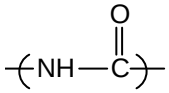
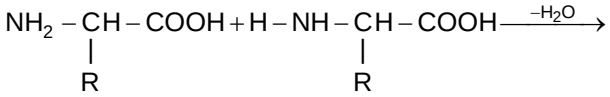
15. BIOMOLECULES

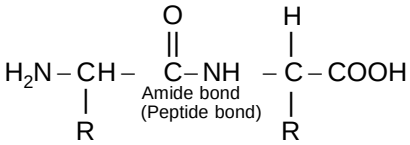
ii) PROTEINS

- Amino acids contains both amine group ($–NH_2$) and carboxylic acid group (–COOH).
- Amino acid molecules are linked by forming an amide bond



- Carboxylic acid of one molecule reacts with the amino group of another molecule to form amide bond.





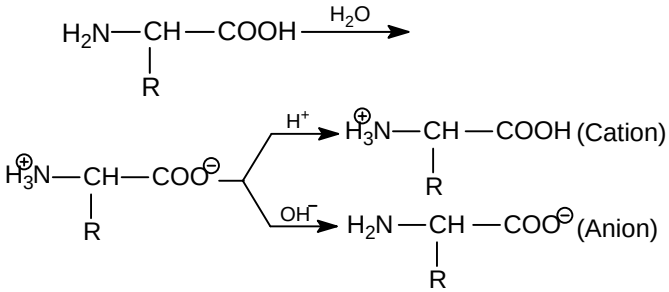
- Linkages between amino acids are known a peptide linkages or peptide bonds.
- The product obtained from two amino acid molecule through peptide bond is called dipeptide.
- Based on number of amino acid molecule in peptide they are called tri, tetra and polypeptides.
- Protein from a Greek word proteios mean prime importance.
- Proteins are naturally occurring, polypeptides containing 100 to 300 amino acid units.
- Silk, hair, skin, connective tissues most of the enzymes, hormone etc are examples for proteins.
- In carboxylic acid chain based on the location of NH_2 group on the carbon amino acids are named as α, β, γ, δ.

  $H_2N – CH_2 – COOH$ α-amino acid

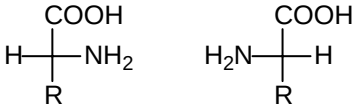
  $H_2 – N – CH_2 – CH_2 – COOH$ β-amino acid

  $H_2N – CH_2 – CH_2 – CH_2 – COOH$ γ-amino acid
- Naturally occurring amino acids are more than 700 but important amino acids are 20.
- Protein forming amino acids are α-amino acid containing a primary amine group except protein a secondary amine.
- Simplex amine acid is glycine Greek meaning sweet.
- IUPAC name of glycine is 2-amino ethanoic acid.
- Amino acid containing equal number of $–NH_2$ and –COOH groups are neutral.
- Amino acid contains more number of $–NH_2$ group it is basic, if it containing more COOH groups it is acedic.
- Amino acids that cannot be synthesized in the body must be supplied through diet are called essential amino acids.
- Non-essential amino acid can be synthesized in the body.
- Amino acids are colourless crystalline solids.
- