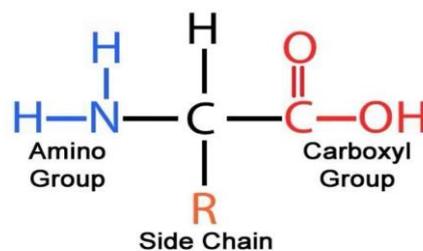


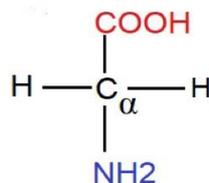
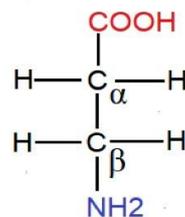
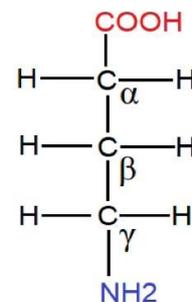
## Amino acids and Proteins

**Amino acids:** Are a group of organic compound containing two functional groups (amino and carboxyl) on the same molecules. Amino acids are considered the structural units of proteins. The amino group (-NH<sub>2</sub>) is basic while the carboxyl group (-COOH) is acidic in nature.

- Each amino acid has four different groups attached to the carbon atom. These groups are: Amino group (NH<sub>2</sub>), Carboxyl group (COOH), Hydrogen atom and Side Chain (R).



- Side chain (R) means the alkyl groups that change according to the chemical nature of amino acid.
- When the amino group and the carboxyl group are attached to the same carbon atom the amino acid are termed as  $\alpha$ -amino acid.

 $\alpha$ -amino acid $\beta$ -amino acid $\gamma$ -amino acid

## Properties of Amino Acids

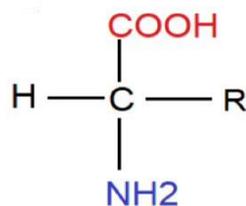
in general , Amino acids are white crystalline solid substances. possess a very high melting and boiling point. in taste, few Amino acids are sweet, tasteless, and bitter. most of the amino acids are soluble in water and are insoluble in organic solvents. The major properties of amino acids can be classified in two categories;

- Optical Properties of Amino Acid

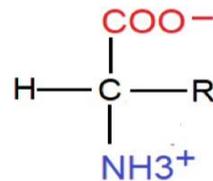
Amino acids are **chiral molecules**, meaning they contain an asymmetric carbon atom (also known as a **chiral center**) bonded to four different groups. Therefore all the amino acid (except Glycine where R=H) have optical properties (optical isomers and ability to rotate the polarize light).

- The Acid – Base Properties of Amino Acid

Amino acids contain both an acidic carboxylic group and basic amino group. At a specific pH called the isoelectric point (PI), which is approximately 7 for most amino acids, the carboxylic group loses a proton ( $H^+$ ) ( $-COO^-$ ) and remains in an anionic form, while the amino group accepts a proton ( $-NH_3^+$ ) and becomes in a cationic form. This results in the formation of a Zwitterion, which is a neutral molecule with both positive and negative charges, making it Amphoteric in nature. This behavior is indeed characteristic of amino acids and is important in their biochemical properties.



Amino acid



Zwitterion form

## Essential and Non-Essential Amino Acid

- 1- **Essential amino acids :-** the amino acids which cannot be synthesized by the body and have to be provided in the diet. The essential amino acids are leucine (Leu) , isoleucine (Ile) , threonine(Thr) , tryptophan (Trp) , phenylalanine (Phe) , valine (Val) , methionine (Met) and lysine (Lys) .

**Tryptophan** is an essential amino acid, meaning the body cannot produce it and must obtain it from the diet. It serves as a precursor for the synthesis of **serotonin**, a neurotransmitter involved in regulating mood, sleep, and appetite, as well as for the synthesis of **niacin** (vitamin B3). Tryptophan-rich foods include poultry, dairy, eggs.

- 2- **Non-Essential amino acids:-** the amino acids which can be synthesized by the body. The non-essential amino acids are alanine(Ala) , aspartic acid (Asp) , asparagine (Asn) , cysteine (Cys) , glutamic acid (Glu) , glutamine (Gln) , glycine (Gly) , proline (Pro) , serine (Ser) and tyrosine (Tyr).

