



Introduction

This chapter uncovers the central role of proteins in our lives. Enzymes drive chemical reactions, hormones regulate our bodies, and immunoglobulins protect us from infections, all hinging on proteins. Understanding denaturation, where proteins unravel due to factors like heat, sheds light on why some injections require refrigeration.

But this journey isn't confined to textbooks; it's practical. In today's fitness-conscious world, proteins are key to sculpting the body you desire. You'll grasp the significance of amino acids, the building blocks of life, and their essential role in nutrition. You'll differentiate between proteins that align with your fitness goals and those to avoid. These insights will guide your daily dietary choices and fitness routines.

Through this exploration, you'll realize that proteins are the foundation of life, shaping not only your health but also your understanding of the world within and around you.

Amino acids and proteins

Amino Acids:

- Compounds with both amino group (NH₂) and carboxyl (COOH) groups.
- Building blocks (monomeric units) of peptides and proteins bonded by peptide bonds.

Peptides and Proteins:

- Polymers of amino acids bonded by peptide bonds.

Peptide Bonds:

- Formed between two amino acids.
- Created between a carboxyl group of the first amino acid and an amino group of the next.
- Number of peptide bonds is one less than the amino acid residues in the chain (e.g., dipeptides have 2 amino acids and 1 peptide bond).

Amino Acids / Amino Acid Residues:

- Once included in a peptide or protein chain, they are called amino acid residues or amino acid moieties.

Difference between Peptides and Proteins:

- Peptides: 2-50 amino acids in the chain.
 - Oligopeptide: 2-10 amino acids.
 - Polypeptide: 11-50 amino acids.
- Proteins: More than 50 amino acids.
 - Note: Some authors consider chains with over 100 amino acids as proteins.
- Example: Insulin (51 amino acids) can be labeled as a protein or polypeptide.

Proteins are organic compounds with a high molecular weight formed of carbon, oxygen, hydrogen and nitrogen and may also contain sulphur, phosphorus and non-protein organic groups and metal ions.

They are polymers formed of subunits called amino acids linked together by peptide linkage.

INTRODUCTION

👉.Functional groups of Amino Acids

1. Amino group is always on left side
2. Acid group is always on right side

👉.Central carbon atom is Asymmetric

👉. Can show both Optical & Structural Isomerism

👉. ALL AA HAVE 1 ASYMMETRIC CARBON , EXCEPTIONS

No asymmetrical carbon - Glycine

2 asymmetrical carbons - Isoleucine , Threonine

Classification of amino acids based on nutritional requirement with suitable examples.

Classification of amino acids based on chemical structure with suitable examples.

Classification of amino acids

The 20 primary protein amino acids can be classified on several basis. These are,

I. Based on the Chemical structure:

Amino acids are classified into 7 structural groups.

1) **Aliphatic amino acids:**

a) Non-branched chain amino acids: Glycine, Alanine.

b) Branched chain amino acids: Valine, Leucine and Isoleucine.

2) **Aromatic amino acids:** Tryptophan, Phenylalanine, Tyrosine, Histidine

3) **Sulphur containing amino acids:** Cysteine and Methionine.

4) **Hydroxy amino acids:** Serine, Threonine and Tyrosine

5) **Amino acids with amide group (CONH₂):** Asparagine, Glutamine

6) **Charged amino acids:** Include Acidic amino acids, basic amino acids.

a) **Acidic amino acids:** Aspartic acid, Glutamic acid

b) **Basic amino acids:** Lysine, Arginine, Histidine.

7) **Imino acids (contain an imino group):** Proline (Pro)

II. Based on the Charge:

Amino acids are classified into 3 groups based on the charge on their R - group.

a) **Acidic Amino Acids** (Monoamino dicarboxylic acids):

These have acidic R groups. E.g.: Glutamic Acid, Aspartic Acid

b) **Basic Amino Acids** (Diamino monocarboxylic acids):

These have basic R groups. E.g.: Lysine, Arginine, and Histidine

c) **Neutral Amino Acids** (Monoamino monocarboxylic acids):

They have neutral R groups. E.g.: Glycine, Alanine etc

III. Based on the polarity

1. Polar amino acids: They are hydrophilic in nature

E.g.: Glycine, serine, cysteine, threonine, glutamine, lysine, arginine, glutamic acid etc.

2. Non-polar amino acids: They are hydrophobic in nature.

E.g.: Alanine, Phenylalanine, tryptophan, valine, leucine, isoleucine, methionine etc.

IV. Based on the Nutritional requirement:

Based on the nutritional requirement, the amino acids can be classified into two groups-

Essential amino acids - examples given in essential amino acid question (MATT VIL PHLY)

Non-essential amino acids. (Glycine, alanine, serine, cysteine, tyrosine, aspartic acid, glutamic acid, asparagine, glutamine, proline.)

Classification based on metabolic status:

Glucogenic :- Can be converted to glucose in the body after the removal of the amino group.

Ex:- Glycine, Alanine, Serine, Threonine, Glutamic acid, Glutamine,

Ketogenic :- Can be converted to ketone bodies, acetyl CoA, or fat after the removal of the amino group.

- Example: Leucine.

Both glucogenic and ketogenic :- Can split into two parts after the removal of the amino group; one part can be converted to glucose, and the other can be converted to ketone bodies or fat. Examples: Lysine, Isoleucine, Tyrosine, Phenylalanine, Tryptophan.

Essential amino acids.

Essential amino acids (Indispensable amino acids):

Amino acids, which are not synthesized in the body and therefore have to be supplied through the diet, are called essential amino acids. These are;

1. Methionine
2. Arginine*
3. Threonine
4. Tryptophan
5. Valine
6. Isoleucine
7. Leucine
8. Phenylalanine
9. Histidine
10. Lysine

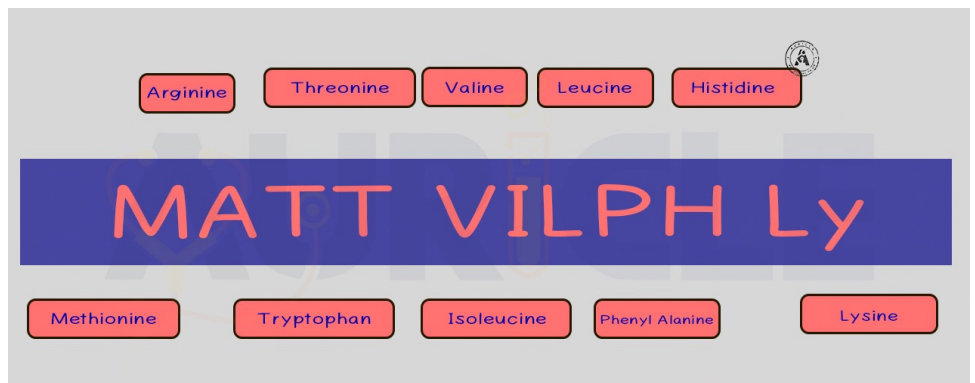
Importance of essential amino acids:

Twenty amino acids needed for protein synthesis, with the body capable of producing non-essential amino acids.

- Essential amino acids must come from dietary proteins as the body cannot synthesize them.
- Dietary proteins are the sole source of essential amino acids for the body.
- Lack of essential amino acids in the diet hinders protein synthesis and results in negative nitrogen balance.
- Proteins lacking one or more essential amino acids fail to support proper growth and body tissue maintenance.



Matt vil phly



Semi-essential amino acids: Among the essential amino acids, **arginine** and **histidine** are called semi-essential amino acids as they are essential in the diet of children, pregnant & lactating women (Semi-essential amino acids are not synthesized in sufficient quantities in these physiological groups) & are not essential in the diet of normal adults.

Extra edge

Amphoteric nature of amino acids (Ampholytes):

Amino acids are ampholytes, because they behave both as an Acid and as a Base.

a) Behavior as an Acid: In the presence of a base, amino acids can donate a proton and thus acts as an acid.

b) Behavior as a Base: In the presence of an acid, amino acid can accept a proton thus acts as base

Since amino acids can act both as an acid (i.e. proton donor) and a base (i.e. proton acceptor), they are said to have amphoteric nature (ampholytes).

Isoelectric pH (pI) of amino acids

What is zwitter ion and their properties ?

Isoelectric pH (pI) of an amino acid is defined as the pH at which amino acids exist as neutral zwitterions (dipolar ion).

E.g.: pI of aspartic acid is 2.9; pI of glycine is 6.1; pI of histidine is 7.6

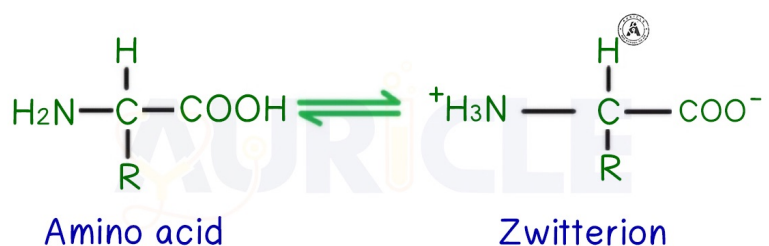
At Isoelectric pH, amino acids possess equal number of positive and negative charges, hence bear no net charge, do not move in an electric field.

A zwitter ion is an ion that contains two functional groups. In simple terms,

it is an ion possessing both positive and negative electrical charges.

Therefore, zwitterions are mostly electrically neutral (the net

formal charge is usually zero).



Define limiting amino acids.

The term "limiting amino acid" is used to describe the essential amino acid present in the lowest quantity in a food protein relative to a reference food protein like egg whites. The term "limiting amino acid" may also refer to an essential amino acid that does not meet the minimal requirements for humans

Examples :- lysine, threonine, methionine, and tryptophan

Explain disorders of sulfur-containing amino acids.

1. Cystinuria:

- Cystinuria is a genetic disorder where the renal tubules fail to reabsorb cystine efficiently. This results in the accumulation of cystine in the urine, leading to the formation of cystine stones in the kidneys and urinary tract.

2. Homocystinuria:

- Homocystinuria is an inherited metabolic disorder characterized by the accumulation of homocysteine in the blood and urine. It can result from deficiencies in enzymes involved in homocysteine metabolism. This condition can lead to various health problems, including eye, skeletal, and cardiovascular issues.

3. Methionine Malabsorption:

- In methionine malabsorption disorders, the body has difficulty absorbing and utilizing methionine. This can lead to various symptoms and issues related to methionine deficiency.

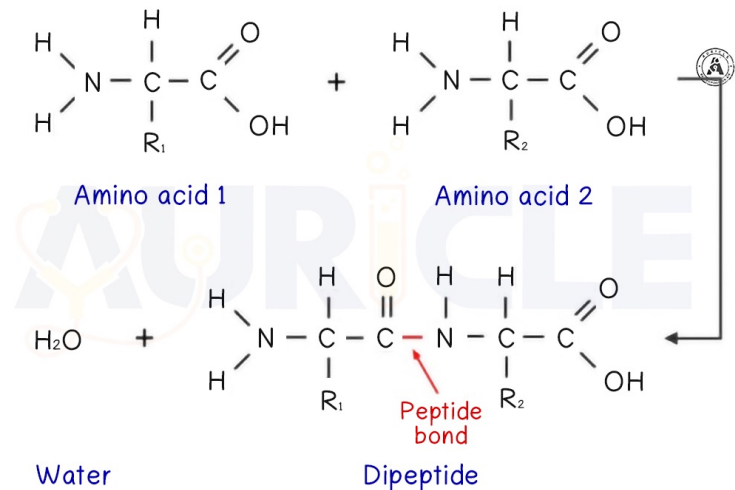
4. Cystathioninuria:

- Cystathioninuria is a metabolic disorder in which there is an elevated excretion of cystathionine in the urine due to an enzyme deficiency. It is typically considered a benign condition with no associated clinical symptoms.

Peptide bonds

Definition :

Peptide bonds are anhydride, covalent bonds formed between a carboxyl group of an amino acid and an amino group of succeeding amino acid.



Salient features of peptide bonds:

- 1) Peptide bond is a strong covalent bond.
- 2) Peptide bond is an anhydride bond (i.e. formed by the loss of a water molecule).
- 3) Peptide bonds are amide linkages.
- 4) Peptide bond generally exists in -trans configuration (exception is peptide bond formed by proline, an imino acid, which has -cis configuration).
- 5) Peptide bonds are partial double bond in nature.
- 6) Peptide bonds are semi-rigid in nature.
- 7) All atoms - C, N, O and H are coplanar.
- 8) During denaturation, peptide bonds are not affected, because peptide bonds are strong covalent bonds.

Importance of peptide bonds:

Peptide bonds are responsible for the polymerization of amino acids to form peptides (oligopeptides and polypeptides) and proteins.

Biologically important peptides (biological importance of peptides).

Physiologically (Biologically) important peptides:

Body contains many important peptides (containing 2-50 amino acids) that have diverse physiological functions.

These are,

1) Carnosine and Anserine: Both are dipeptides. Carnosine is made up of α -alanine & histidine; anserine is a derivative of carnosine. These peptides are present in muscles.

2) Glutathione (γ - glutamyl cysteinyl glycine): It is a tripeptide made up of γ -glutamic acid, cysteine and glycine.

Present in erythrocytes in large amounts. It is a powerful reducing agent and involved in various reduction reactions in the body. (**further information given in glutathione question**)

Glutathione functions are discussed in detail in next page.

3) Thyrotropin releasing hormone (TRH): A tripeptide secreted by hypothalamus, stimulates the pituitary gland to release thyrotropin stimulating hormone (TSH).

4) Enkephalins: Pentapeptide neurotransmitters. Enkephalins inhibit pain sensation.

5) Oxytocin: A nonapeptide hormone secreted by posterior pituitary. It causes uterine contraction.

6) Vasopressin (ADH): A nonapeptide hormone secreted by posterior pituitary. It is required for smooth muscle contraction and water reabsorption.

7) Bradykinin: Nonapeptide. It is a vasodilator.

8) Kallidin: Decapeptide. It is a vasodilator.

9) Angiotensins: Angiotensin II (octapeptide) is derived from Angiotensin I (decapeptide). Angiotensin II is a hypertensive peptide, stimulates the release of aldosterone from adrenal glands.

10) Glucagon :It is a hyperglycemic hormone.

11) Gramicidin, Actinomycin (Antibiotics) are peptides in nature.

12) Gastrin, Secretin (Gastrointestinal hormones) are also peptides.

