SNS COLLEGE OF ALLIED HEALTH SCIENCES

SNS Kalvi Nagar, Coimbatore - 35

Affiliated to Dr MGR Medical University, Chennai

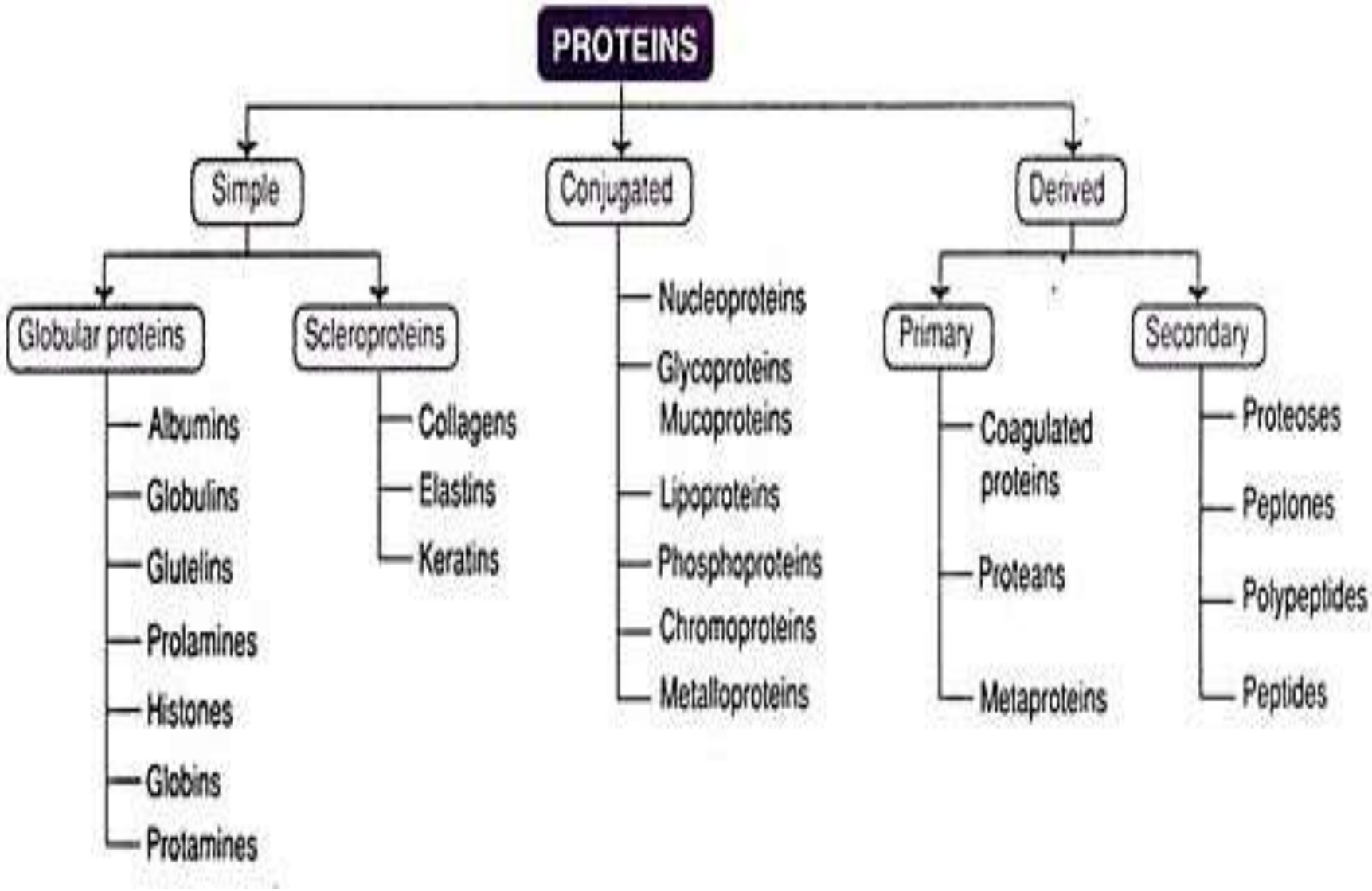
DEPARTMENT OF OPERATION THEATRE & ANESTHESIA TECHNOLOGY

COURSE NAME : BIOCHEMISTRY

TOPIC : PROTEINS

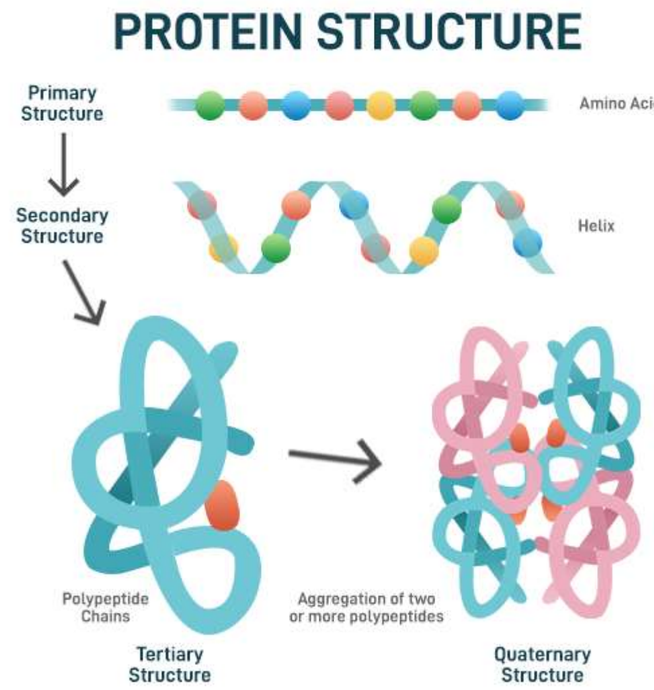
Proteins

- Proteins are very complex molecules involved in some chemical processes that are important for life.
- Protein is made of small units of amino acids.
- Helps in metabolism, communication, and movement in our body.
- Proteins are made up of smaller units known as amino acids and the bond linking them is known as a peptide bond.
- This bond is formed when the carboxyl group (-COOH) of one amino acid bonds with the amino group (– NH_2) of another amino acid releasing a molecule of water (H2O).
- A peptide may be dipeptide, tripeptide, and polypeptide.
- When peptide bond is established more than 10 amino acids, it is called polypeptides.


PROTEINS
Simple
Conjugated
Derived
Globular proteins
Albumins
Globulins
Glutelins
Prolamines
Histones
Globins
Protamines
Scleroproteins
Collagens
Elastins
Keratins
Nucleoproteins
Glycoproteins
Mucoproteins
Lipoproteins
Phosphoproteins
Chromoproteins
Metalloproteins
Primary
Coagulated proteins
Proteans
Metaproteins
Secondary
Proteoses
Peptones
Polypeptides
Peptides

Structure of Proteins

- **Structural Hierarchy**
- There are four levels in the structural hierarchy of proteins. They are



Primary structure

- In the primary structure of proteins, the polypeptide chain consists of a sequence of amino acids.
- This primary structure has a unique protein structure.
- The primary structure of this level contains mainly amino acids which are present anywhere in the chain.
- Peptide bonds are present in the primary structure of the protein.
- If two amino acids are there to form a chain of proteins it is called a dipeptide bond. Similarly, if three amino acids are ready to form a link it is called tripeptide.

Characteristics of peptide bond:

- A peptide bond is rigid and planar
- It is not able to charge but it is polar.
- It has a partial double bond character.

Secondary structure

- This secondary structure of proteins contains a folding structure polypeptide chain.
- This secondary structure is formed by the H-bonds.
- This secondary structure is formed mostly with the alpha helix and beta pleated sheets.
- Example: Myoglobin.