**Glycine** is a non-essential amino acid, meaning it can be synthesized by the body. It can be synthesized via various pathways, one of which involves the reaction of  $\text{CO}_2 + \text{NH}_2 + \text{H}_2\text{O}$  catalyzed by the enzyme glycine synthase. Additionally, glycine can also be synthesized from other amino acids such as serine and threonine through specific metabolic pathways.

Glycine is the precursor for Purine bases, Collagen, Glutathione, Creatine, Serine Neurotransmitter.

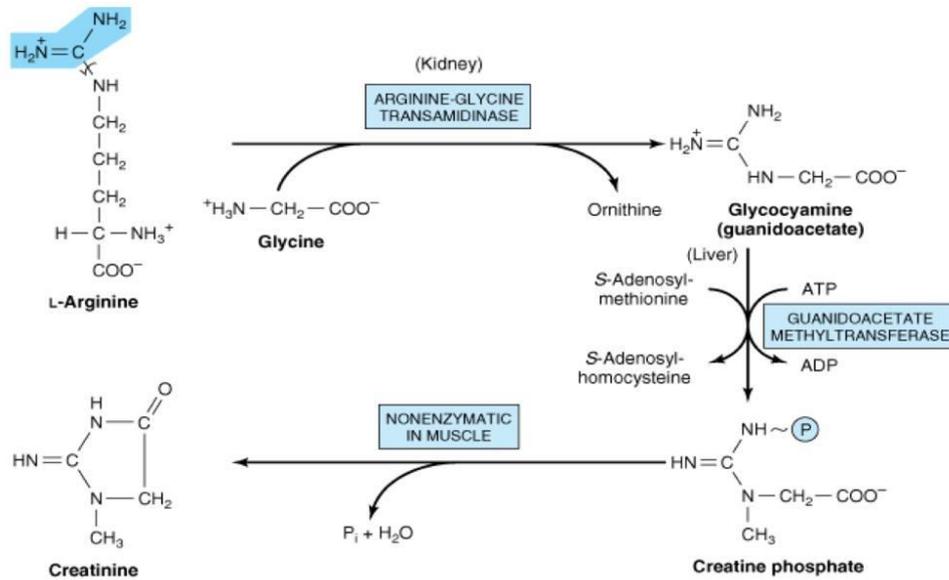
**Creatine** is a non-essential amino acid synthesized from three amino acids: glycine, arginine, and methionine. This occurs by three reactions in kidney, liver and muscle.

1) **in kidney:** glycine and arginine react to form guanidoacetic acid.

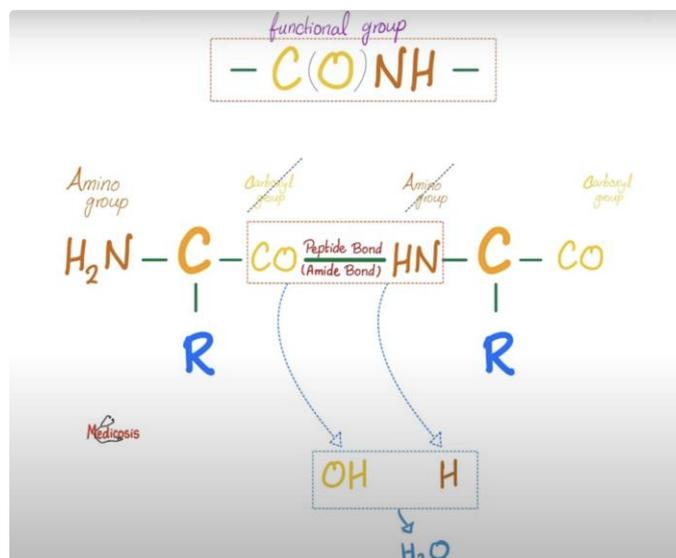
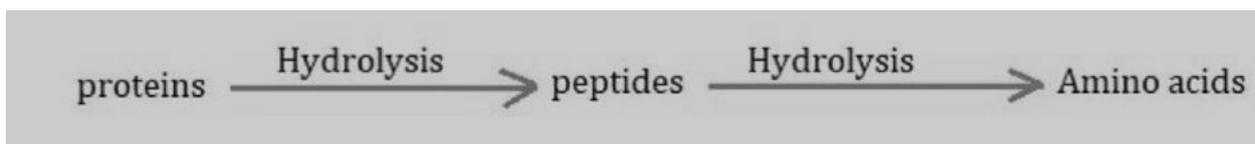
2) **in liver:** methylation of guanidoacetic acid takes place to form methyl-guanidoacetic acid (creatine).

