

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

In the name of Allah, Most Gracious, Most Merciful.

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CLASSIFICATION OF PROTEINS

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Learning Objectives

Various ways of classification

- On the basis of shape and size
- Functional classification
- Based on solubility and chemical nature
- Properties of proteins
- Functions of proteins

ON THE BASIS OF SHAPE (structural classification)

Fibrous

- Axial ratio (Length: Width) of protein molecule is more than 10. these are thread like
- e.g., α -Keratin from hair, Collagen

Globular

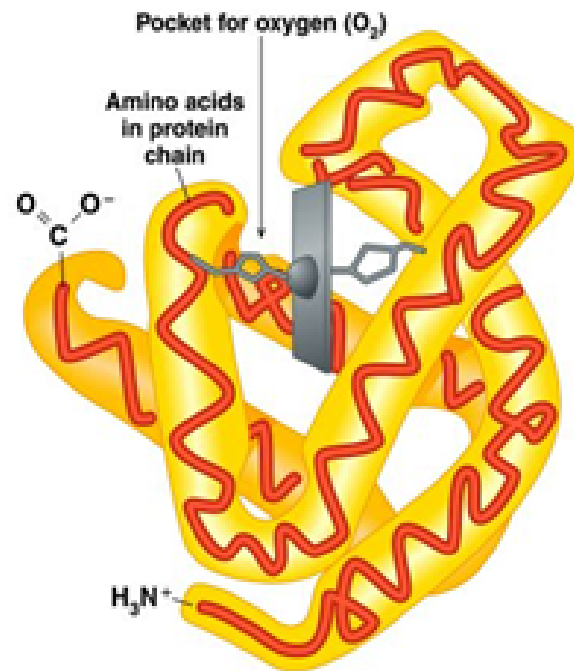
- Axial ratio is less than 10. These are spherical in shape e.g., Hb, Myoglobin, Albumin, globulin etc,

Globular Proteins

- Globular proteins fold up into compact, spherical shapes
- Their functions include biosynthesis, transport and metabolism
- For example, myoglobin is a globular protein that stores oxygen in the muscles

- myoglobin is a single peptide chain that is mostly α -helix

- the O_2 binding pocket is formed by a heme group and specific amino acid side-chains that are brought into position by the tertiary structure



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2. On the basis of Functional Properties: (functional classification)

- A. Defense Proteins: Immunoglobins
- B. Contractile Proteins: Actin & Myosin filaments
- C. Respiratory Proteins: Hb., Mb., Cytochromes
- D. Structural Proteins: Collagen, Keratin, Elastin
- E. Enzyme: All enzymes are protein in nature.

F. Hormones(regulatory proteins):

Insulin, Glucagon, GH, etc

G. Storage Proteins: Ovalbumin,
Casein, Gluten, & Gliadin

H. Transport Proteins: Transferrin,
Ceruloplasmin

I. Genetic Proteins: Histones &
Protamines

3. Physico chemical classification:

Divided into *Three* different sub classes

A. Simple Proteins:

B. Conjugated Proteins:

C. Derived Proteins:

simple

- On hydrolysis yield only amino acids

conjugated

- Contain prosthetic group(non-protein) in addition to amino acid
- Eg nucleoproteins, glycoproteins etc

derived

- Formed from simple and conjugated

CLASSIFICATION OF PROTEINS

Simple

Conjugated

Derived

Globular

Scleroproteins

Nucleoprotein

Primary

Secondary

Albumin

Globulin

Glutelins

Protamines

Histones

Globins

Collagen

Elastin

Keratin

Glycoproteins
(Mucoproteins)

Lipoproteins

Phosphoprotein

Chromoprotein

Metalloprotein

Coagulated
Proteins

Protean

Meta
protein

Proteoses

Peptones

Polypepti-
des

Peptides

SIMPLE PROTEINS

SIMPLE PROTEINS

» Further classified into

1. Protamine
2. Histone
3. Albumin
4. Globulin
5. Prolamin (gliadins, glutelins)
6. Scleroprotein or albuminoid

1. Protamine

- » Soluble in water, acids, bases, ammonia
- » Non-coagulable by heat
- » Rich in arginine so are basic proteins
- » Isoelectric PH is around 7.4
- » Form nucleoproteins
- » Examples salmine, sardinine from fish.

medical importance (antidote for heparin)

2.Histones

- » Rich in arginine and histidine
- » Soluble in H₂O, acid, salt solutions but insoluble in ammonia
- » **DONOT** coagulate on heating
- » Forms nucleoproteins
- » E.g nucleohistones, globin of Hb

3. Albumins

- » Soluble in H₂O & dilute salt solution.
- » Coagulated by heat.
- » low isoelectric PH ,so exist as acidic proteins at PH 7.4
- » Examples ; ovalbumin, legumelin

Medical importance: Maintains oncotic pressure, transport Ca²⁺, bile, drugs, fatty acids and steroids
Deficiency can causes edema.