There are some types of secondary structure

- Alpha Helix
- Beta plated sheet
- Strand
- Loops

Tertiary structure

- The tertiary structure of proteins is in the form of a 3 Dimentional structure of the monomeric and multimeric structures.
- Three dimension structure of a polypeptide is simply called the tertiary structure of the protein.
- This tertiary structure is because of the lowest energy and greatest stability state of the polypeptide chain.
- The tertiary structure came from folding secondary structure of the protein.

Functions of Tertiary structure:

- It has a unique function like interacting with other molecules.

Quaternary structure

- The quaternary structure of proteins is in the form of a 3 Dimensional structure of macromolecules which is a combination of individual polypeptide chains.
- This quaternary structure is also formed from a special combination of tertiary structures.
- Quaternary structure is also known as oligomeric proteins.
- Example: Hemoglobin

Functions of quaternary structure:

- It helps in the chromosome replication process.
- It helps in metabolism

Classification

1. Based on shape

- Fibrous protein
- Globular proteins

2. Based on the constitution

- Simple proteins
- Conjugated proteins
- Derived proteins

3. Based on the constitution

- Acidic Proteins
- Basic Proteins

Fibrous protein(Scleroprotein):

- These proteins are found 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.
- Eg: 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
- Eg: Albumin, Insulin, and Hormones like oxytocin, etc.

On the basis of Constitution

- **Simple proteins:** These proteins are made up of amino acids only. e.g. albumins, globulins, prolamins, etc.
- **Conjugated proteins:** These are complex proteins that are combined with the characteristic of non–amino acid substance called as a prosthetic group. These are of following types:–
  - Nucleoproteins: Combination of protein and nucleic acid
  - Mucoproteins: Combination of proteins and carbohydrates (>4%)
  - Glycoproteins: Combination of proteins and carbohydrates(<4%)
  - Chromoproteins: Combination of proteins and coloured pigments.
  - Lipoproteins: Combination of proteins and lipids.
  - Metalloprotein: Combination of proteins and metal ions.
  - Phosphoprotein: Combination of proteins and phosphate group.
- **Derived proteins:** When proteins are hydrolyzed by acids, alkalies or enzymes, the degradation products obtained from them are called derived proteins.

On the basis of Nature of Molecules

Acidic proteins: They exist as anion and contain acidic amino acids.

- Eg: Blood groups.

Basic proteins: They exist as cations and are rich in basic amino acids

- Eg: Lysine, Arginine etc.

Functions of Proteins

- Protein helps in maintaining good shape and fit for our body.
- Protein repairs the body's damaged tissues.
- Protein is used to build bones, skin, and muscles.

Enzymes:

- Enzymes mostly carry out all numerous chemical reactions which take place within a cell.
- They also help in regenerating and creating DNA molecules and carry out complex processes.

Hormones:

- Proteins are involved in the creation of various types of hormones which help in balancing the components of the body.
- For example hormones like insulin, which helps in regulating blood sugar and secretin. It is also involved in the digestion process and formation of digestive juices.

Antibody:

- Antibody also known as an immunoglobulin.
- It is a type of protein which is majorly used by the immune system to repair and heal the body from foreign bacteria.
- They often work together with other immune cells to identify and separate the antigens from increasing until the white blood cells destroy them completely.

Energy:

- Proteins are the major source of energy that helps in the movements of our body.
- It is important to have the right amount of protein in order to convert it into energy.
- Protein, when consumed in excess amounts, gets used to create fat and becomes part of the fat cells.

Listed below are few functions of Proteins.