13) Insulin (51 amino acids): Secreted from β -cells of islet of Langerhans. It is a hypoglycemic hormone, lowers blood glucose level.

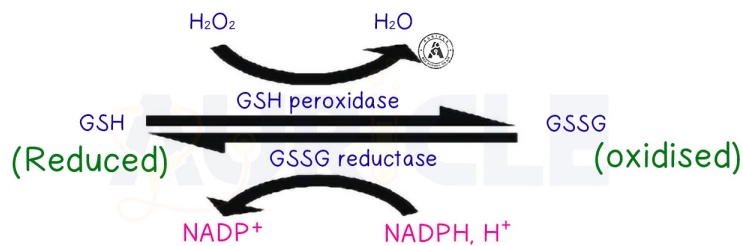
Glutathione

Glutathione (Abbreviated as GSH):

Glutathione (or γ - glutamyl cysteinyl glycine) is tripeptide made up of γ -glutamic acid, cysteine and glycine. Glutathione is abbreviated as GSH, because sulfhydryl group (SH) of cysteine is the active group of glutathione.

Structure of GSH : γ Glutamic acid - Cystein - Glycine

It exists in 2 forms, reduced glutathione (GSH) and oxidized glutathione (GS-SG).



Reduced form of glutathione is biologically active and it is a powerful reducing agent, required for many reduction reactions.

Functions:

1. GSH is involved in the anti-oxidation of toxic oxidants like hydrogen peroxide, and superoxides by its peroxidase activity. This reaction is catalyzed by glutathione peroxidase, a selenium containing enzyme. In this reaction, reduced glutathione (GSH) will be converted to oxidized glutathione (GS-SG).

Glutathione's antioxidant properties are utilized in skin whitening treatments



2. GSH required for the intestinal absorption of iron by converging Fe^{+3} to Fe^{+2}
3. GSH required for the reversion of methemoglobin (Fe^{+3}) to Hemoglobin (Fe^{+2}).
4. Glutathione also has a coenzyme role (E.g. Maleyl acetoacetate isomerase etc.)
5. GSH protects the sulfhydryl (SH) group of several enzymes I proteins.
6. Meister cycle: Glutathione is also involved in the transport of amino acids in the kidney tubules via Meister cycle or γ - glutamyl cycle.
7. GSH is involved in the detoxification of bromobenzene to mercapturic acid.

Proteins

Structure of protein

The structure of proteins is rather complex which can be divided into 4 levels of organisation

1.Primary structure: The linear sequence of amino acids forming the backbone of proteins (polypeptides).

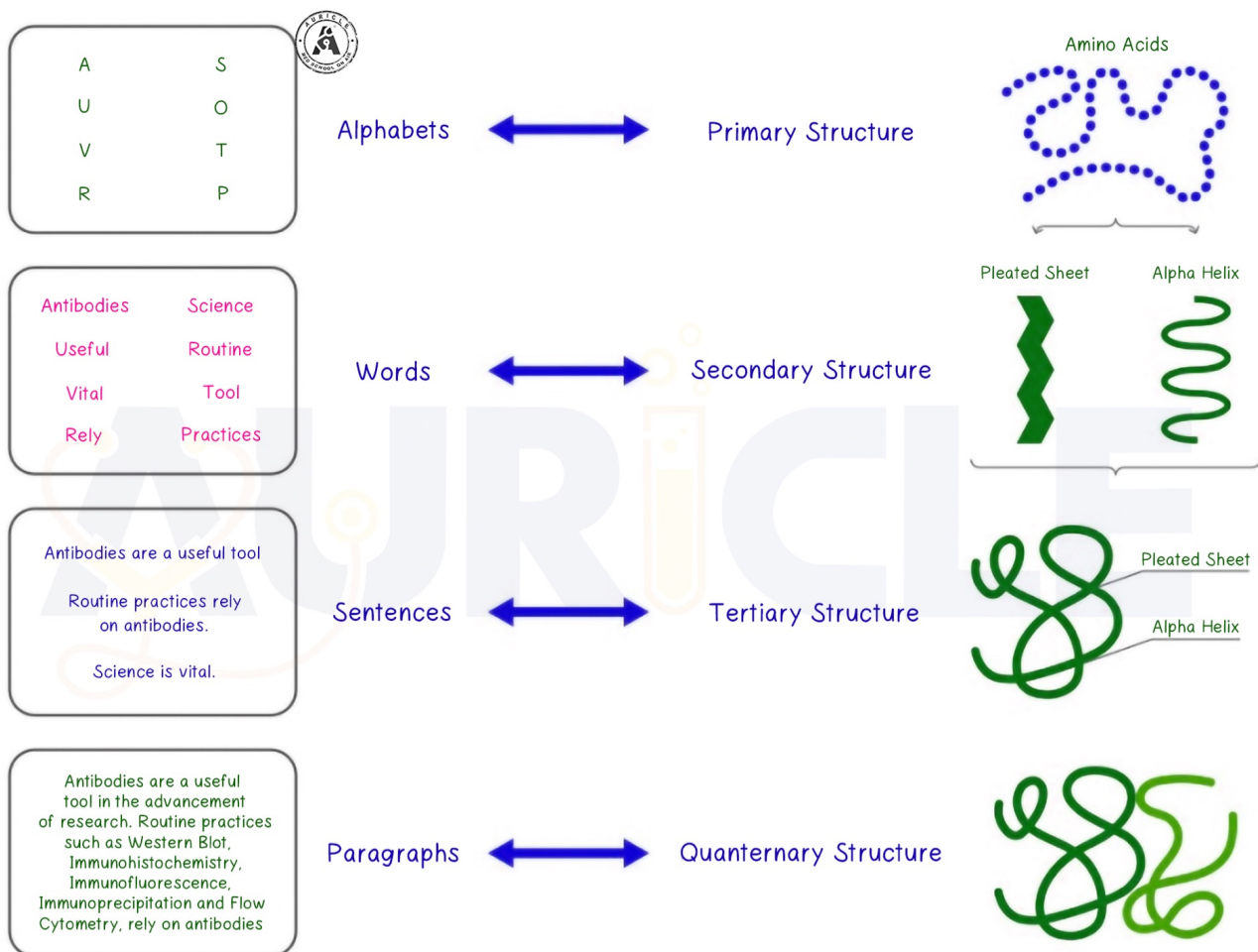
2.Secondary structure:The spatial arrangement of protein by twisting of the polypeptide chain.

3.Tertiary structure: The three dimensional structure of a functional protein.

4. Quaternary structure: Some of the proteins are composed of two or more polypeptide chains referred to as subunits.

The spatial arrangement of these subunits is known as quaternary structure.