4. Globulins

- » Insoluble in H_2O , Soluble in dil. salt solution.
- » Heat coagulable
- » Binds various substances in blood
- » Examples :
 - transferrin(Fe), ceruloplasmin(Cu^{2+}), immunoglobulins, ovoglobulin, lactoglobulin etc

Types of Globulins

α -globulin

- Carrier function, e.g. α 1-antitrypsin, AFP, ceruloplasmin,
- C-reactive Protein

β -globulin

- Carrier function
- eg Haptoglobin, transferrin, complements,

γ -globulin

- Defensive function
- immunoglobulins

5. Prolamine

» Plant storage protein

» Alcohol soluble

» Insoluble in water or salt solution

GLIADINS: rich in proline, poor in lysine e.g
gliadin of wheat

GLUTELINS: rich in glutamic acid e.g glutelin of
wheat

➔ **MEDICAL IMPORTANCE:** may induce Celiac
disease in genetically predisposed individuals.

» Other examples of prolamines:

➔ hordein (barley)

➔ secalin (rye)

6. Scleroproteins (albuminoids):

- » Fibrous proteins
- » High stability ,low solubility
- » Supporting structures
- » Found in ectodermal tissues like skin, hair, nail, hoofs etc
- » It includes:
 - a) collagen
 - b) elastin
 - c) keratin

A:Collagen

- *Most abundant protein in human body*
- *Made up of three polypeptide chains(α chains) forming TRIPLE HELIX*
- *Tough and high tensile strength*
- *Type and organization depends on its structural role*
e.g

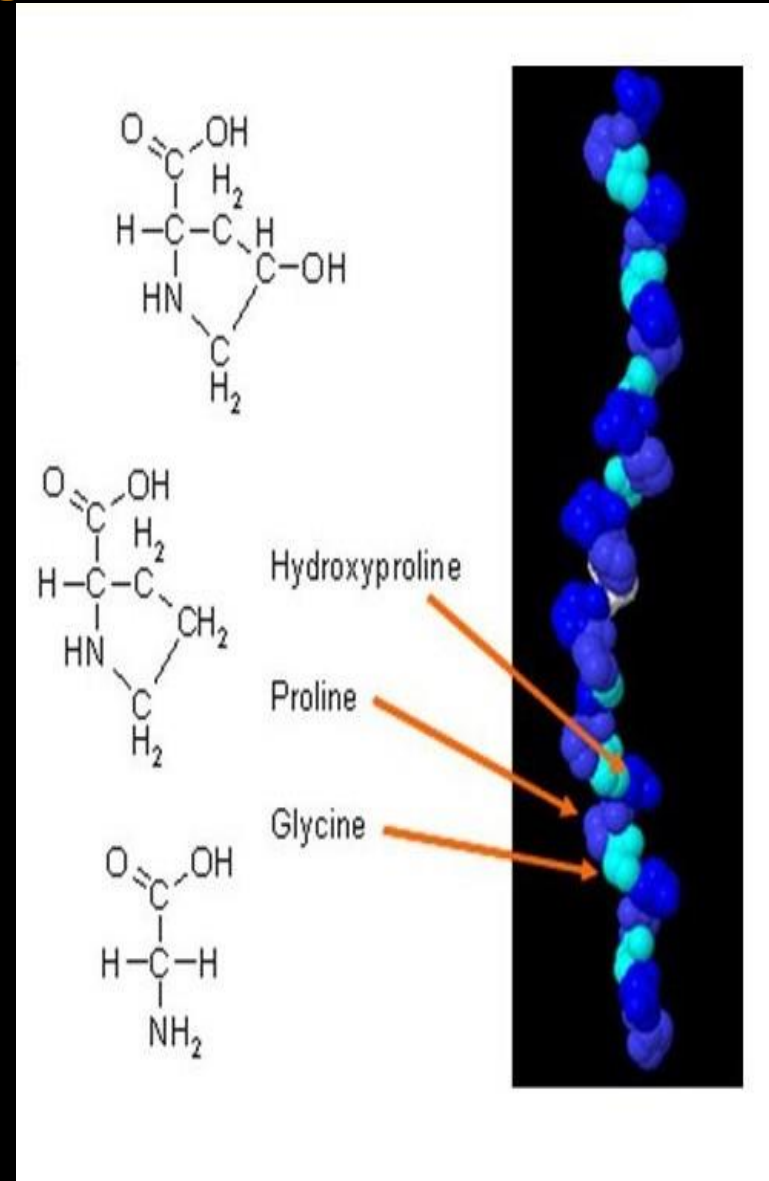
GEL form in vitreous humour

BUNDLED as tight fibers eg tendon

ANGLED arrangement in bone

Structure of collagen

- » Rich in proline and glycine
- » Every third amino acid is glycine
- » -Gly-X-Y is the repeating sequence where X is frequently proline and Y is often hydroxyproline or hydroxylysine