3) **in muscles:** Creatine is phosphorylated to Creatine-phosphate.

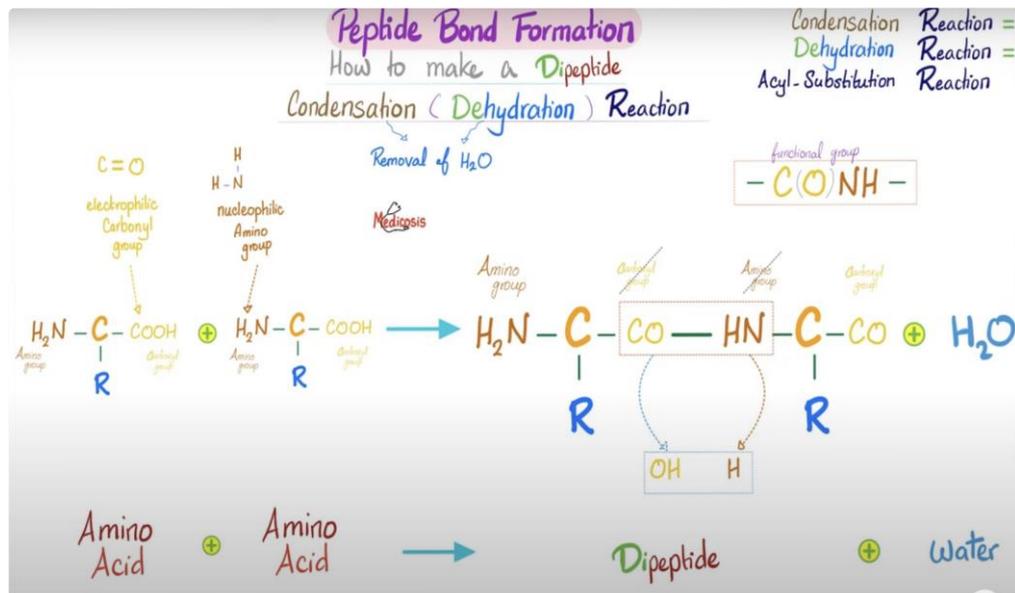
Creatine phosphate acts as a store of high energy phosphate in muscles and used during muscle exercise.



**Proteins :-** The most abundant biological macromolecule that is present in all living organisms. consist of one or more long chains of  $\alpha$ -amino acids covalently linked by the peptide bonds. ranging in size from relatively small peptides ( short chain of amino acids typically 2 to 50) to proteins (generally used for a polypeptide containing more than 50 amino acids). The building blocks units of proteins are the twenty naturally occurring amino acids. Thus, proteins are the polymers of amino acids.



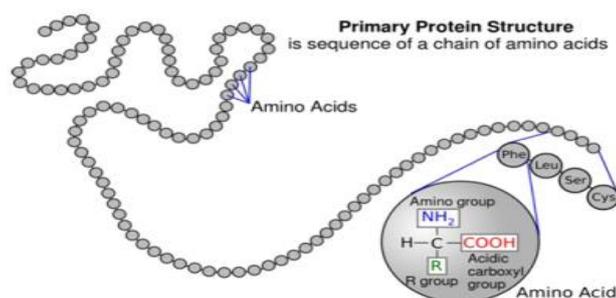
**Peptide bond formation :-** Is a chemical bond an amide type of covalent bond between two  $\alpha$ -amino acids by linking carboxyl group(-COOH) of the one amino acid to the amino group (-NH<sub>2</sub>) of another amino acid with releasing a water molecule. The resulting bond is called a peptide bond, and the resulting molecule is an amide (-CO-NH-).



