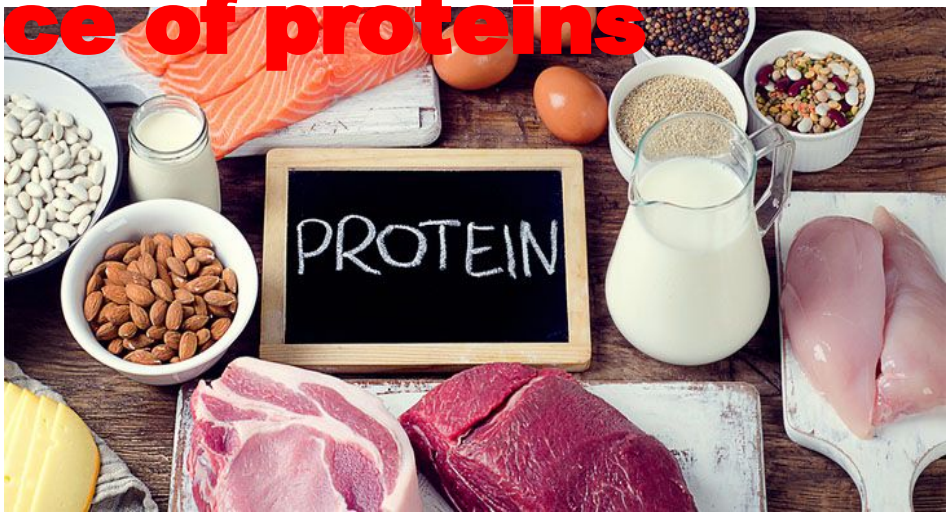
Proteins: definition, classification, Structural organization & Biological significance of proteins



Topics:
Proteins: definition, classification, composition, important functions, Structural organization of proteins, Biological significance of proteins

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What is Protein?

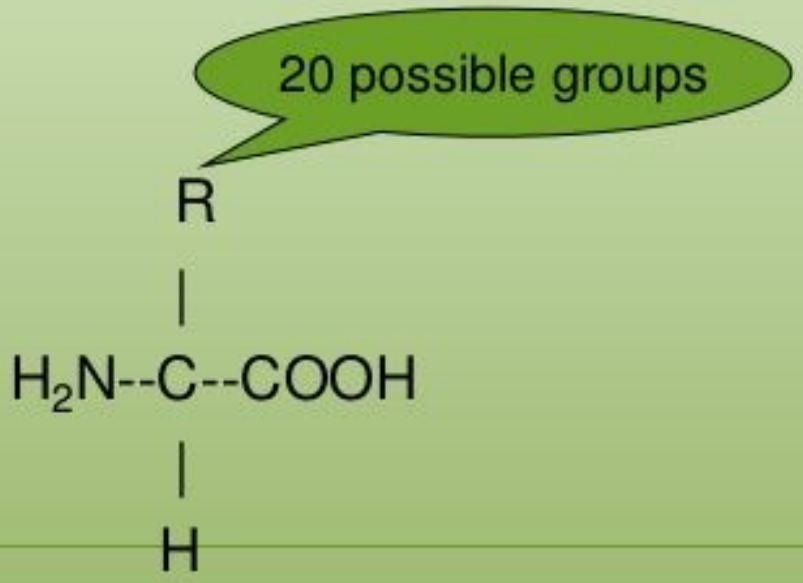
- **Proteins are very large molecules composed of basic units called *amino acids*.**
- **Proteins contain carbon, hydrogen, oxygen, nitrogen, and sulphur.**
- **Proteins are *highly complex molecules* that are actively involved in the most basic and important aspects of life.**
    - **These include metabolism, movement, defense, cellular communication, and molecular recognition.**

Characteristics of Proteins

- Contain carbon, hydrogen, oxygen, nitrogen, and sulfur
- Serve as structural components of animals
- Serve as control molecules (enzymes)
- Serve as transport and messenger molecules
- Basic building block is the amino acid

Proteins

Composed of a chain of amino acids.

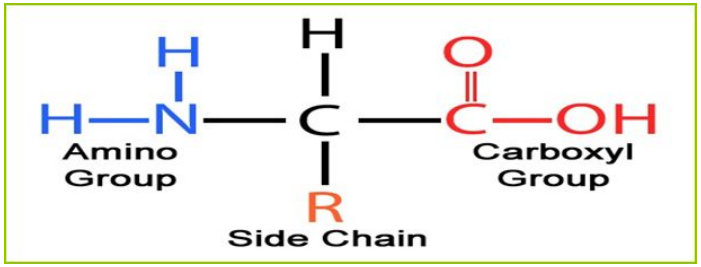


Amino Acids

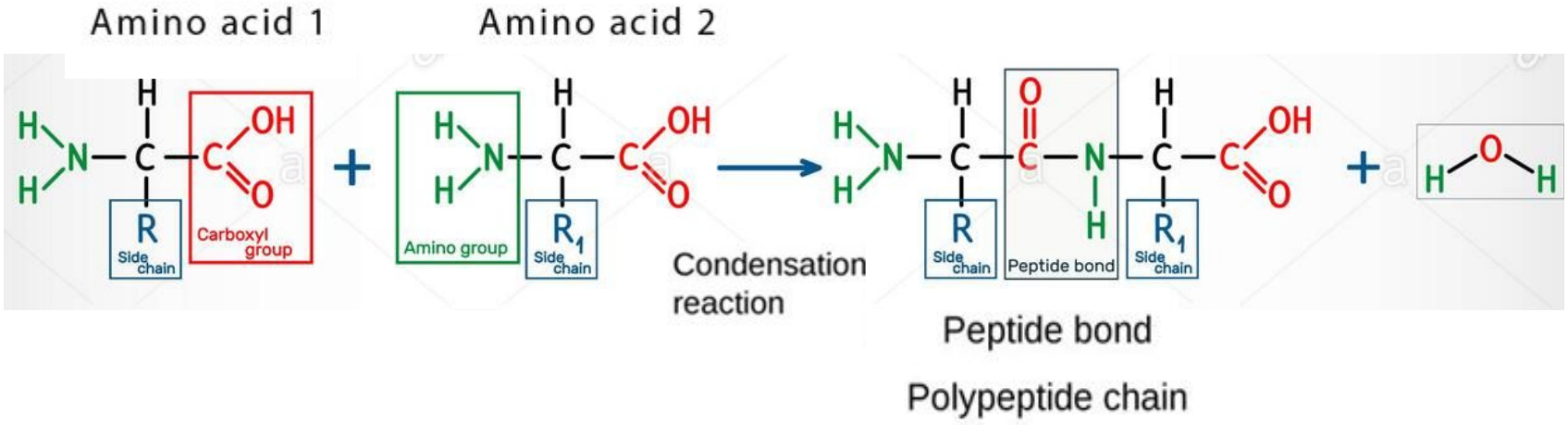
Amino Acids are the building units of proteins. Proteins are polymers of amino acids linked together by what is called " Peptide bond".

- There are about 300 amino acids occur in nature. Only 20 of them occur in proteins.

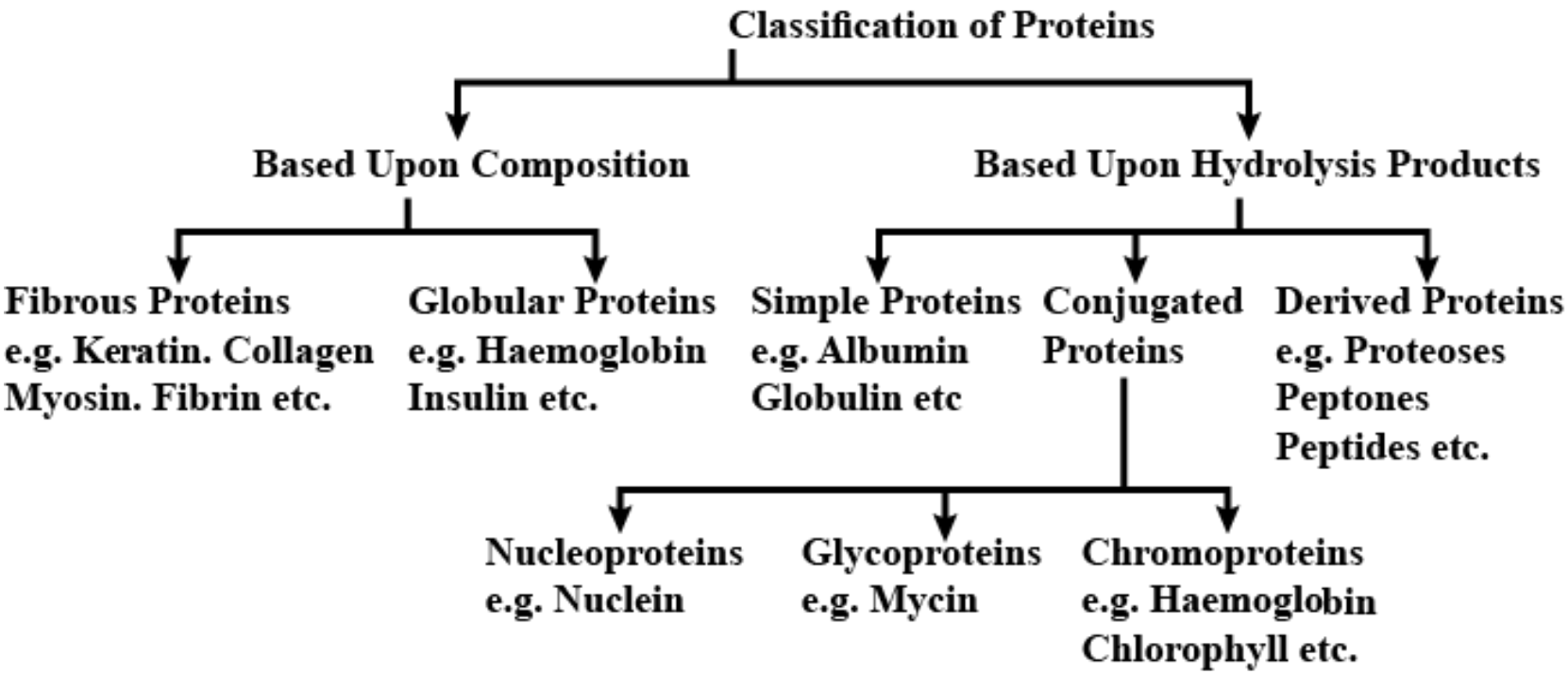
Structure of amino acids:



Peptide bond

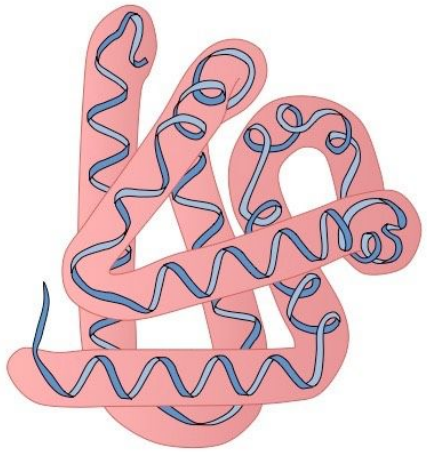


Classification of Proteins



Fibrous protein	Globular protein
Consists of long, parallel polypeptide chains forming helical structures or pleated sheets	Consists of coiled and folded polypeptide chains forming spherical shape
Insoluble in water	Soluble in water
The structures is stable	The structures is unstable
Plays a major role in mechanical and structural functions	Takes part in metabolite and chemical processes
Example: Keratin and collagen	Example: Enzymes and haemoglobin