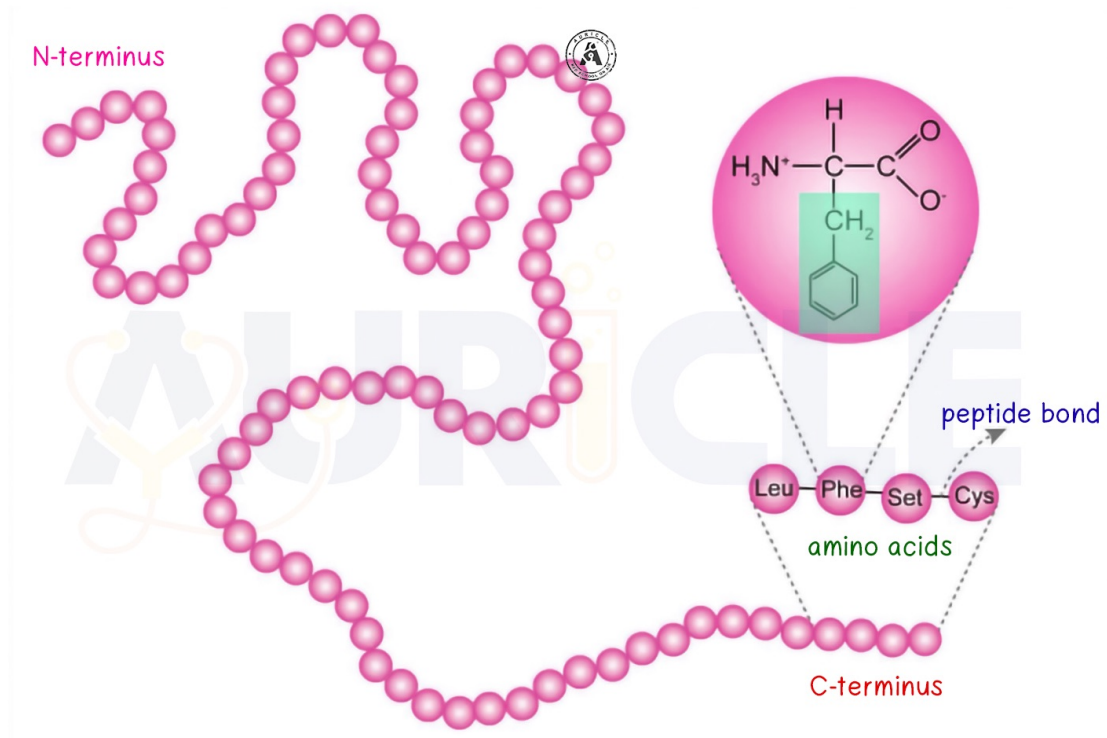
For your understanding



Structural organisation of proteins (primary, secondary, tertiary and quaternary structure).

PRIMARY STRUCTURE OF PROTEIN

1. Each protein has a unique sequence of amino acids which is determined by the genes contained in DNA.
2. The primary structure of a protein is largely responsible for its function. Lead to many genetic diseases.
3. The amino acids are held together in a protein by covalent peptide bonds or linkages.
4. These bonds are rather strong.
5. Formation of a peptide bond: When the amino group of an amino acid combines with the carboxyl group of another amino acid, a peptide bond
6. dipeptide will have two amino acids and one peptide bond
7. The peptide bond is rigid and planar with partial double bond in character.



Secondary structure of proteins

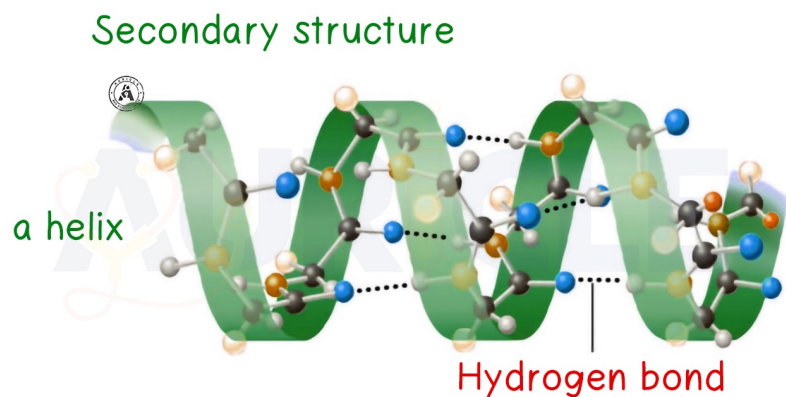
SECONDARY STRUCTURE OF PROTEIN

1. The conformation of polypeptide chain by twisting or folding is referred to as secondary structure.
2. The amino acids are located close to each other in their sequence.
3. Two types of secondary structures, α -helix and β -sheet

alpha - Helix

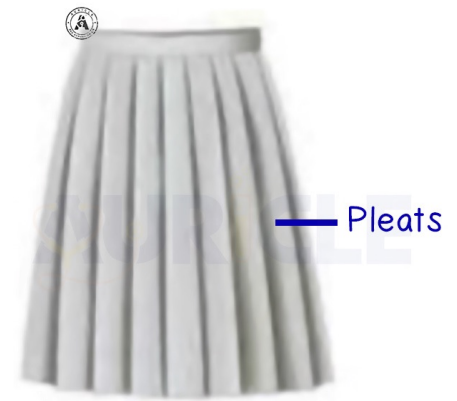
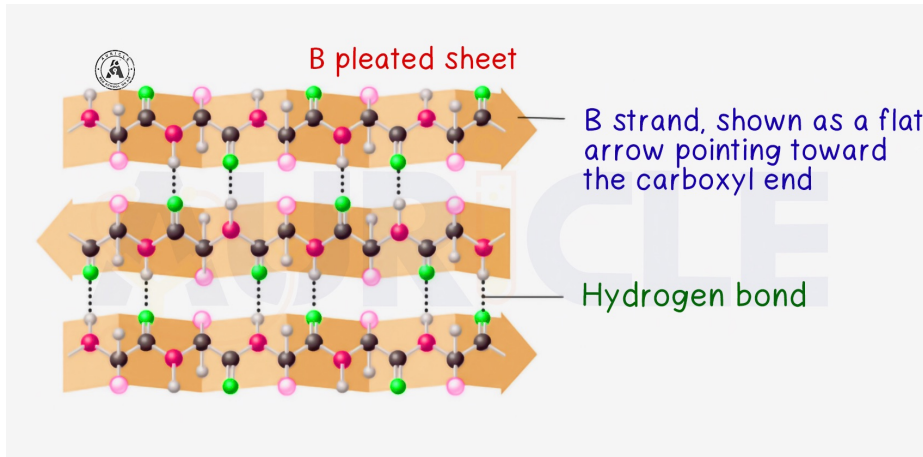
it is most common spiral structure of protein.

- . It has a rigid arrangement of polypeptide chain.
- . The α -helix is a tightly packed coiled structure with amino acid side chains extending outward from the central axis.
- . The α -helix is stabilised by extensive hydrogen bonding. It is formed between H atom attached to peptide N, and O atom attached to peptide C.
- . The hydrogen bonds are individually weak but collectively, they are strong enough to stabilise the helix.
- . All the peptide bonds, except the first and last in a polypeptide chain, participate in hydrogen bonding.
- . Each turn of α -helix contains 3.6 amino acids and travels a distance of 0.54 nm.
- . The spacing of each amino acid is 0.15 nm.
- . α -Helix is a stable conformation formed spontaneously with the lowest energy.



