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CLASSIFICATION OF PROTEINS

Proteins are classified based on their

- Solubility and composition
- Function
- Shape & size

A. Classification based on solubility and composition

According to this classification, proteins are divided into three main groups as
simple, conjugated and derived proteins.

1. **Simple proteins**

Simple proteins yield on hydrolysis, only amino acids.
These proteins are further classified based on their solubility in different solvents
as well as their heat coagulability.

- **Albumins**

Albumins are readily soluble in water, dilute acids and alkalies
coagulated by heat.
Seed proteins contain albumin in lesser quantities.
Albumins may be precipitated out from solution using high salt concentration, a
process called 'salting out'.
They are deficient in glycine.
Serum albumin and ovalbumin (egg white) are examples.

- **Globulins**

Globulins are insoluble or sparingly soluble in water, but their solubility is greatly increased by the addition of neutral salts such as sodium chloride.
These proteins are coagulated by heat.
They are deficient in methionine.
Serum globulin, fibrinogen, myosin of muscle and globulins of pulses are examples.

- **Prolamins**

Prolamins are insoluble in water but soluble in 70-80% aqueous alcohol.

Upon hydrolysis they yield much proline and amide nitrogen, hence the name
prolamin.
They are deficient in lysine.
Gliadin of wheat and zein of corn are examples of prolamins.

- **Glutelins**

Glutelins are insoluble in water and absolute alcohol but soluble in dilute alkalies and acids.
They are plant proteins e.g., glutenin of wheat.

- **Histones**

Histones are small and stable basic proteins
They contain fairly large amounts of basic amino acid, histidine.
They are soluble in water, but insoluble in ammonium hydroxide.
They are not readily coagulated by heat.
They occur in globin of hemoglobin and nucleoproteins.

- **Protamines**

Protamines are the simplest of the proteins.
They are soluble in water and are not coagulated by heat.
They are basic in nature due to the presence of large quantities of arginine.
Protamines are found in association with nucleic acid in the sperm cells of
certain fish.
Tyrosine and tryptophan are usually absent in protamines.

- **Albuminoids**

  These are characterized by great stability and insolubility in water and salt solutions.

These are called albuminoids because they are essentially similar to albumin and
globulins.
They are highly resistant to proteolytic enzymes.
They are fibrous in nature and form most of the supporting structures of animals.
They occur as chief constituent of exoskeleton structure such as hair, horn and
nails.

2. **Conjugated or compound proteins**

These are simple proteins combined with some non-protein substances known as prosthetic groups.
The nature of the non-protein or prosthetic groups is the basis for the sub
classification of conjugated proteins.

- **Nucleoproteins**

Nucleoproteins are simple basic proteins (protamines or histones) in salt combination with nucleic acids as the prosthetic group.
They are the important constituents of nuclei and chromatin.

- **Mucoproteins**

These proteins are composed of simple proteins in combination with carbohydrates like mucopolysaccharides, which include hyaluronic acid and

- **Chromoproteins**

chondroitin sulphates.
On hydrolysis, mucopolysaccharides yield more than 4% of amino-sugars,
hexosamine and uronic acid e.g., ovomucoid from egg white.
Soluble mucoproteins are neither readily denatured by heat nor easily precipitated by common protein precipitants like trichloroacetic acid or picric acid.
The term glycoproteins are restricted to those proteins that contain small amounts of carbohydrate usually less than 4% hexosamine.
These are proteins containing coloured prosthetic groups e.g., haemoglobin,
flavoprotein and cytochrome.

- **Lipoproteins**

These are proteins conjugated with lipids such as neutral fat, phospholipids and cholesterol

- **Metalloproteins**

These are metal-binding proteins.
A _-globulin, termed transferrin is capable of combining with iron, copper and zinc.
This protein constitutes 3% of the total plasma protein.
Another example is ceruloplasmin, which contains copper.

- **Phosphoproteins**

These are proteins containing phosphoric acid.
Phosphoric acid is linked to the hydroxyl group of certain amino acids like serine
in the protein e.g., casein of milk.

3. **Derived proteins**

These are proteins derived by partial to complete hydrolysis from the simple or
conjugated proteins by the action of acids, alkalies or enzymes.
They include two types of derivatives, **primary-derived proteins and secondary-derived proteins.**

Primary-derived proteins

These protein derivatives are formed by processes causing only slight changes
in the protein molecule and its properties.
There is little or no hydrolytic cleavage of peptide bonds.