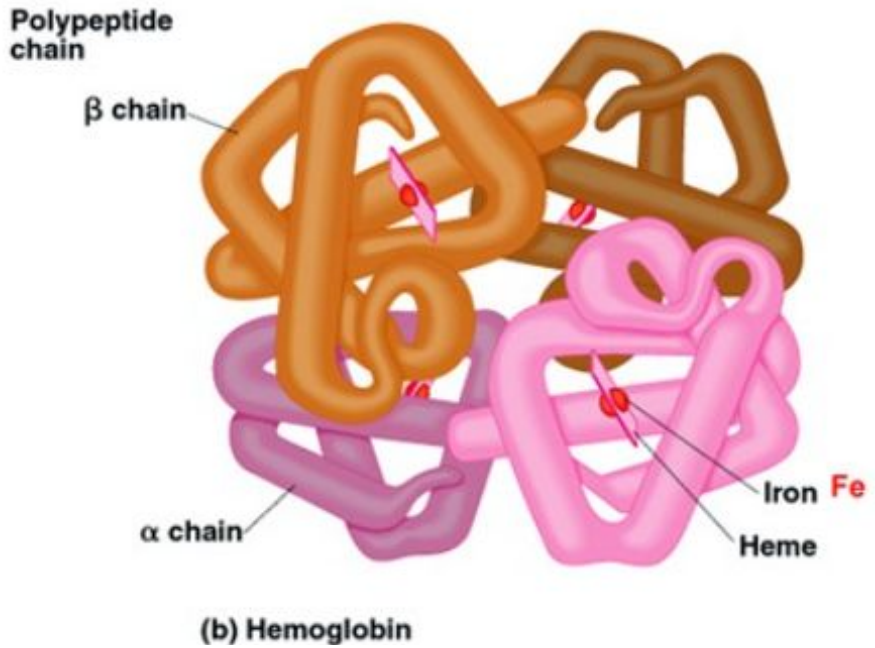
Fibrous Protein



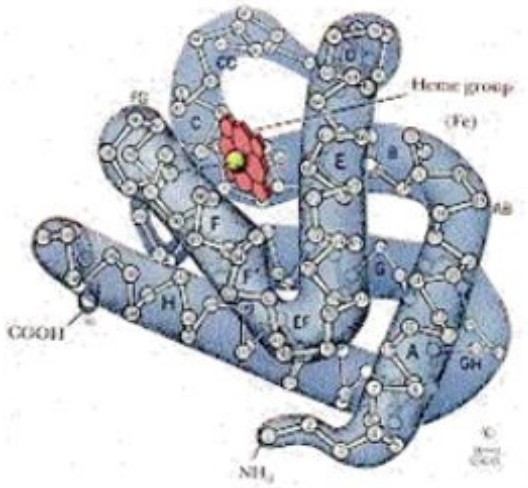
Globular Protein

Globular Proteins

Hemoglobin and myoglobin are examples of globular proteins.



(b) Hemoglobin



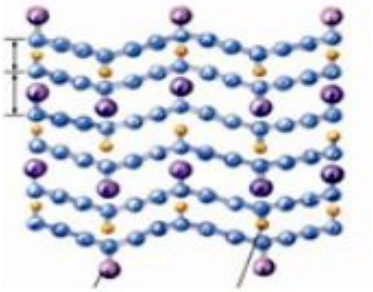
Fibrous Proteins or Scleroproteins

Collagen, keratin and elastin are examples of fibrous proteins.