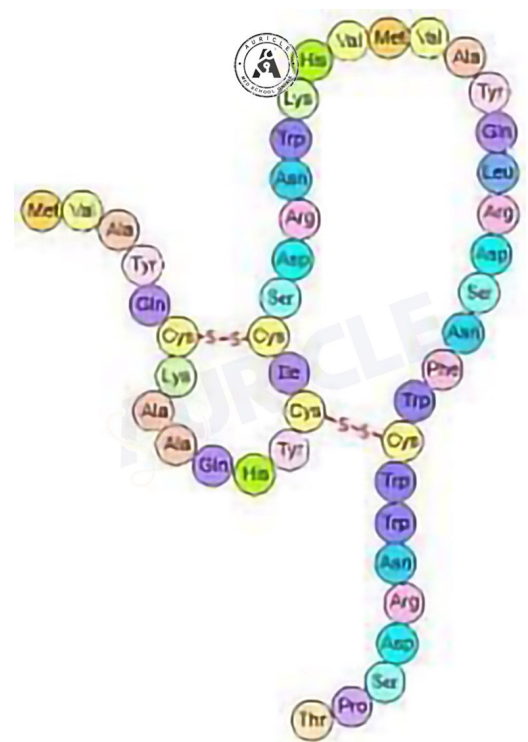
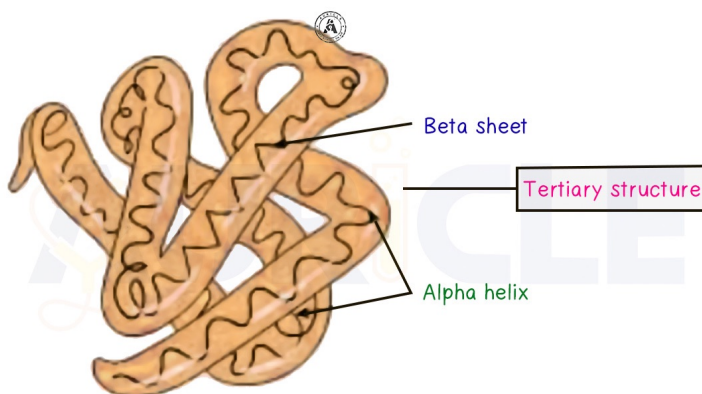
β -Pleated sheet

- . This is the second type of structure. β -sheets are composed of two or more segments of fully extended peptide chains.
- . In the β -sheets, the hydrogen bonds are formed between the neighbouring segments
- Parallel and anti-parallel -sheets



TERTIARY STRUCTURE OF PROTEIN

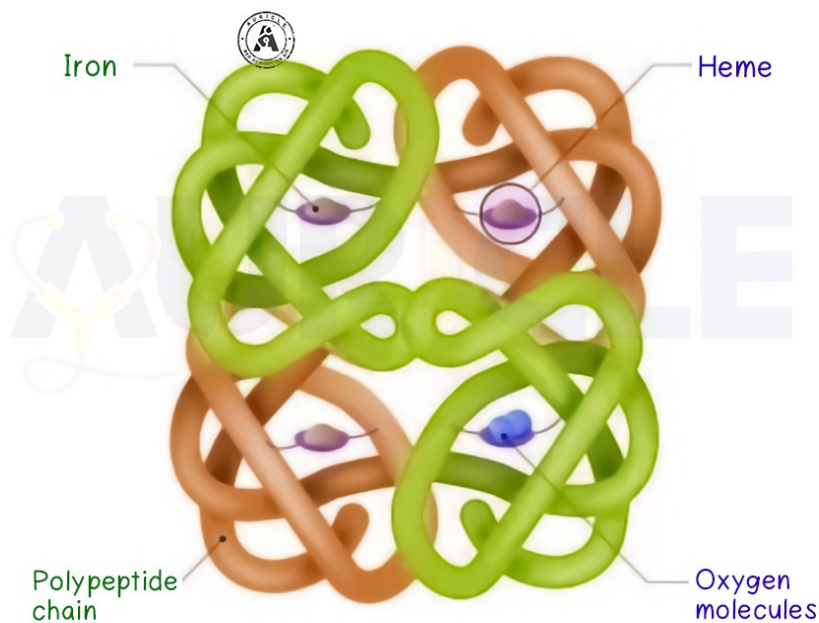
1. The three-dimensional arrangement of protein structure is referred to as tertiary structure.
2. It is a compact structure with hydrophobic side chains held interior while the hydrophilic groups are on the surface of the protein molecule.
3. This type of arrangement ensures stability of the molecule.
4. Bonds of tertiary structure: Besides the hydrogen bonds, disulfide bonds (-S-S), ionic interactions (electrostatic bonds) and hydrophobic interactions also contribute to the tertiary structure of proteins.



