Classification of proteins

Dr Ali Taha

Classes of proteins

Functional definition:

Enzymes: Accelerate biochemical reactions

Structural: Form biological structures

Transport: Carry biochemically important substances

Defense: Protect the body from foreign invaders

Structural definition:

Globular: Complex folds, irregularly shaped tertiary structures

Fibrous: Extended, simple folds -- generally structural proteins

Cellular localization definition:

Membrane: In direct physical contact with a membrane; generally water insoluble.

Soluble: Water soluble; can be anywhere in the cell.

Classification of proteins is done on the basis of the following:

- Shape
- Constitution
- Nature of molecules

On the basis of shape

Fibrous protein (Scleroprotein): We can find these proteins in animals and are insoluble in water. Fibrous proteins are resistant to proteolytic enzymes and are coiled and exist in threadlike structures to form fibres. e.g. collagen, actin, and myosin, keratin in hair, claws, feathers, etc.

Globular proteins: These proteins, unlike fibrous proteins are soluble in water. They are made up of polypeptides that are coiled about themselves to form oval or spherical molecules e.g. albumin, insulin, and hormones like oxytocin, etc.

On the basis of Constitution

(a) Simple proteins. On hydrolysis they yield only the amino acids and occasional small carbohydrate compounds. Examples are: albumins, globulins, glutelins, albuminoids, histones and protamines.

(b) Conjugated proteins. These are simple proteins combined with some non-protein material in the body. Examples are: nucleoproteins, glycoproteins, phosphoproteins, haemoglobins and lecithoproteins.

(c) Derived proteins. These are proteins derived from simple or conjugated proteins by physical or chemical means. Examples are: denatured proteins and peptides.

I- Simple proteins:

Examples:

1- Albumin and globulins: present in egg, milk and blood

They are proteins of high biological value i.e. contain all essential amino acids and easily digested.

Types of globulins:

α1 globulin: e.g. antitrypsin: see later

α2 globulin: e.g. hepatoglobin: protein that binds hemoglobin to prevent its excretion by the kidney

β-globulin: e.g. transferrin: protein that transport iron

γ-globulins = **Immunoglobulins** (antibodies) : responsible for immunity.

2- Globins (Histones): They are basic proteins rich in histidine amino acid.

They are present in : a- combined with DNA

b- combined with heme to form hemoglobin of RBCs.

3- Gliadines are the proteins present in cereals.

4- Scleroproteins: They are structural proteins, not digested.

Include: keratin, collagen and elastin.

a- α-keratin: protein found in hair, nails, enamel of teeth and outer layer of skin.

- It is α-helical polypeptide chain, rich in cysteine and hydrophobic (non polar) amino acids so it is water insoluble.

b- collagens: protein of connective tissues found in bone, teeth, cartilage, tendons, skin and blood vessels.

- Collagen may be present as gel e.g. in extracellular matrix or in vitreous humor of the eye.
- Collagens are the most important protein in mammals. They form about 30% of total body proteins.
- There are more than 20 types of collagens, the most common type is **collagen I** which constitutes about 90% of cell collagens.
- **Structure of collagen:** three helical polypeptide chains (trimeric) twisted around each other forming triplet-helix molecule.
- ⅓ of the structure is glycine, 10% proline, 10% hydroxyproline and 1% hydroxylysine. Glycine is found in every third position of the chain. The repeating sequence –Gly-X-Y-, where X is frequently proline and Y is often hydroxyproline and can be hydroxylysine.

Solubility: collagen is insoluble in all solvents and not digested.

- When collagen is heated with water or dil. HCl it will be converted into **gelatin** which is soluble , digestible and used as diet (as jelly). Gelatin is classified as derived protein.

Some collagen diseases:

1- Scurvy: disease due to deficiency of vitamin C which is important coenzyme for conversion of proline into hydroxyproline and lysine into hydroxylysine. Thus, synthesis of collagen is decreased leading to abnormal bone development, bleeding, loosing of teeth and swollen gum.

2- Osteogenesis Imperfecta (OI): Inherited disease resulting from a genetic deficiency or mutation in gene that synthesizes collagen type I leading to abnormal bone formation in babies and frequent bone fracture in children. It may be lethal.

C- Elastin: present in walls of large blood vessels (such as aorta). It is very important in lungs, elastic ligaments, skin, cartilage, ..
It is elastic fiber that can be stretched to several times as its normal length.

Structure: composed of 4 polypeptide chains (tetramer), similar to collagen being having 33% glycine and rich in proline but in that it has low hydroxyproline and absence of hydroxy lysine.

Emphysema: is a chronic obstructive lung disease (obstruction of air ways) resulting from deficiency of α1-antitrypsin particularly in cigarette smokers.

Role of α1-antitrypsin: Elastin is a lung protein. Smoke stimulate enzyme called elastase to be secreted form neutrophils (in lung). Elastase cause destruction of elastin of lung.

b- Copper containing proteins:

e.g. - Ceruloplasmin which oxidizes ferrous ions into ferric ions.
- Oxidase enzymes such as cytochrome oxidase.

c- Zn containing proteins: e.g. Insulin and carbonic anhydrase

d- Mg containing proteins: e.g. Kinases and phosphatases.

6-Chromoproteins: These are proteins conjugated with pigment. e.g.

- All proteins containing heme (Hb, myoglobin, ……..)
- Melanoprotein:e.g proteins of hair or iris which contain melanin.

Derived proteins

Produced from hydrolysis of simple proteins.

e.g. - Gelatin: from hydrolysis of collagen
- Peptone: from hydrolysis of albumin

α1-antitrypsin is an enzyme (secreted from liver) and inhibit elastase and prevent destruction of elastin. So deficiency of α1-antitrypsin especially in smokers leads to degradation of lung and destruction of lung (loss of elasticity of lung, a disease called emphysema.

Conjugated proteins

i.e. On hydrolysis, give protein part and non protein part and subclassified into:

1- Phosphoproteins: These are proteins conjugated with phosphate group. Phosphorus is attached to oh group of serine or threonine.
e.g. Casein of milk and vitellin of yolk.

2- Lipoproteins:

These are proteins conjugated with lipids.

Functions: a- help lipids to transport in blood

b- Enter in cell membrane structure helping lipid soluble substances to pass through cell membranes.

3- Glycoproteins:

proteins conjugated with sugar (carbohydrate)

e.g. – Mucin

- Some hormones such as erythropoietin
- present in cell membrane structure
- blood groups.

4- Nucleoproteins: These are basic proteins (e.g. histones) conjugated with nucleic acid (DNA or RNA).

e.g. a- chromosomes: are proteins conjugated with DNA

b- Ribosomes: are proteins conjugated with RNA

5- Metalloproteins: These are proteins conjugated with metal like iron, copper, zinc, ……

a- Iron-containing proteins: Iron may present in heme such as in

- hemoglobin (Hb)
- myoglobin (protein of skeletal muscles and cardiac muscle),
- cytochromes,
- catalase, peroxidases (destroy H_2O_2)
- tryptophan pyrrolase (desrtroy indole ring of tryptophan).

Iron may be present in free state (not in heme) as in:

- Ferritin: Main store of iron in the body. ferritin is present in liver, spleen and bone marrow.

- Hemosidrin: another iron store.

- Transferrin: is the iron carrier protein in plasma.