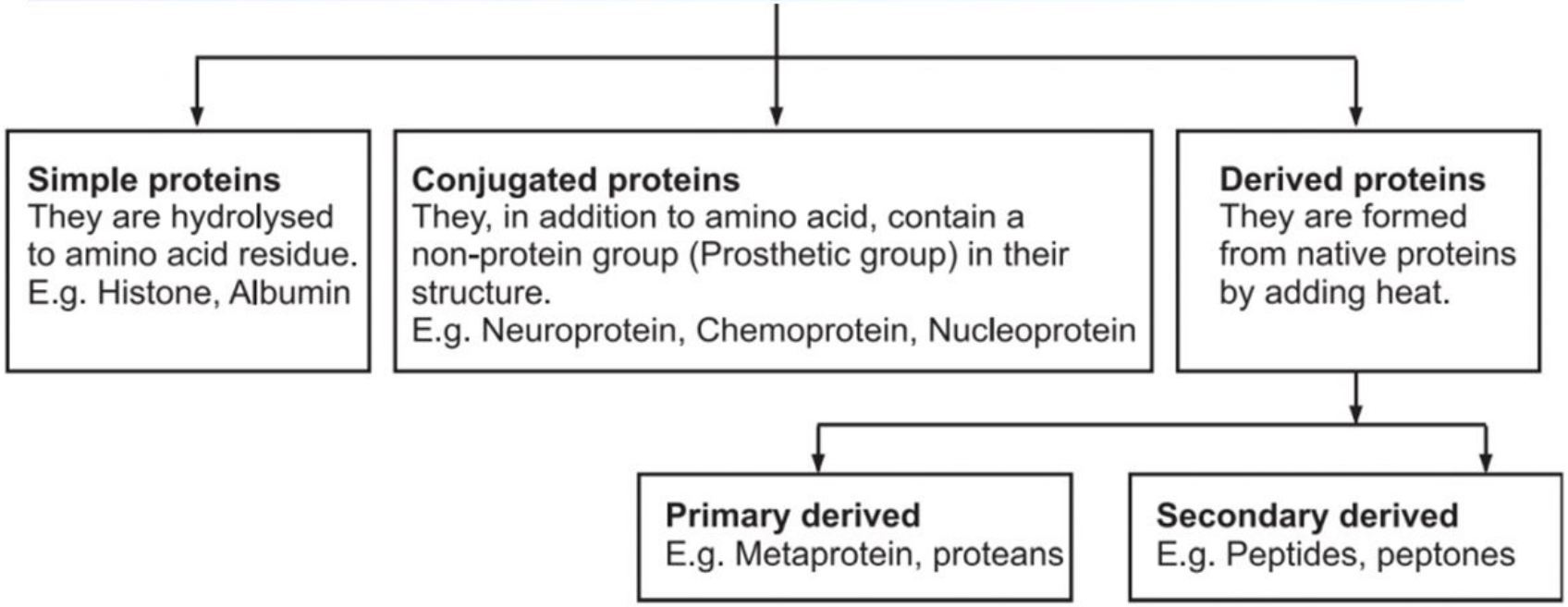
α-keratin

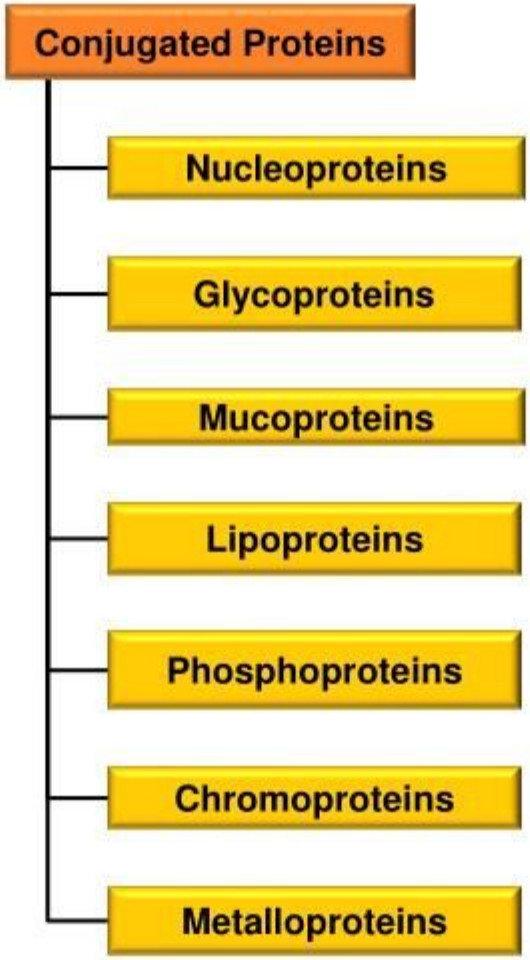
Collagen fiber

β-keratin



Classification Based on Composition

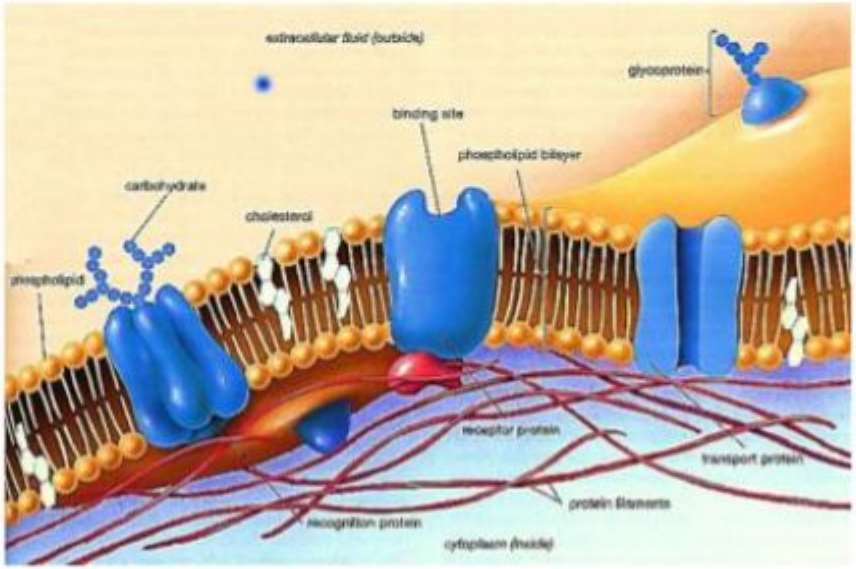



Conjugated Proteins
Nucleoproteins
Glycoproteins
Mucoproteins
Lipoproteins
Phosphoproteins
Chromoproteins
Metalloproteins

Glycoproteins

Proteins examples:

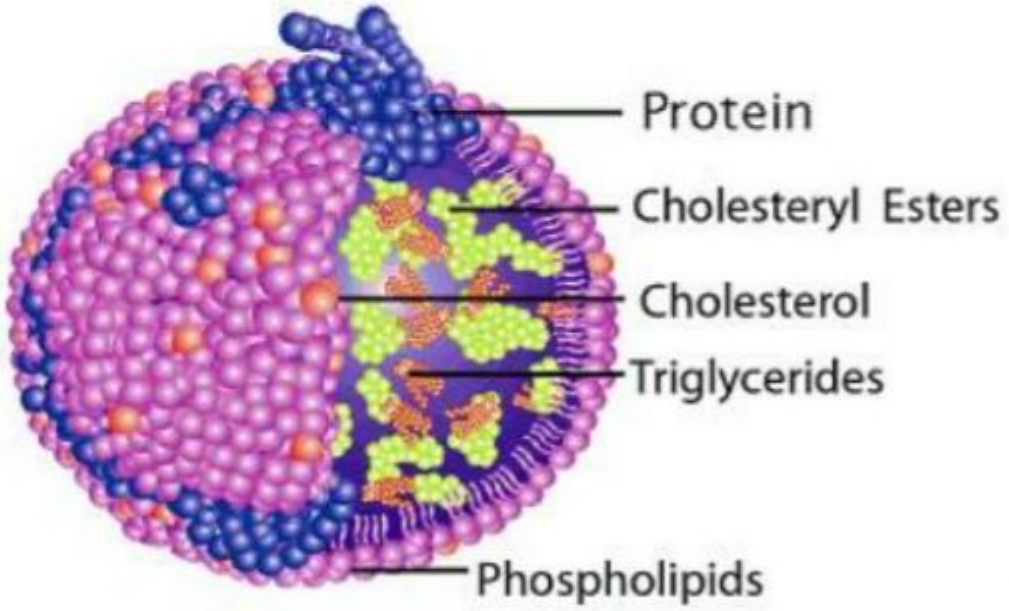
Glycoproteins of cell membrane, Follicle-stimulating hormone (FSH), Luteinizing hormone (LH).



Lipoproteins

Proteins examples:

Low density lipoprotein (LDL), high density lipoprotein (HDL).



Classification based on Function

Structural Proteins

Proteins gives our cells shape, strength as well as enable movements.

Proteins examples:

keratin, collagen, elastin.

Structure Examples:

Hair, wool, nails, horns, hoofs, tendons, cartilage.

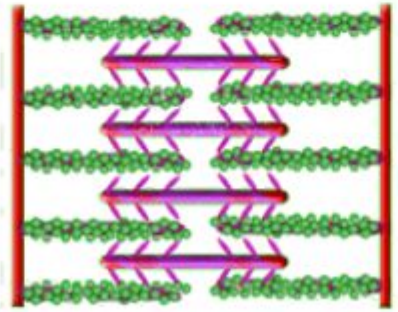
Contractile Proteins

Proteins examples:

Actin & myosin

Location in body:

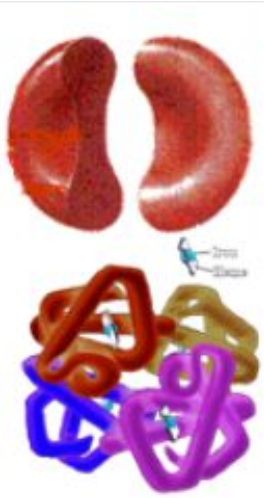
Contracting fibers in muscle.