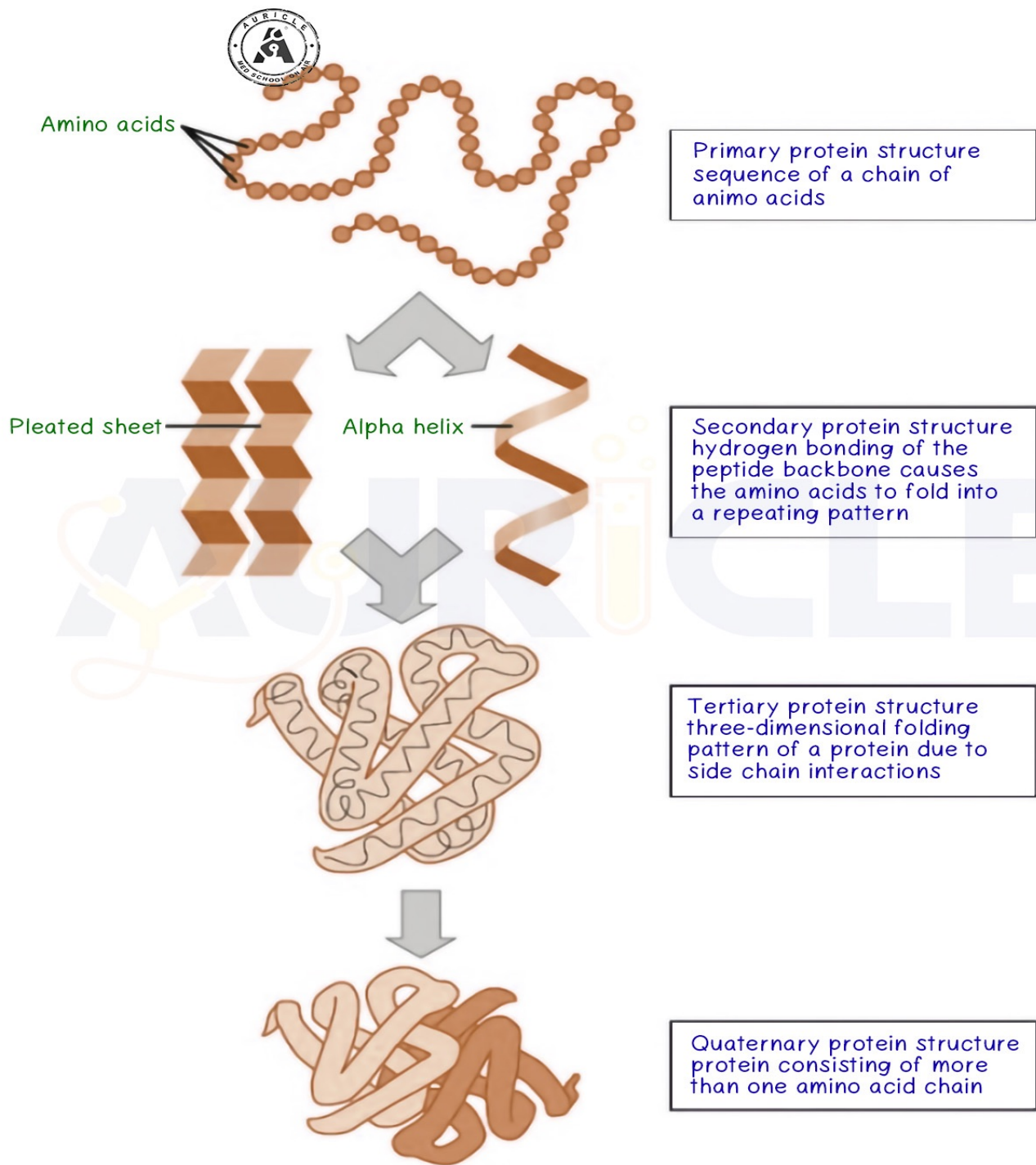
QUATERNARY STRUCTURE OF PROTEIN

1. Some of the proteins, however, consist of two or more polypeptides which may be identical or unrelated.
2. Such proteins are termed as oligomers and possess quaternary structure.
3. . A dimer consists of two polypeptides while a tetramer has four
- Bonds in quaternary structure
4. The monomeric subunits are held together by non-covalent bonds namely hydrogen bonds, hydrophobic interactions and ionic bonds.
5. These proteins play a significant role in the regulation of metabolism and cellular function.
6. Examples of oligomeric proteins: Hemo-globin, aspartate transcarbamylase, lactate

HEMOGLOBIN



Summary



Extra edge

Chaperones (Heat shock proteins):

Some proteins can spontaneously undergo folding to attain the active conformation. But, some proteins require a specialized group of proteins known as chaperones (or heat shock proteins) that assist in protein folding. Chaperones reversibly bind with unfolded proteins to cause the proteins to fold and attain the compact and biologically active conformations.

Bonds responsible for protein structure Protein structure

- **Covalent Bonds:** These are strong bonds in protein structure.

- **Peptide Bonds:** Formed between amino acids, creating the protein's backbone.

- **Disulfide Bonds:** Created by the sulfur groups (SH) of cysteine residues, contributing to structural stability. They can form within a single polypeptide chain or between different chains.

- **Non-Covalent Bonds:** These are weaker, but collectively crucial for protein structure.

- **Hydrogen Bonds:** Formed by sharing hydrogen atoms between the nitrogen and carbonyl oxygen of different peptide bonds.

- **Hydrophobic Bonds:** Non-polar amino acid side chains tend to associate with each other.

- **Electrostatic Bonds:** Occur between negatively charged (COO^-) and positively charged (NH_3^+) groups in amino acids.

- **Van der Waals Forces:** Non-covalent associations between electrically neutral molecules, resulting from electrostatic interactions due to dipoles.

Protein Characteristics:

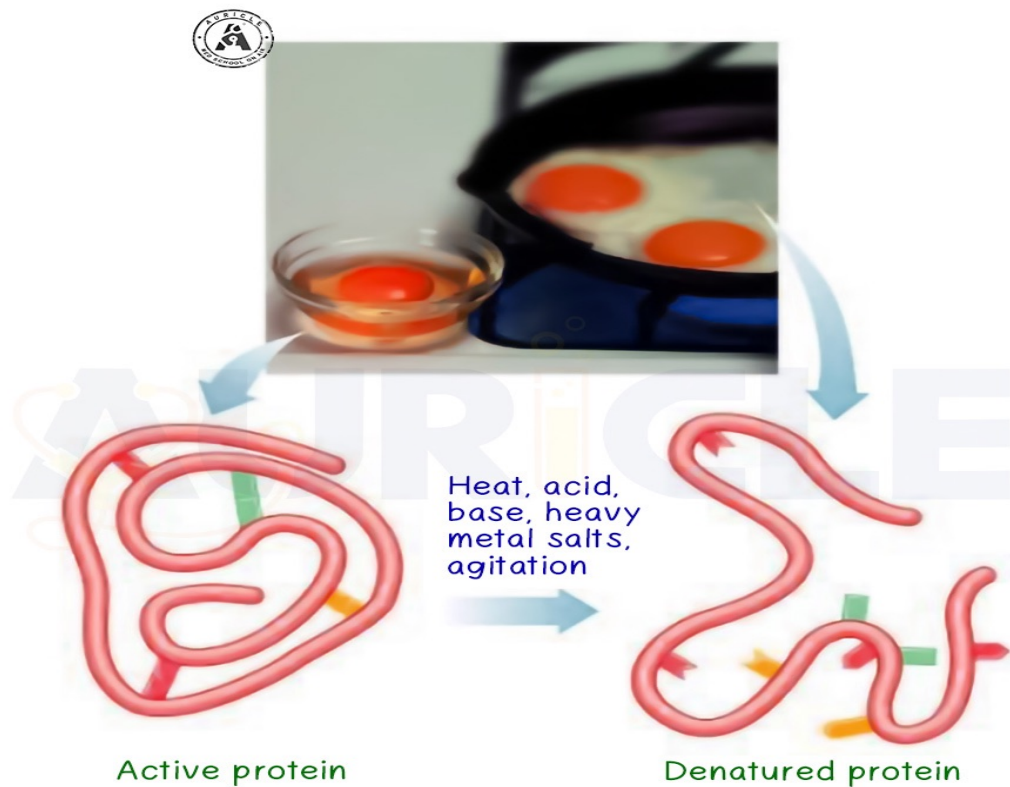
1. Solubility: Proteins form colloidal solutions in water due to their large size.
2. Molecular Weight - Protein molecular weights vary based on the number of amino acid residues. They range from 4,000 to 440,000.
 - Examples: Insulin (5,700), Myoglobin (17,000), Hemoglobin (64,450), Serum albumin (69,000).
3. Shape:- Proteins exhibit a wide variety of shapes, including globular (insulin), oval (albumin), and fibrous (fibrinogen).
4. Isoelectric pH (pI):- The isoelectric pH (pI) is determined by the nature of amino acids. At pI, proteins are electrically neutral.
 - Examples: Pepsin (1.1), Casein (4.6), Human albumin (4.7), Urease (5.0), Hemoglobin (6.7), Lysozyme (11.0)
5. Acidic and Basic Proteins:- Basic proteins have a higher ratio of (Lys + Arg) to (Glu + Asp), while acidic proteins have a lower ratio.
6. Precipitation of Proteins:-
 - Precipitation at pI: Proteins are least soluble at their isoelectric pH and can be precipitated.
 - Precipitation by Salting Out:- Neutral salts like ammonium sulfate cause protein precipitation, with the amount required depending on molecular weight.
 - Salting In: Small salt quantities increase protein solubility.
 - Precipitation by Heavy Metal Salts:- Heavy metal ions like Pb^{2+} cause protein precipitation.
 - Precipitation by Anionic Reagents:- Anionic acids like tannic acid can precipitate proteins.
 - Precipitation by Organic Solvents:- Organic solvents like alcohol dehydrate proteins, causing precipitation.
7. Color Reactions:- Proteins give various color reactions useful for identifying amino acids present in them.

Denaturation of proteins and agents causing denaturation.

Definition: The process of disorganization of native protein structure is called Denaturation. Denaturation involves the loss of secondary, tertiary and quaternary structures without breaking the primary structure.

Denaturation causes the unfolding of native 3-dimensional form of proteins.

Reason: Higher structures of proteins (3-D conformation) are maintained by weak non-covalent bonds, which can be easily disrupted by a variety of physical and chemical agents, whereas the primary structure of proteins are not easily broken because they are maintained by strong covalent peptide bonds.