Aspect	Functions of Proteins in Human Body	Examples
Storage	Legume Storage, albumin, and proteins.	Supplies food during the early stage of the seedling or embryo.
Hormone Signalling	Counterpart activities of different body parts.	Glucagon and Insulin.
Transport	It transport substances throughout the body through lump or blood cells.	Hemoglobin.
Contraction	To carry out muscle contraction.	Myosin.
Digestive Enzyme	Breaks down nutrients present in the food into smaller portions so that it can be easily absorbed	Pepsin, Amylase, and Lipase

Functions

Enzymatic protein

- The function of enzymatic protein:
- It accelerates the metabolic process in our cells.
- It also accelerates the metabolic process in stomach digestion, liver functions, and blood clotting.

Hormonal protein

- The function of hormonal protein
- Hormonal proteins are protein-based chemicals secreted by endocrine glands.
- By using hormonal protein each hormone affects particular cells in the body.

Structural protein

- The function of structural protein
- Structural proteins are very important for the body because they are fibrous proteins.
- It helps in developing muscles, bones, skin, and cartilage.

Defensive protein

- The function of defensive protein
- These defensive proteins help in developing antibodies for attacking.
- These antibodies are developed in white blood cells to attack bacteria.

Storage protein

- The function of storage protein
- Storage protein stores minerals like potassium.
- Storage protein contains ovalbumin and casein found in milk, and egg whites.

Transport protein

- The function of transport protein
- Transport protein called calbindin which is useful for absorption of calcium from intestinal walls.
- Transport proteins carry important materials to the cells of the body.

Receptor protein

- It controls the substances which enter and leave the cells.

Contractile protein.

- The function of contractile protein
- It helps in regulating the strength, speed of the heart, and muscle contractions.
- Contractile proteins cause heart complications if the heart produces severe contractions.

Physical Properties of Proteins

- **Colour and Taste**
  Colourless and usually tasteless. These are homogeneous and crystalline.
- **Shape and Size**
  Simple crystalloid spherical structures to long fibrillar structures.
- **Molecular Weight**
  The proteins generally have large molecular weights ranging between 5 × 103 and 1 × 106. It might be noted that the values of molecular weights of many proteins lie close to or multiples of 35,000 and 70,000.
- **Colloidal Nature**
  Because of their giant size, the proteins exhibit many colloidal properties.
- Their diffusion rates are extremely slow and they may produce considerable light-scattering in solution, thus resulting in visible turbidity (Tyndall effect).

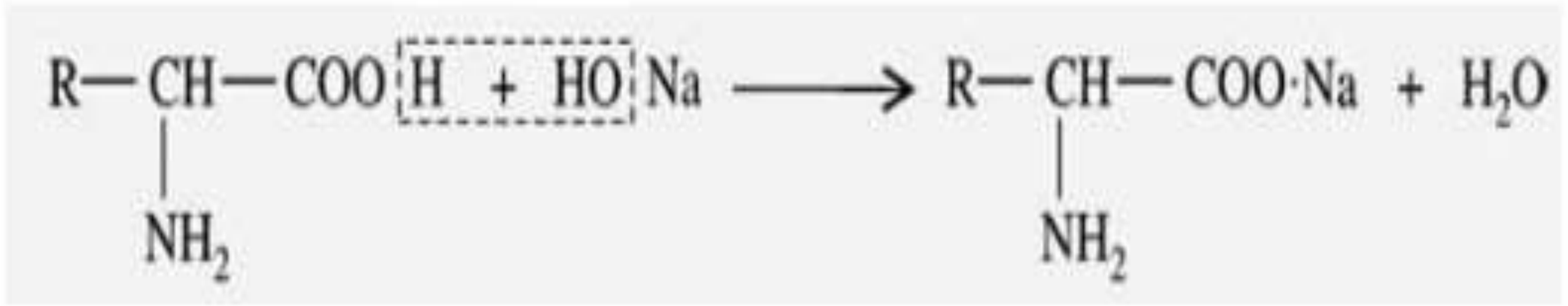
- **Denaturation**
  Denaturation refers to the changes in the properties of a protein.
- In other words, it is the loss of biologic activity. In many instances the process of denaturation is followed by coagulation— a process where denatured protein molecules tend to form large aggregates and to precipitate from solution.
- **Ion Binding Capacity**
  The proteins can form salts with both cations and anions based on their net charge.
- **Solubility**
  The solubility of proteins is influenced by pH.
- When the protein molecules exist as either cations or anions, repulsive forces between ions are high. They will be more soluble than in the isoelectric state.
- **Optical Activity**
  All protein solutions rotate the plane of polarized light to the left, i.e., these are levoratotory.