- Collagen can be converted to *Gelatin* on boiling with acid water.
- Gelatin is easily digestible protein but poor nutritionally because lack *Tryptophan* & very low in *Tyrosine* & *Cystine*
- Used as a food because of its easy digestion
- Gelatin is used Pharmaceutically in manufacture of capsule, emulsion, & suppositories

TYPE	TISSUE DISTRIBUTION
Fibril-forming	
I	Skin, bone, tendon, blood vessels, cornea
II	Cartilage, intervertebral disk, vitreous body
III	Blood vessels, fetal skin
Network-forming	
IV	Basement membrane
VII	Beneath stratified squamous epithelia
Fibril-associated	
IX	Cartilage
XII	Tendon, ligaments, some other tissues

Various disorders of Collagen are as under;

i) Osteogenesis Imperfecta: It is caused by gene defect resulting in abnormal collagen synthesis

(type I collagen defect)

- » Multiple fractures, occurring with minimal trauma
(Brittle bone disease)
- » **Blue sclera**: due to translucency of the connective tissue.
- » Trauma may occur during childbirth
- » Patient may be confused with Child abuse due to multiple fractures

ii) Ehlers - Danlos Syndrome: Congenital mutation in the synthesis & processing of collagen.

It is characterized by

- » Hyperextensible skin
- » Hypermobile joints
- » Abnormalities of internal organs
- » Increased tendency to bleed

There are 10 types of EDS, inheritance varies from AD(type-IV) to AR(type -VI) to X-linked recessive(type -IX)

iii) Marfan's Syndrome: is a genetic disorder of connective tissue caused by a mutation in the gene for fibrillin-1 (a protein that is imp. Part of CT).

- » People with MS tends to be
- » Tall & thin with long arms, legs, fingers & toes.
- » They have flexible joints & scoliosis.

iv) Scurvy: Deficiency of Vitamin C because vitamin C is required for hydroxylation of collagen
Symptoms of weakness, anemia, bleeding from the gums & skin may occur.

B. Elastin

- *Rubber-like properties*
- It gives capacity to **stretch without tearing**
- Classed as Fibrous Proteins, because of its structural function & relative insolubility in water
- Abundant in Ligaments, Lungs, walls of Arteries, Skin
- Are formed in excess during pregnancy in Uterus

- » Synthesized from tropo-elastin(linear polypeptide having 700 amino acids that are non polar) (glycine, alanine and valine)
- » Also rich in proline and lysine

C. Keratin

- Found in Epidermis, Nails, Horns, Hoofs, & Hair
- ✓ **HARD KERATIN:** yield histidine, lysine and arginine on hydrolysis in ratio of 1:4:12
- ✓ **SOFT/ PSEUDOKERATIN:** found In skin, different ratio of amino acids e.g neurokeratin has ratio of 1:2:2

α - keratin

- e.g human hair
- High ratio of cystine
- α -helical structure

β - keratin

- Present in spider web, reptile skin
- Cystine deficient and rich in glycine and alanine
- β -pleated structure

CONJUGATED PROTEINS

Conjugated protein

» Protein(apoprotein)+Non-proteinpart
(Prosthetic group) = HOLOPROTEIN

Classes of Conjugated Proteins

TABLE 3-4

Conjugated Proteins

Class	Prosthetic group	Example
Lipoproteins	Lipids	β_1-Lipoprotein of blood
Glycoproteins	Carbohydrates	Immunoglobulin G
Phosphoproteins	Phosphate groups	Casein of milk
Hemoproteins	Heme (iron porphyrin)	Hemoglobin
Flavoproteins	Flavin nucleotides	Succinate dehydrogenase
Metalloproteins	Iron	Ferritin
	Zinc	Alcohol dehydrogenase
	Calcium	Calmodulin
	Molybdenum	Dinitrogenase
	Copper	Plastocyanin

NUCLEOPROTEINS:

Simple basic proteins (Protamine, Histones) +
Nucleic Acids (Prosthetic Group)

They are proteins of cell nuclei & are the chief constituents of *Chromatin*

o Most abundant in tissues having large proportion of nuclear materials e.g., Thymus, Glandular organs

Examples are Nucleo histone, Nucleo protamines.

- » Deoxyribonucleoprotein: in nuclei, mitochondria
- » Ribonucleoprotein: nucleoli, ribosome

Phosphoproteins

(Protein + Phosphoric Acid)

- They contains about 1% of Phosphorous
- Examples :Casein, Ovovitellin

- **Mucoproteins**

- » Simple Protein + MPS (such as Hyaluronic acid & Chondriotin Sulphate)
- Present in large amount in Umbilical cord
- Also present in all kind of Mucins & Blood group substances
- Examples of mucoproteins are FSH, LH, & HCG

GLYCOPROTEINS:

- o Protein + Carbohydrates as prosthetic group

(less than 4% in contrast to mucoproteins which contain more than 4%)

- o Includes Immunoglobins, many enzymes
- o They carry Mannose, Galactose Xylose & Aribinose in oligosaccharide chains

CHROMOPROTEINS:

» Proteins + Colored Substances as prosthetic group

Hemoproteins

- Contain heme group
- e.g hemoglobin, cytochromes

Flavoproteins

- Riboflavin (vit B2)

Rhodopsin

- Vitamin A

LIPOPROTEINS:

- » Protein + Lipids (Cephalin, Lecithin, Cholesterol)
- » Water soluble, but insoluble in organic solvent
- » Present in blood plasma, nervous tissue, cell membrane, bacterial and viral antigens

METALLOPROTEINS:

- » Metal ions as prosthetic group.

Examples:

- » Ferritin (Iron),
- » Carbonic anhydrase (Zn),
- » Ceruloplasmin (Cu)

B. DERIVED PROTEINS:

- Are formed from simple & compound proteins.
- produced by physical & chemical factors.

Primary derived

- Denatured or coagulated
- First hydrolyzed products

Secondary derived

- Degraded(due to breakdown of peptide bonds)

Primary Derived

- » Almost Same mol.wt as native protein
- » Differ in solubility, precipitation and crystallization due to intramolecular rearrangement
- » Peptide bond remains intact
- » X-ray, UV-rays, vigorous shaking,
- » Acid & alkali

Primary Derived

proteans

- Predominantly formed from globulins by action of water, acid, alkali
- Myosan(myosin), fibrin(fibrinogen)

metaproteins

- Formed from further action of acids and alkalis on protein
- Are soluble in dilute acids & alkalis but insoluble in neutral solvents

Coagulated proteins

- Insoluble products formed by action of heat or alcohol
- Cooked meat, cooked egg