- **Proteans**

Proteans are insoluble products formed by the action of water, dilute acids and
enzymes.
These are particularly formed from globulins but are insoluble in dilute salt
Solutions e.g., myosan from myosin, fibrin from fibrinogen.

- **Metaproteins**

These are formed by the action of acids and alkalies upon protein.
They are insoluble in neutral solvents.

- **Coagulated proteins**

Coagulated proteins are insoluble products formed by the action of heat or
alcohol on natural proteins
e.g., cooked meat and cooked albumin.

Secondary-derived proteins

These proteins are formed in the progressive hydrolytic cleavage of the peptide
bonds of protein molecule.
They are roughly grouped into proteoses, peptones and peptides according
to average molecular weight.
Proteoses are hydrolytic products of proteins, which are soluble in water and are
not coagulated by heat.
Peptones are hydrolytic products, which have simpler structure than proteoses.
They are soluble in water and are not coagulated by heat.
Peptides are composed of relatively few amino acids.
They are water-soluble and not coagulated by heat.
The complete hydrolytic decomposition of the natural protein molecule into amino
acids generally progresses through successive stages as follows:
Protein -----> Protean -------_□Metaprotein
Proteoses ------>□Peptones ------->□Peptides ------_□amino acids

B. Classification of proteins based on function

Proteins are classified based on their functions as:

1. **Catalytic proteins – Enzymes**

The most striking characteristic feature of these proteins is their ability to function within the living cells as biocatalysts**.**
These biocatalysts are called as enzymes.
Enzymes represent the largest class.
Nearly 2000 different kinds of enzymes are known, each catalyzing a different
kind of reaction.
They enhance the reaction rates a million fold.

2. **Regulatory proteins - Hormones**

These are polypeptides and small proteins found in relatively lower concentrations in animal kingdom but play highly important regulatory role in
maintaining order in complex metabolic reactions
e.g., growth hormone, insulin etc.

3. **Protective proteins - Antibodies**

These proteins have protective defense function.
These proteins combine with foreign protein and other substances and fight
against certain diseases.
e.g., immunoglobulin.
These proteins are produced in the spleen and lymphatic cells in response to
foreign substances called antigen.
The newly formed protein is called antibody which specifically combines with the
antigen which triggered its synthesis thereby prevents the development of
diseases.
Fibrin present in the blood is also a protective protein.

4. **Storage proteins**

It is a major class of proteins which has the function of storing amino acids as
nutrients and as building blocks for the growing embryo.
Storage proteins are source of essential amino acids, which cannot be synthesized by human beings.
The major storage protein in pulses is globulins and prolamins in cereals.
In rice the major storage protein is glutelins.
Albumin of egg and casein of milk are also storage proteins.

5. **Transport proteins**

Some proteins are capable of binding and transporting specific types of molecules through blood.

Haemoglobin is a conjugated protein composed of colourless basic protein, the globin and ferroprotoporphyrin or haem.

It has the capacity to bind with oxygen and transport through blood to various tissues.

Myoglobin, a related protein, transports oxygen in muscle.

Lipids bind to serum proteins like albumin and transported as lipoproteins in the blood.

6. **Toxic proteins**

Some of the proteins are toxic in nature.

Ricin present in castor bean is extremely toxic to higher animals in very small amounts.

Enzyme inhibitors such as trypsin inhibitor bind to digestive enzyme and prevent the availability of the protein.

Lectin, a toxic protein present in legumes, agglutinates red blood cells.

A bacterial toxin causes cholera, which is a protein.

Snake venom is protein in nature.

7. **Structural proteins**

These proteins serve as structural materials or as important components of extra cellular fluid.

Examples of structural proteins are myosin of muscles, keratin of skin and hair and collagen of connective tissue**.**

Carbohydrates, fats, minerals and other cellular components are organized around such structural proteins that form the molecular framework of living material.

8. **Contractile proteins**

Proteins like actin and myosin function as essential elements in contractile system of skeletal muscle.

9. **Secretary proteins**

Fibroin is a protein secreted by spiders and silkworms to form webs and cocoons.

10. **Exotic proteins**

Antarctic fishes live in -1.9oC waters, well below the temperature at which their
blood is expected to freeze.

These fishes are prevented from freezing by antifreeze glycoproteins present
in their body.

C. Classification based on size and shape

Based on size and shape, the proteins are also subdivided into globular and fibrous proteins.

1. **Globular proteins** are mostly water-soluble and fragile in nature
   e.g., enzymes, hormones and antibodies.

2. **Fibrous proteins** are tough and water-insoluble.

They are used to build a variety of materials that support and protect specific
   tissues, e.g., skin, hair, fingernails and keratin

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