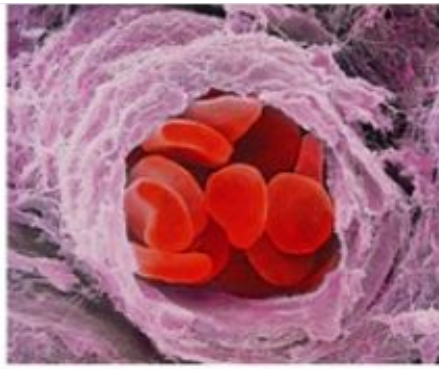


Transport Proteins

Protein examples:

- hemoglobin (Carries oxygen in blood)
- serum albumin (Carries fatty acids in blood)





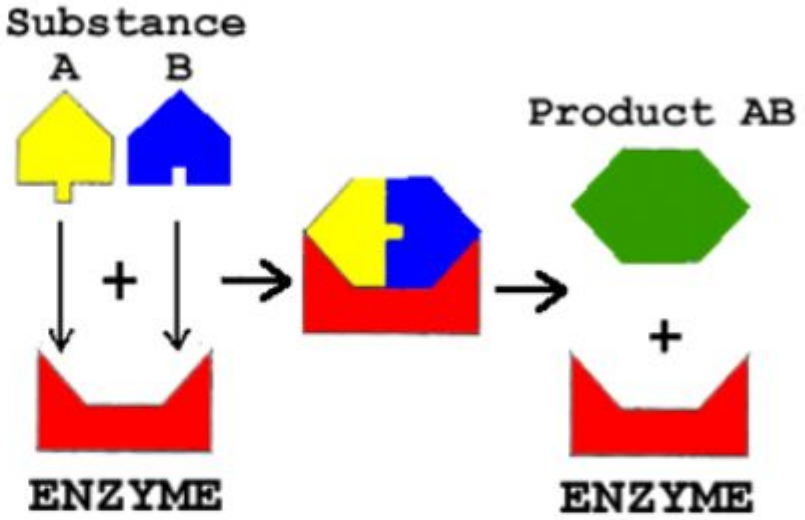
Storage Proteins

Proteins examples:

- Different for different sustances.
- Ferritin (Stores iron in spleen)
- legumes and beans in plants

Proteins as Enzymes

- Many proteins act as biological catalysts or enzymes.
- Thousands of different enzymes exist in the body.
- **Examples:** catalase, amylase, trypsin, lipase.

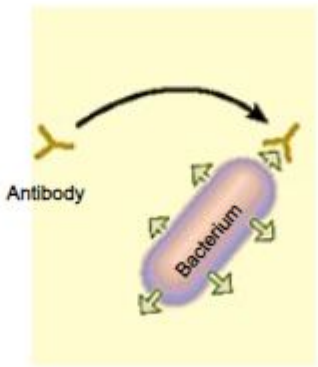


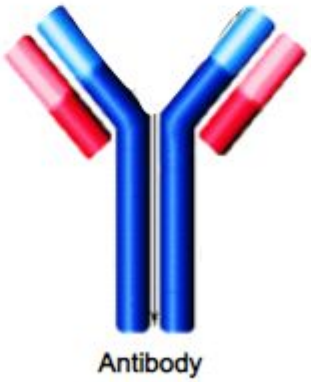
Immunological Proteins

Proteins examples:

Gamma globulins

- when a pathogen enters the body, the immune system produces antibodies against it that fight against the invader.



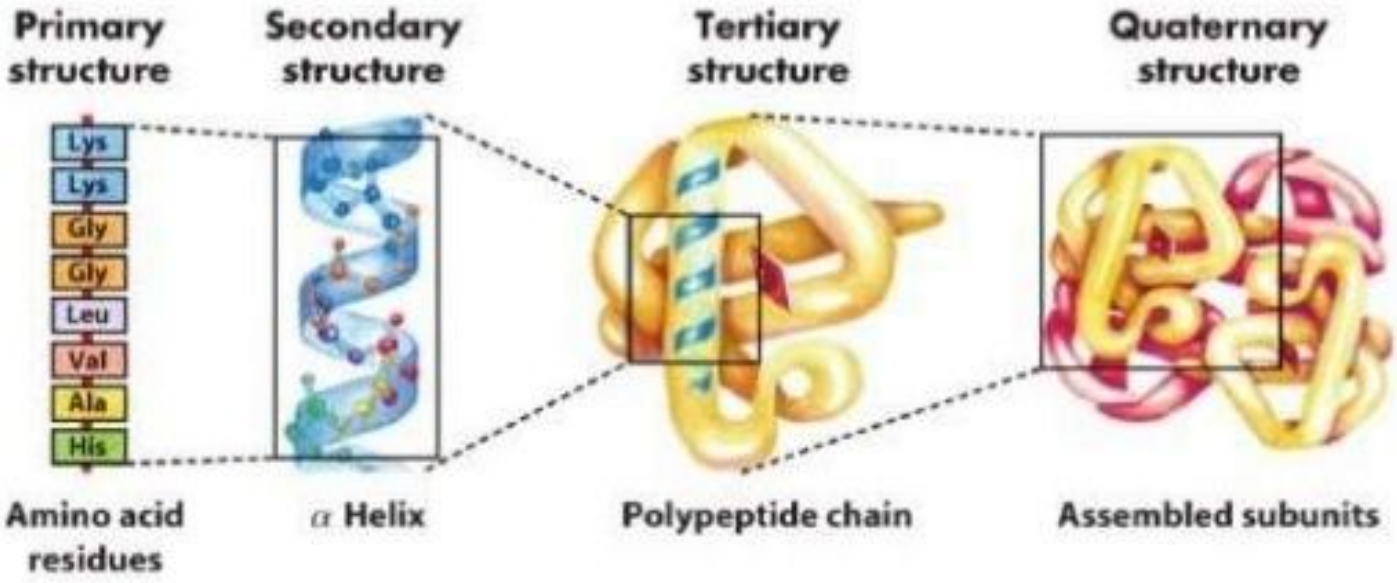


http://www.microbiologyonline.org.uk/about-microbiology/microbes-and-the-human-body

STRUCTURAL ORGANIZATION OF PROTEINS

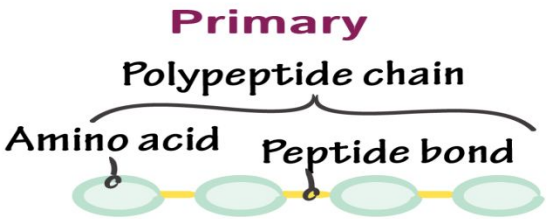
The structural and functional features of proteins and protein complexes are addressed at four levels of hierarchal organization. These are:

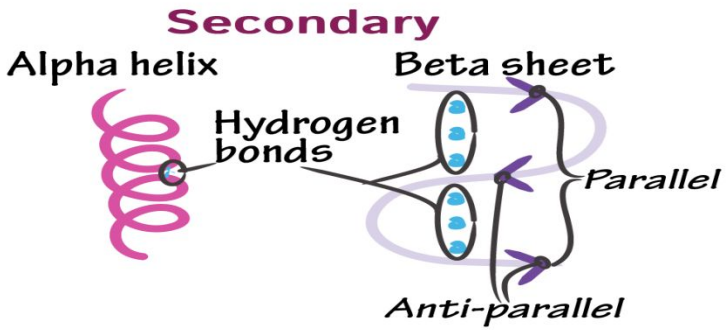
1. Primary structure (1°-Structure)
2. Secondary structure (2°-Structure)
3. Tertiary structure (3°-Structure)
4. Quaternary structure (4°-Structure)

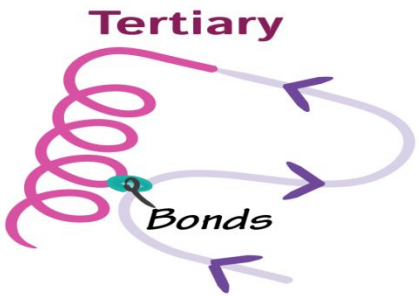


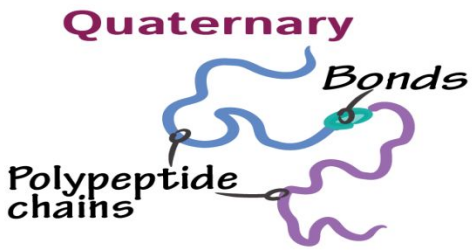
Structural organization of proteins

- **Primary (first level) – Protein structure is a sequence of amino acids in a chain.**
- **Secondary (secondary level) – Protein structure is formed by folding and twisting of the amino acid chain.**
- **Tertiary (third level) – Protein structure is formed when the twists and folds of the secondary structure fold again to form a larger three dimensional structure.**
- **Quaternary (fourth level) – Protein structure is a protein consisting of more than one folded amino acid chain.**



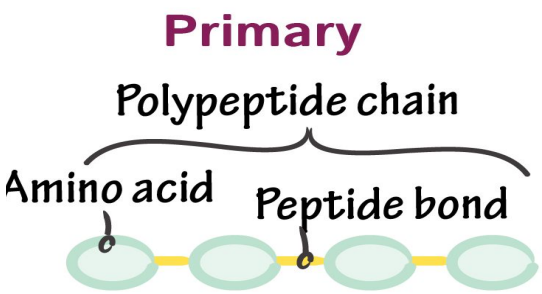


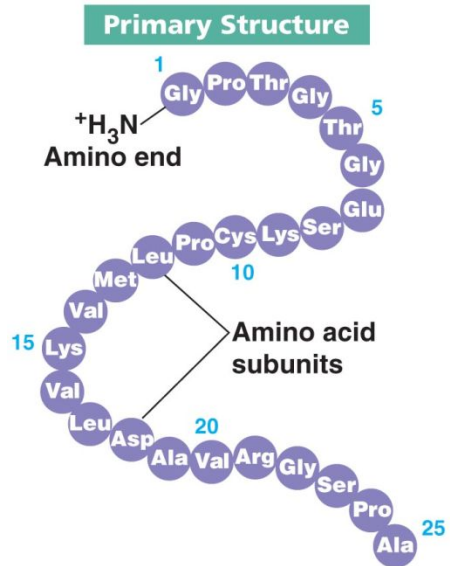




PRIMARY STRUCTURE

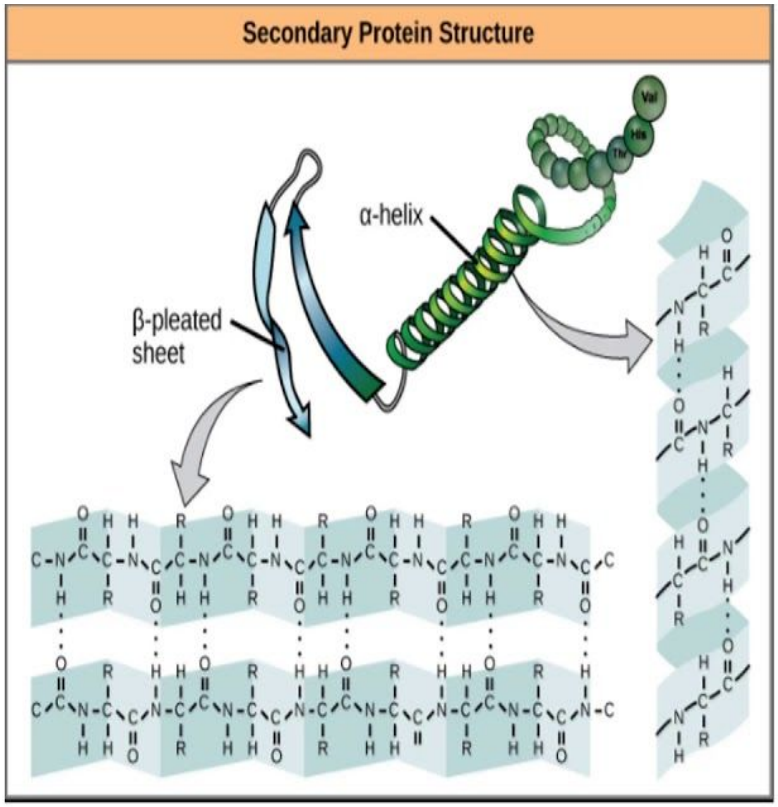
- The primary structure of protein refers to the sequence of amino acids present in the polypeptide chain.
- Amino acids are covalently linked by peptide bonds.
- Each component amino acid in a polypeptide is called a "residue" or "moiety"
- By convention, the 1^0 structure of a protein starts from the amino-terminal (N) end and ends in the carboxyl-terminal (C) end.





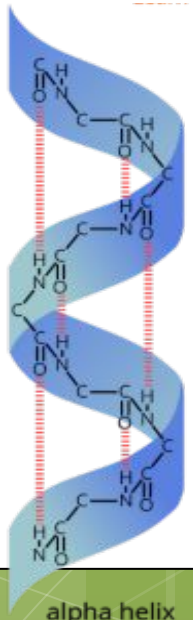
Secondary Structure

- Secondary structure refers to the local folded structure of protein.
- The secondary structures are hold together by hydrogen bonds.
- The most common types of secondary structures are α-helix & β-pleated sheets.