Agents causing denaturation:

Denaturation can be caused by various physical and chemical agents.

- i) Physical agents: Pressure, heat, X-ray, UV radiation, ultrasound etc.
- ii) Chemical agents: Acids, alkali, organic solvents (ether, alcohol etc.), high concentration of urea, salicylates and heavy metals (lead, mercury, silver etc).

Characterstics of Protein Denaturation:

1. Native helical structure of the protein is lost.
2. The primary structure remains intact; peptide bonds are not hydrolyzed.
3. Denatured protein loses its biological activity.
4. It becomes insoluble in the solvent where it was originally soluble.
5. Denatured protein's solution becomes more viscous with reduced surface tension.
6. Denaturation increases the presence of ionizable and sulfhydryl groups due to the loss of hydrogen and disulfide bonds.
7. Denatured protein is more easily digested due to increased exposure of peptide bonds to enzymes.
8. Denaturation is typically irreversible.
9. Some careful denaturation can be reversible, known as renaturation (e.g., hemoglobin in the presence of salicylate).
10. Denatured protein cannot be crystallized.

EXTRA EDGE

Denaturation vs Coagulation



	Denaturation	Coagulation
DEFINITION	Denaturation is the process of changing properties of a molecule from its native state	Coagulation is the process of clumping small molecules together and form aggregates.
IMPORTANCE	Important in sterilization and killing of microorganisms.	Important in blood coagulation and water treatment
DISADVANTAGES	Denaturation abolishes the properties of a molecule	Coagulation changes the liquid state of the molecules
CAUSES	Denaturants such as strong acids, bases, heat, radiation, etc	Coagulants such as alum sulfate, clotting factors, etc.

Classification of proteins based on the biological function:

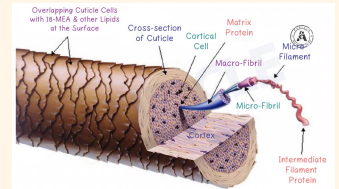
Proteins have diverse biological functions, based on which they can be classified as,

1) Catalytic proteins:
All enzymes are protein in nature (exception is ribozymes, which are RNA in nature). E.g.: Hexokinase, Amylase etc.

2) Defence proteins:
E.g.: Immunoglobulins as antibodies

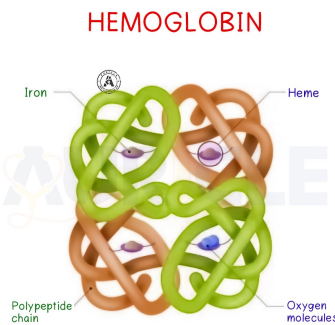


3) Structural proteins:
E.g.: Keratin present in hair and nail; Collagen is present in muscles.



10) Haemostatic proteins:
E.g.: Fibrinogen, Prothrombin etc.

12) Respiratory proteins:
E.g.: Hemoglobin, Myoglobin

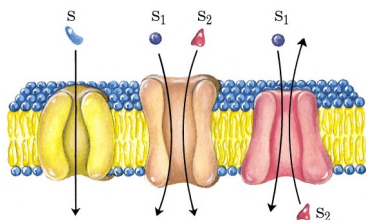


4) Hormonal proteins:
Some hormones are protein in nature. E.g.: Growth hormone, Insulin etc.

5) Contractile proteins:
E.g.: Actin, Myosin and Tropomyosin present in muscle



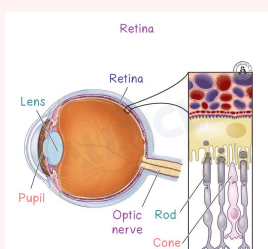
9) Membrane proteins:
E.g.: Sodium potassium pump or Sodium potassium ATPase.



7) Storage proteins:
E.g.: Ferritin storage of iron in liver and bone marrow.

6) Transport proteins:
E.g.: Serum albumin carries bilirubin, fatty acids etc. Transferrin transports Iron.

8) Visual proteins:
E.g.: Rhodopsin and Iodopsin present in the retina of eye.

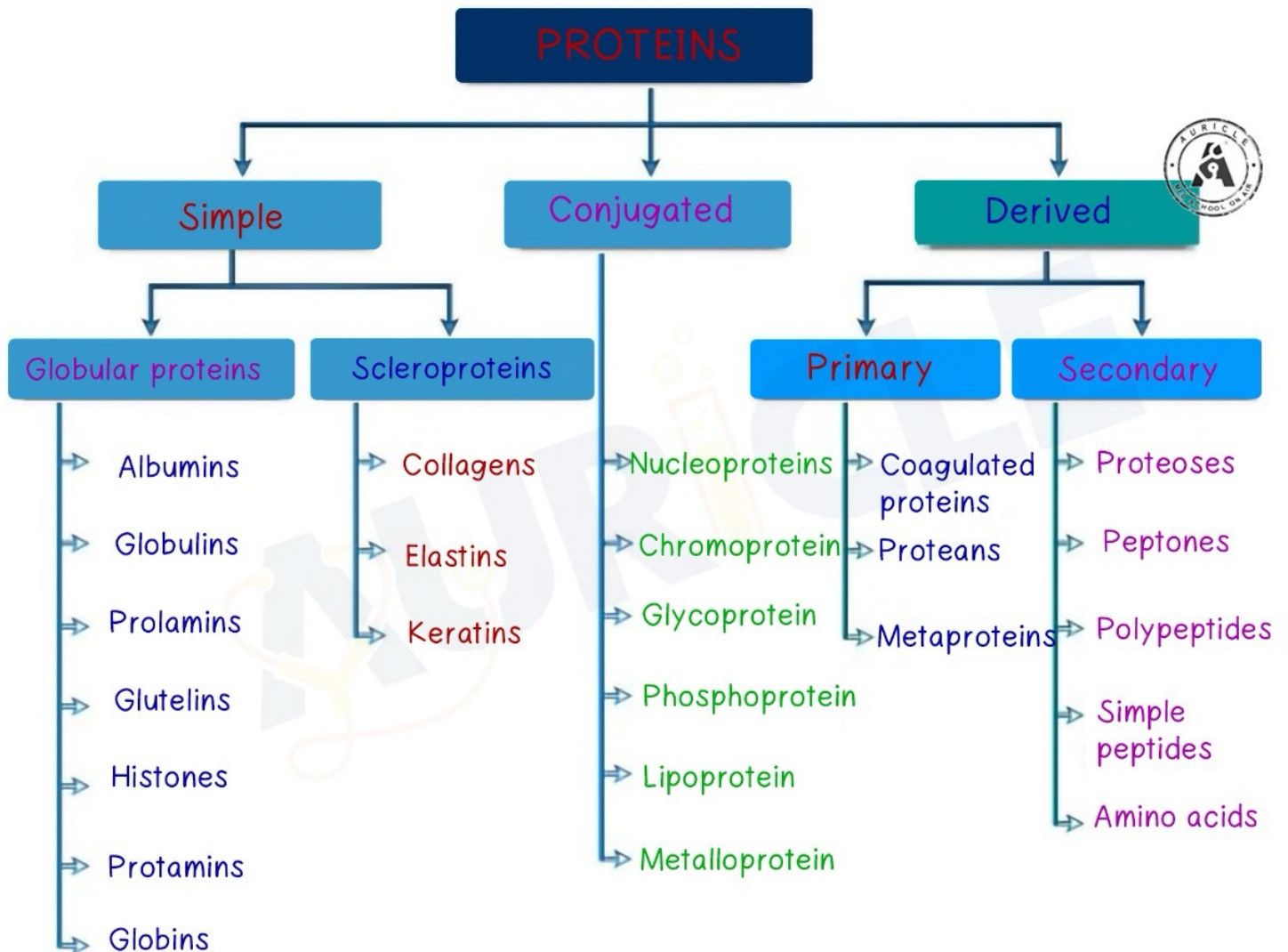


13) Receptor proteins:
E.g.: Insulin receptors, Glucagon receptor, steroid hormone receptors etc.

