelial tissues (skin, hair, feathers, horns, hoofs, nails)
 - ❖ Contain large amounts of sulfur in the form of cysteine– human hair has about 14% of cysteine.
- ❖ **Fibroin**
 - ❖ Principal constituent of the fibres of silk

- ❖ Composed mainly of glycine, alanine and serine units
- ❖ Insoluble in water and organic solvent

Classification based on composition and solubility

The most accepted system of classification is based on the recommendations made by the committees of *British Physiological Society* (1907) and the *American Physiological Society* (1908). The system divides the proteins into 3 major groups based on their composition

- ❖ Simple Proteins or Holoproteins
- ❖ Conjugated or Complex Proteins or Heteroproteins.
- ❖ Derived Proteins.

Simple Proteins or Holoproteins

- ❖ Mostly globular (except scleroproteins are fibrous in nature).
- ❖ Only consist of amino acids as structural components.
- ❖ These are further classified mainly on their solubility basis as follows

Protamines and Histones

- ❖ **Low molecular weight**, strongly basic (high contents of lysine, arginine) in nature, soluble in water, not coagulated by heat
- ❖ Protamines are mainly found in sperm cells.
- ❖ Histones are nucleoproteins found in chromosomes of all the eukaryotes

Albumins

- ❖ Widely distributed in nature specifically in seeds.
- ❖ Soluble in water and dilute solutions of acids, bases and salts.
- ❖ Coagulated by heat.
- ❖ e.g., leucosine in cereals, legumeline in legumes, ovalbumin from white of egg, serum albumin from blood plasma, myosin of muscles and lactalbumin of milk whey.

Globulins

- ❖ Mainly of two types: pseudoglobulins (water soluble) and euglobulins (water insoluble)
- ❖ Euglobulins are widely distributed in nature
- ❖ Include serum globulin from blood plasma, *ovoglobulin* from egg white; *myosinogen* from muscle; globulins of various plant seeds like hemp (*edestin*), soybeans (*glycinine*), peas (*legumine*), peach (*amandine*), oranges (*pomeline*); also potato (*tuberin*).

- ❖ Lesser abundant in nature e.g., than the pseudoglobulins (water soluble)
- ❖ e.g., pseudoglobulins of milk whey.

Glutelins

- ❖ Present in plant seeds.
- ❖ Insoluble in water, dilute salt solutions and alcohol solutions but soluble in dilute acids and alkalis
- ❖ Coagulated by heat e.g., *glutenin* from wheat, *glutelin* from corn, *oryzenin* from rice, etc.

Prolamins

- ❖ Only present in plant seeds
- ❖ Insoluble in water and dilute salt solutions but soluble in dilute acids and alkalis and also in 60 – 80% alcohol solutions;
- ❖ Not coagulated by heat e.g., *gliadin* from wheat, *zein* from corn, *hordein* from oat etc.

Scleroproteins or Albuminoids

- ❖ Present only in animals and commonly known as the ‘*animal skeleton proteins*’.
- ❖ insoluble in water
- ❖ e.g., collagen of bones, *elastin* in ligaments, *keratin* in hair and *fibroin* of silk.

Conjugated or Complex Proteins or Heteroproteins

- ❖ Proteins linked with a separable non-protein portion called ***prosthetic group***.
- ❖ Prosthetic group may be either a metal or a organic compound.
- ❖ ***On decomposition with acids, these liberate the constituent amino acids as well as the prosthetic group.***
- ❖ Mostly of globular type except for the pigment in chicken feathers which is probably of fibrous nature.
- ❖ Conjugated proteins can be further classified on the basis of the type of prosthetic group present.
 - ❖ Metalloproteins,
 - ❖ Chromoproteins
 - ❖ Glycoproteins
 - ❖ Phosphoproteins
 - ❖ Lipoproteins
 - ❖ Nucleoproteins

(Instead of metalloproteins, chromoproteins etc., the terms metalloproteids, chromoproteids etc., are sometimes used.)