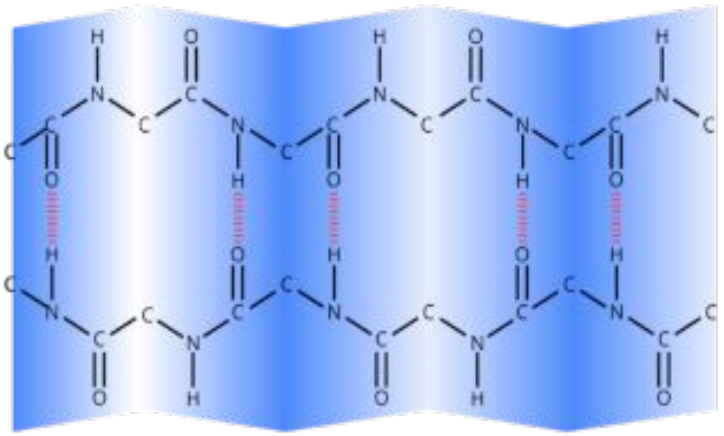


Secondary Structure

α– Helix	β– Pleated
1. It is rod like structure, coiled polypeptide chain arranged in spiral structure	1. It is Sheet like structure, composed of two or more peptide chain
2. All the peptide bond components participate in hydrogen bonding	2. All the peptide bond components participate in hydrogen bonding
3. All hydrogen bonding are intrachain Eg. It is abundant in hemoglobin and myoglobin	3. Interchain between separate polypeptide chain and intrachain in a single polypeptide chain folding back on its self.



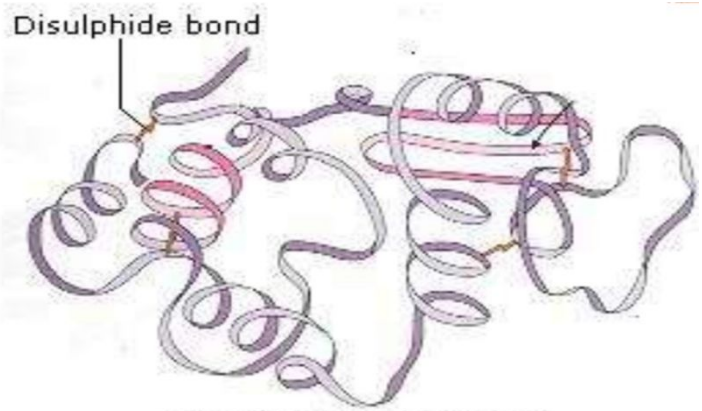
alpha helix



β pleated sheet

3. Tertiary structure of proteins:

- It denotes **three-dimensional structure** of the whole protein
- Occurs when certain attraction occurs between **α-helix and β-pleated sheets** to gives the overall shape of the protein molecules.
- It is maintained by **hydrophobic bonds, electrostatic bonds and Van der Waals force**.
- It is the three dimensional structure of each polypeptide chain. There are two main forms of tertiary structure: **fibrous and globular types**.

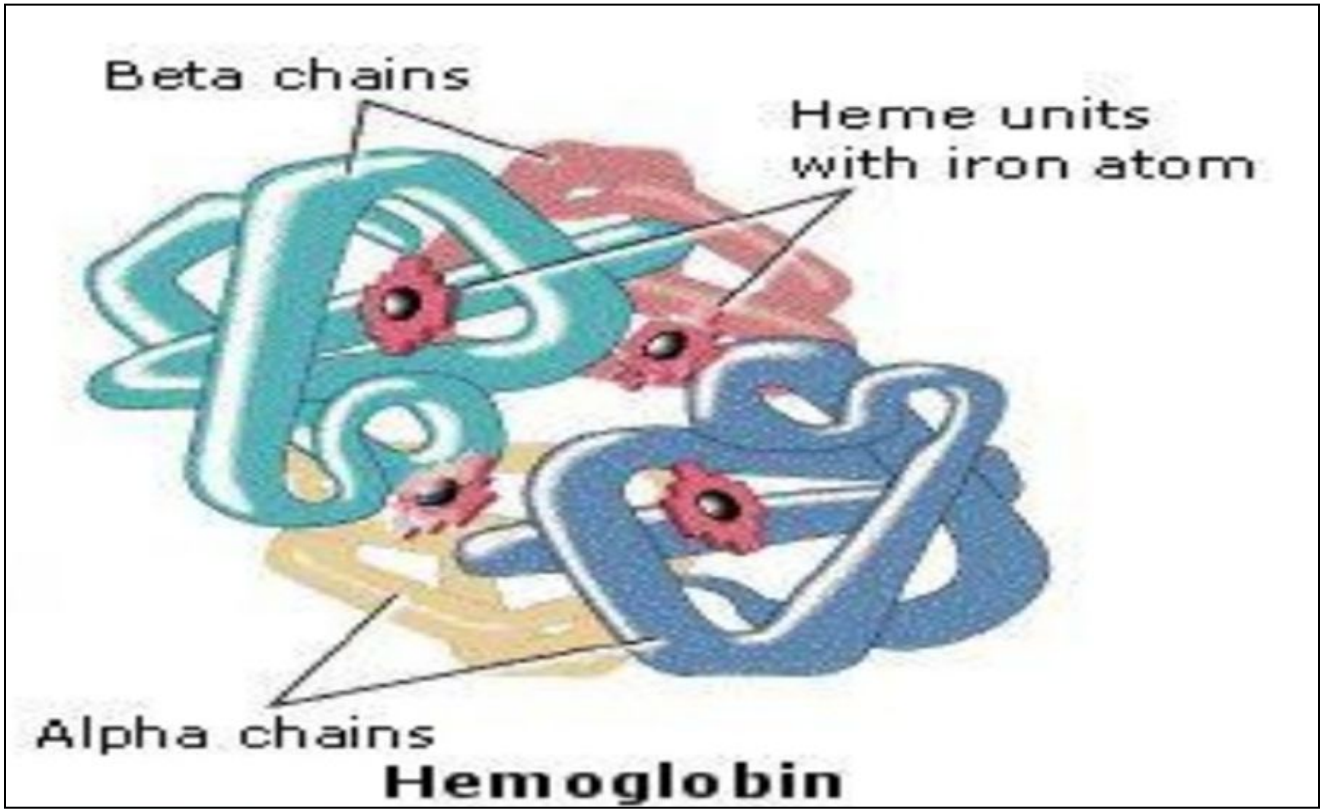


TERTIARY STRUCTURE

MYOGLOBIN

QUATERNARY STRUCTURE

- **The quaternary structure is defined as the spatial arrangement of multiple subunits of a protein.**
- **These subunits are associated through H-bonds, ionic interactions, and hydrophobic interactions**