## Structure of Proteins

Proteins are made up of one or more polypeptide chains. Four levels of structural organization can be recognized in proteins:

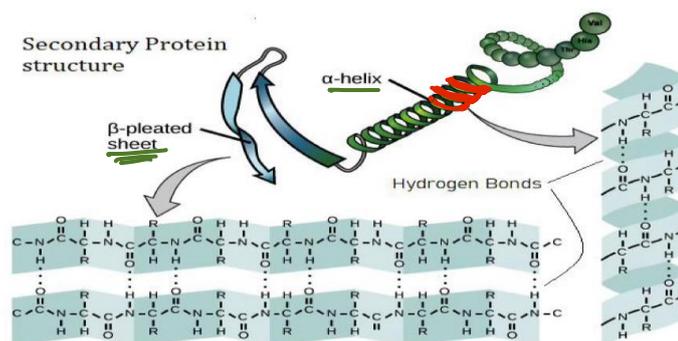
- 1- Primary structure:- refers to the linear sequence of amino acids in a protein, determined by the DNA. It is maintained by peptide linkages and is the simplest level of protein structure. For instance, insulin consists of two chains, one with 31 amino acids and the other with 20.



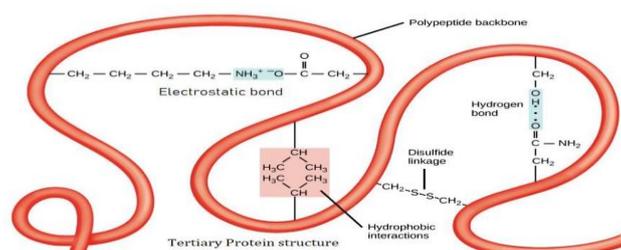
2- Secondary structure:- refers to local folded structures within a polypeptide chain, resulting from interactions between backbone atoms, excluding R groups. Common types include the  $\alpha$  helix and the  $\beta$  pleated sheet, stabilized by hydrogen bonds between carbonyl and amino groups.

The  **$\alpha$  helix** is a common secondary structure in proteins, forming a spiral shape. It's held together by hydrogen bonds between the carbonyl group of one amino acid and the amino group of another amino acid. This creates a helical ribbon-like structure, with each turn containing about 3.6 amino acids.

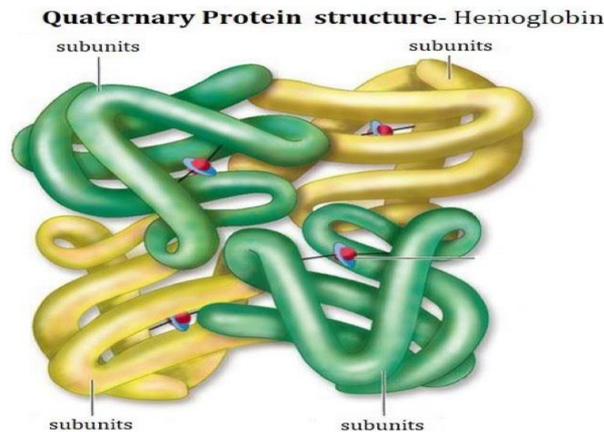
The  **$\beta$  pleated sheet** is formed when two or more segments of a protein chain align next to each other, creating a sheet-like structure. Hydrogen bonds form between the carbonyl and amino groups of adjacent segments.



3- Tertiary structure refers to the three-dimensional arrangement of a protein, primarily determined by interactions between R groups of amino acids. These interactions include hydrogen bonds, hydrophobic bonds, electrostatic bonds, and Van Der Waals forces, as well as disulfide bonds.



4- Quaternary structure involves the assembly of multiple protein subunits into a larger protein. Subunits are held together by weak interactions, not strong chemical bonds. For instance, hemoglobin, comprising four subunits, forms the complete protein responsible for carrying oxygen in the blood.



### **Proteins, made of amino acids, play various roles in the body:**

- They provide structure (e.g., keratin in hair, collagen in bones).
- They help express genetic information.
- They transport oxygen and carbon dioxide (e.g., hemoglobin).
- They help regulate blood volume and interstitial fluids (e.g., plasma proteins).
- They contribute to blood clotting (e.g., thrombin, fibrinogen).
- They defend against infections (e.g., antibodies).
- Some proteins store nutrients (e.g., ovalbumin, glutelin).