Metalloproteins

- ❖ Proteins linked with various metals such as iron, zinc, copper, calcium, selenium, magnesium and nickel.
- ❖ Metal may bind weakly (cofactor) or tightly (prosthetic group) to the proteins
 - ❖ Iron containing protein (Hemoglobin, Myoglobin, cytochromes, ferritin etc)
 - ❖ Copper containing proteins (Ceruloplasmin , Oxidase enzymes)
 - ❖ Zn containing proteins (Carbonic anhydrase)
 - ❖ Mg containing proteins (Kinases and phosphatases)

Chromoproteins

- ❖ Proteins coupled with a colored pigment.
- ❖ Such pigments have also been found in the enzymes like catalase, peroxidase and flavoenzymes.
- ❖ Chlorophyll in the form of chloroplastin in leaf cells.
- ❖ Other examples are *myoglobin*, *hemoglobin*, *hemocyanin*, *hemoerythrin*, *cytochromes*, *flavoproteins*, *catalase*, etc.

Glycoproteins and Mucoproteins

- ❖ Proteins containing carbohydrate as prosthetic group
- ❖ Glycoproteins contain small amounts of carbohydrates (less than 4%)
- ❖ Whereas mucoproteins contain comparatively higher amounts (more than 4%)
- ❖ Glycoproteins— *egg albumin*, elastase, certain *serum globulins* and certain *serum albumins*. Mucoproteins— *ovomuroid* from eggwhite, *mucin* from saliva and *Dioscorea* tubers, *osseomuroid* from bone and *tendomuroid* from tendon.

Phosphoproteins

- ❖ Proteins linked with phosphoric acid
- ❖ Mostly acidic in nature. *e.g.*, *casein* from milk and *ovovitellin* from egg yolk.

Lipoproteins

- ❖ Proteins forming complexes with lipids (cephalin, lecithin, cholesterol)
- ❖ Soluble in water but insoluble in organic solvents.
- ❖ *Examples are lipovitellin* and *lipovitellenin* from egg yolk; lipoproteins of blood such as VLDL, IDL, LDL, HDL etc.

Nucleoproteins

- ❖ Proteins associated with nucleic acid, i.e., protamines and histones.

Derived Proteins

- ❖ Derivatives of proteins resulting from the action of heat, enzymes or chemical reagents.

- ❖ This group also includes the artificially-produced polypeptides.

Primary derived proteins

- ❖ Protein derivatives in which the size of protein molecules is not altered materially.

Proteans

- ❖ Insoluble in water
- ❖ Appear as the first product produced by the action of acids, enzymes or water on proteins. *e.g.*, *edestan* derived from edestin and *myosan* derived from myosin.

Metaproteins or Infraproteins

- ❖ Insoluble in water but soluble in dilute acids or alkalis.
- ❖ Produced by further action of acid or alkali on proteins at about 30–60°C. *e.g.*, *acid* and *alkali metaproteins*.

Coagulated Proteins

- ❖ Insoluble in water produced by the action of heat or alcohol on proteins. *e.g.*, *coagulated egg white*.

Secondary derived proteins.

- ❖ Hydrolytic products of proteins.
- ❖ Smaller than the original proteins.

Proteoses

- ❖ Soluble in water
- ❖ Coagulable by heat
- ❖ Produced when hydrolysis proceeds beyond the level of metaproteins *e.g.*, *albumose* from albumin; *globulose* from globulin.

Peptones

- ❖ Soluble in water
- ❖ Non-coagulable by heat
- ❖ Produced by the action of dilute acids or enzymes when hydrolysis proceeds beyond proteoses.

Peptides

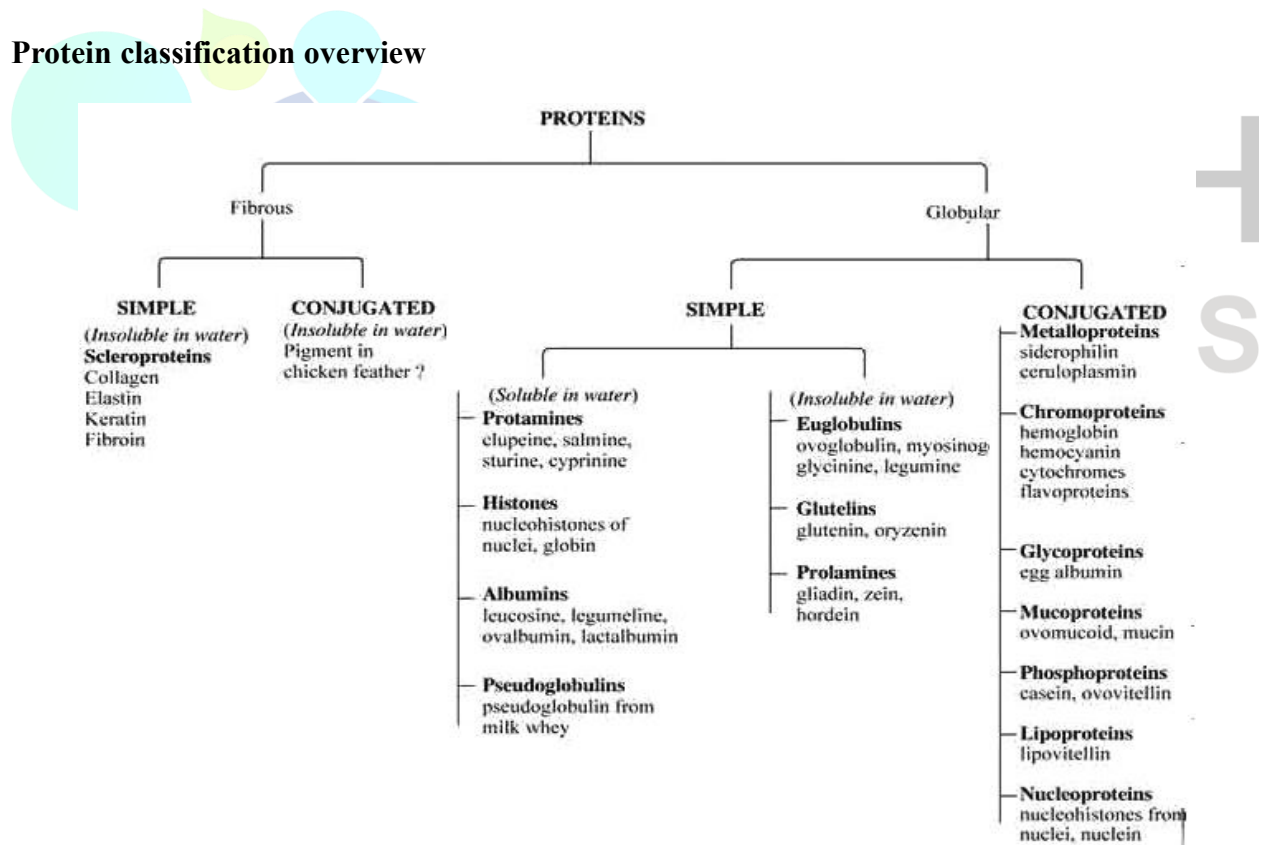
- ❖ These are combinations of two or more amino acid units.

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Table: Classification based on biological function

<i>Class of protein</i>	<i>Function</i>	<i>Examples</i>
Enzyme proteins	Biological catalysts	Alcohol dehydrogenase, Cytochrome C, Urease, Amylase, Catalase,
Structural proteins	Strengthening or protecting biological structures	Collagen, Elastin, Keratin, Fibroin
Transport or carrier proteins	Transport of ions or molecules	Hemoglobin, Myoglobin
Nutrient and storage proteins	Provide nutrition to growing embryos and store ions	Ovalbumin, Casein, Ferritin
Contractile or motile proteins	Function in the contractile system	Actin, Myosin, Tubulin system
Defense proteins	Defend against other organisms	Antibodies, Fibrinogen, Thrombin
Regulatory proteins	Regulate cellular or metabolic activities	Insulin, G proteins, Growth hormone
Toxic proteins	Hydrolyze (or degrade) enzymes	Snake venom, Ricin

Protein classification overview



References

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