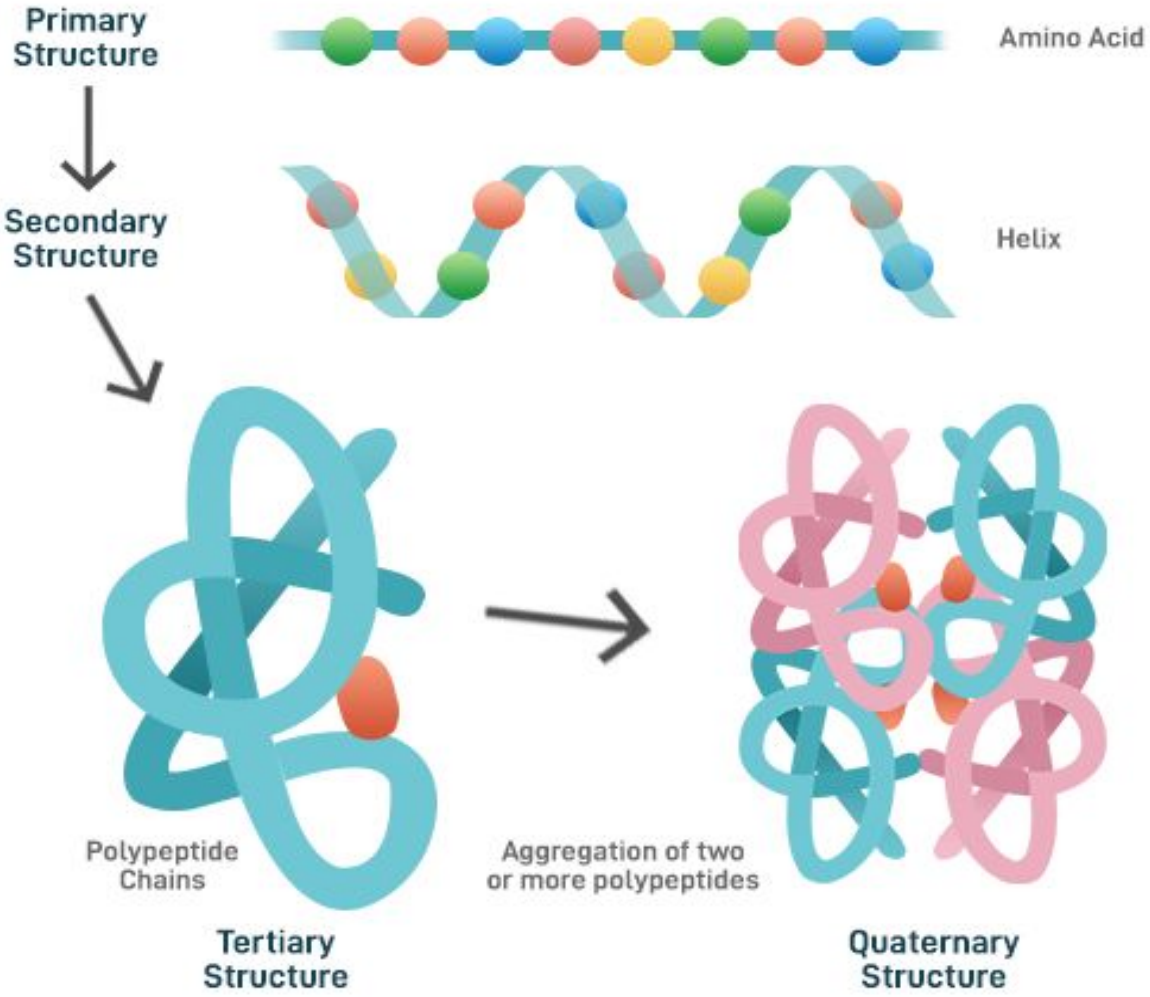


Hemoglobin

Biological significance of proteins

- All enzymes are proteins.
- Storing amino acids as nutrients and as building blocks for the growing organism.
- Transport function (proteins transport fatty acids, bilirubin, ions, hormones, some drugs etc.).
- Proteins are essential elements in contractile and motile systems (actin, myosin).
- Protective or defensive function (fibrinogen, antibodies).
- Some hormones are proteins (insulin, somatotropin).
- Structural function (collagen, elastin).

PROTEIN STRUCTURE



Complete Vs. Incomplete Proteins

- Dietary protein is required for the body as there are 9 essential amino acids the body cannot create and must obtain from ones diet. Complete proteins contain all 9 of these essential amino acids versus Incomplete proteins which do not.
  Complementary proteins are combinations of two or more incomplete proteins that supply all 9 essential amino acids.

Complete Proteins:

Animal Based:

- Meat
- Poultry
- Dairy
- Eggs
- Fish

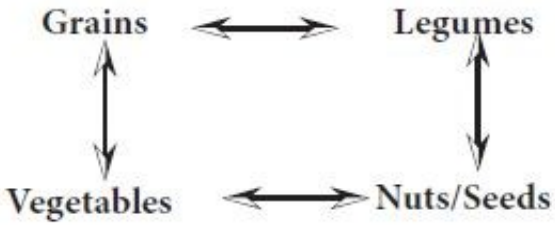
Incomplete Proteins:

plant Based

- Vegetables
- Grains
- Legumes/Beans
- Nuts/Seeds

Complementary Proteins:

- Grains+Legumes/Vegetables
- Nuts/Seeds+Vegetables/Legumes



Important Functions of Proteins

Class of Protein	Function in the Body	Examples
Structural	Provide structural components	*Collagen* is in tendons and cartilage. *Keratin* is in hair, skin, wool, and nails.
Contractile	Movement of muscles	*Myosin* and *actin* contract muscle fibers.
Transport	Carry essential substances throughout the body	*Hemoglobin* transports oxygen. *Lipoproteins* transport lipids.
Storage	Store nutrients	*Casein* stores protein in milk. *Ferritin* stores iron in the spleen and liver.
Hormone	Regulate body metabolism and nervous system	*Insulin* regulates blood glucose level. *Growth hormone* regulates body growth.
Enzyme	Catalyze biochemical reactions in the cells	*Sucrase* catalyzes the hydrolysis of sucrose. *Trypsin* catalyzes the hydrolysis of proteins.
Protection	Recognize and destroy foreign substances	*Immunoglobulins* stimulate immune responses.


Thank you!