11) Buffer proteins:
E.g.: Plasma proteins, Hemoglobin

14) Genetic proteins:
E.g.: Histones, various transcription and translation factors.

Classification of proteins based on their chemical composition



Classification of proteins based on shape (conformation)

: Based on shape, proteins are classified into 2 groups.

1) Globular proteins: These are spherical or oval in shape. E.g.: Hemoglobin, Albumin and Enzymes.

2) Fibrous proteins: These are elongated and fiber- like structures. E.g.: Keratin, collagen, elastin etc.

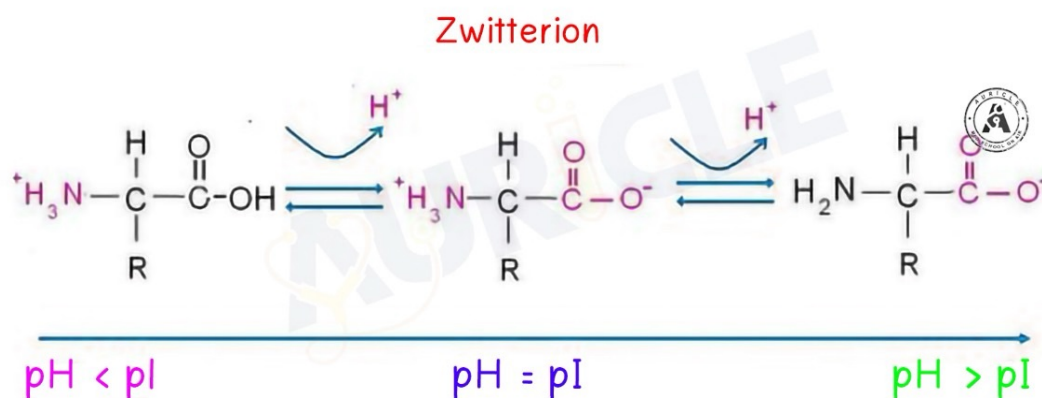
Isoelectric pH and isoelectric precipitation of proteins.

Isoelectric pH (pI) of Proteins:

- Definition: The pH at which proteins exist as zwitterions, with an equal number of positive and negative charges.
- Examples: Pepsin (pI 1.1), Casein (pI 4.6), Albumin (pI 4.7), Human Hemoglobin (pI 6.7), etc.
- Properties:
 1. At pI, the net charge is zero; the protein doesn't move in an electric field.
 2. Proteins have minimal buffering capacity and viscosity at their isoelectric pH.
 3. Proteins are least soluble and most precipitable at their isoelectric pH, as they tend to aggregate and precipitate.

Isoelectric Point (pI):

- Definition: The pH at which a molecule carries no net electrical charge, especially for amino acids.
- Proteins have their own isoelectric pH (pI) values based on their amino acid composition.
- pI is important in various biological and chemical processes, such as electrophoresis and isoelectric precipitation.



Isoelectric Precipitation of Proteins:

- Definition: Precipitation of proteins at their isoelectric pH.
- Some proteins, like casein, precipitate immediately when adjusted to their isoelectric pH.
- Explanation: Proteins are least soluble at their isoelectric pH, where they exist as zwitterions with minimal electrostatic repulsion. This leads to easy aggregation and precipitation.
- Example: Casein precipitates readily when pH is adjusted to 4.6 (the isoelectric pH of casein).

Which of the following is not an aromatic amino acid?

- A. Phenylalanine
- B. Tyrosine
- C. Tryptophan
- D. Arginine

Which of the following amino acids has an imino ring

- A Proline
- B. Tyrosine
- C. Tryptophan
- D. Histidine

Which of the following is not a basic amino acid?

- A Histidine
- B. Arginine
- C. Lysine
- D. Glycine

Which of the following amino acids is polar in nature?

- A Aspartic acid
- B Alanine
- C Proline
- D Methionine

Which of the following contain a phenol group?

- A. Arginine
- B. Phenylalanine
- C. Tyrosine
- D. Proline

Answers

- 1.D
- 2.A
- 3.D
- 4.A
- 5.C

a. Deamination is _____ of amino group.

- (A) Removal
- (B) Addition
- (C) Supplementation
- (D) None of these

Answer:

The removal of amino group from the amino acids as ammonia is deamination. It may be oxidative or non-oxidative in nature. The NH_3 so liberated is used for synthesis of urea.

. The amino acids required for creatine formation:

- (A) Glycine
- (C) Methionine
- (B) Arginine
- (D) All of these

Answer:

The three amino acids glycine, arginine and methionine are required for creatine formation. Glycine combines

Biuret test is specific for

- (A) Two peptide linkage
- (B) Phenolic group
- (C) Imidazole ring
- (D) None of these

Answer:

Biuret test is answered by compounds containing two or more $\text{CO}-\text{NH}$ groups i.e., peptide bonds. All protein and peptides possessing at least two peptide linkages i.e., tripeptide (with 3 amino acids) give positive biuret test. The principle of biuret test is conveniently used to detect the presence of proteins in biological fluids. The mechanism of biuret test is not clearly known. It is believed that the colour is due to the formation of a copper co-ordinated complex.

1 The basic amino acids are

- (A) Lysine
- (B) Bile acids
- (C) Glycine
- (D) Alanine

Answer:

Lysine, arginine, histidine. These are dibasic monocarboxylic acids.

Non-Protein amino acids are

- (A) Ornithine
- (B) β -alanine
- (C) γ -amino butyric acid
- (D) All of these

Answer:

The amino acids which are never found in protein structure are collectively referred to as non-protein amino acids. However, the non- protein amino acids perform several biological functions. e.g., ornithine, citrulline, thyroxine.

In metabolic point of view, amino acids are classified as

- (A) Glycogenic
- (B) Ketogenic
- (C) Glycogenic or Ketogenic
- (D) All of these

Answer:

Amino acids are divided into 3 groups based on their metabolic fates.

- a. Glycogenic: These amino acids can serve as precursors for the synthesis of glucose (or glycogen) e.g., alanine, aspartate, glycine.
- b. Ketogenic: Fat can be synthesized from these amino acids e.g., leucine, lysine.
- c. Glycogenic or ketogenic: The amino acids that can form glucose as well as fat e.g., isoleucine, phenylalanine, lysine.

A Zwitterion is

- (A) Positive ion
- (B) Negative ion
- (C) Both (A) and (B)
- (D) None of these

Answer:

Zwitterion (dipolar ion) is a hybrid molecule containing positive and negative ionic groups. Each amino acid has a characteristic pH (e.g., leucine pH 6.0), at which it exists as zwitterions.