Secondary derived

Proteoses/ albuminoses

- Soluble in water
- Coagulated by heat

Peptones

- Hydrolysed products of proteoses
- Soluble in water
- Non-coaguable by heat

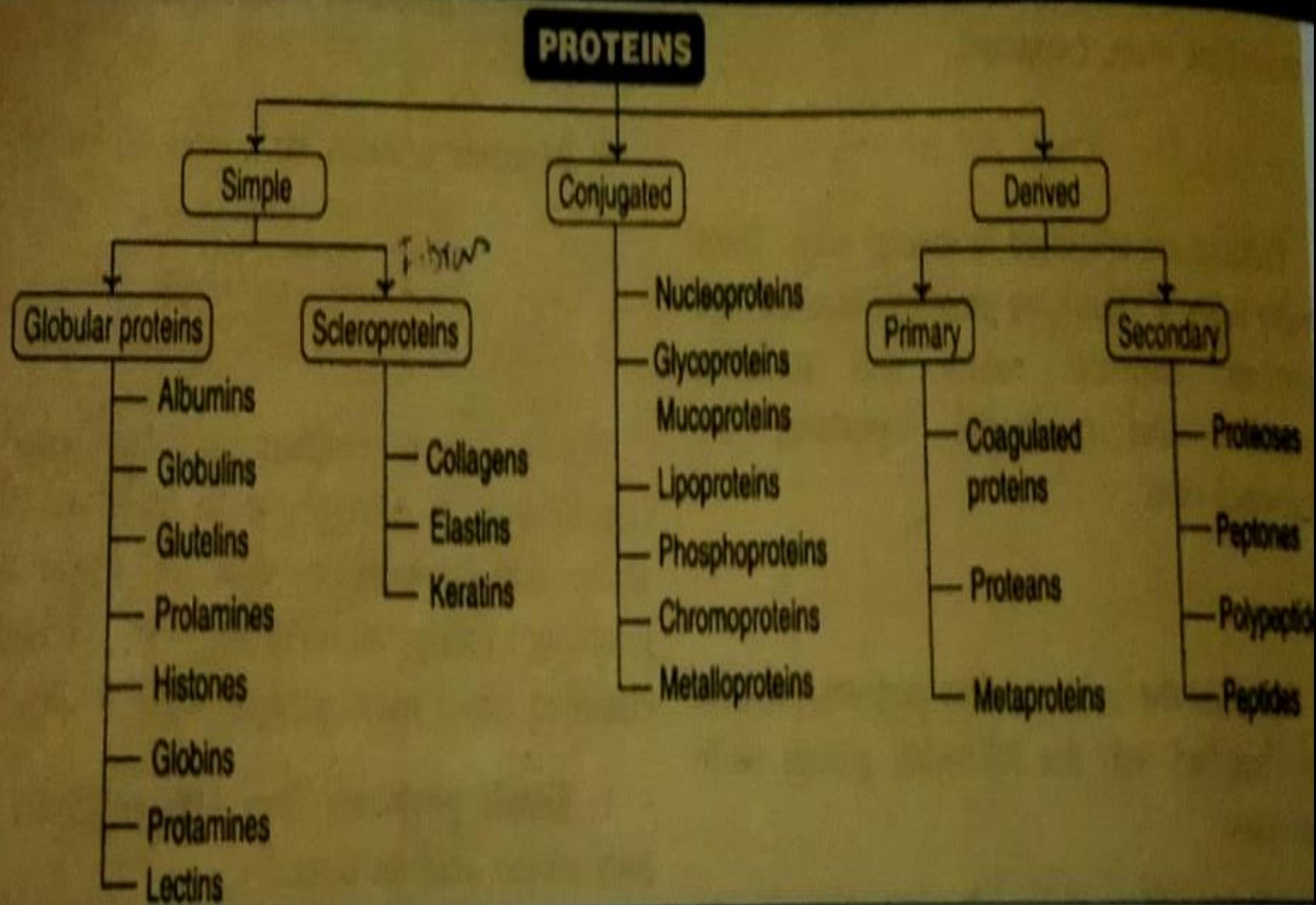
Peptides

- Small no. of amino acids joined by peptide bond
- Named according to no. of amino acids

» HYDROLYSIS

protein → protean → metaprotein →
protease → peptone → peptide →
amino acids

TABLE 4.4 Summary of classification of proteins



PROPERTIES OF PROTEINS

- » Tasteless, odourless
- » High mol.wt
- » Viscosity depends on shape; fibrous are more viscous
- » Proteins coagulate on heating ,during coagulation it undergoes denaturation
- » Amphoteric in nature
- » Can be precipitated by positive and negative ions; important for isolation of proteins

FUNCTIONS OF PROTEINS

STATIC FUNCTIONS

- Structure and strength(**Brick and Mortar role**)
- Eg elastin, collagen

DYNAMIC FUNCTIONS

- working of cell
- Eg;enzymes,hormones,transport,clotting factors,immunoglobulins,contraction

Table 5.1 An Overview of Protein Functions

Type of Protein	Function	Examples
Enzymatic proteins	Selective acceleration of chemical reactions	Digestive enzymes catalyze the hydrolysis of the polymers in food.
Structural proteins	Support	Insects and spiders use silk fibers to make their cocoons and webs, respectively. Collagen and elastin provide a fibrous framework in animal connective tissues. Keratin is the protein of hair, horns, feathers, and other skin appendages.
Storage proteins	Storage of amino acids	Ovalbumin is the protein of egg white, used as an amino acid source for the developing embryo. Casein, the protein of milk, is the major source of amino acids for baby mammals. Plants have storage proteins in their seeds.
Transport proteins	Transport of other substances	Hemoglobin, the iron-containing protein of vertebrate blood, transports oxygen from the lungs to other parts of the body. Other proteins transport molecules across cell membranes.
Hormonal proteins	Coordination of an organism's activities	Insulin, a hormone secreted by the pancreas, helps regulate the concentration of sugar in the blood of vertebrates.
Receptor proteins	Response of cell to chemical stimuli	Receptors built into the membrane of a nerve cell detect chemical signals released by other nerve cells.
Contractile and motor proteins	Movement	Actin and myosin are responsible for the movement of muscles. Other proteins are responsible for the undulations of the organelles called cilia and flagella.
Defensive proteins	Protection against disease	Antibodies combat bacteria and viruses.



THANK YOU