Chemical Properties of Proteins

- **Hydrolysis**
  Proteins are hydrolyzed by a variety of hydrolytic agents.
  By acidic agents: Proteins, upon hydrolysis with conc. HCl (6–12N) at 100–110° C for 6 to 20 hrs, yield amino acids in the form of their hydrochlorides.
  By alkaline agents: Proteins may also be hydrolyzed with 2N NaOH.
- **Reactions involving COOH Group**
  A. Reaction with alkalies (Salt formation)
  B. Reaction with alcohols (Esterification)
- **Reactions involving NH2 Group**
  A. Reaction with mineral acids (Salt formation): When either free amino acids or proteins are treated with mineral acids like HCl, the acid salts are formed.
  B. Reaction with formaldehyde: With formaldehyde, the hydroxy-methyl derivatives are formed.

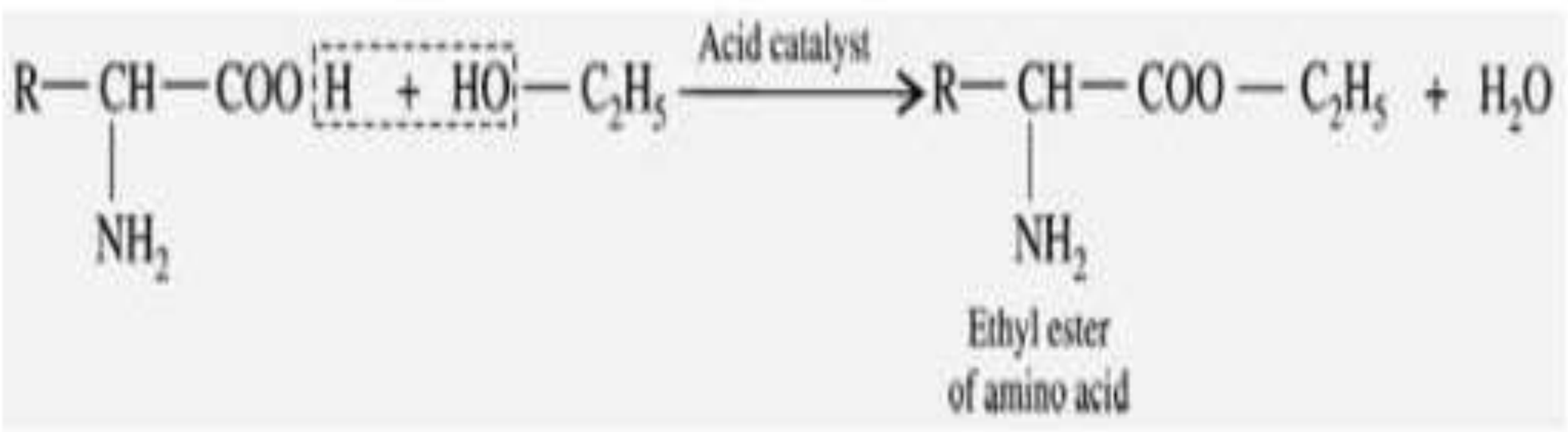
Reaction with Alkalies (Salt formation)

- The carboxyl group of amino acids can release a H+ ion with the formation of Carboxylate (COO–) ions.



Reaction with Alcohols (Esterification)

- The amino acids is reacted with alcohol to form, “Ester”.
- The esters are volatile in contrast to the form amino acids.



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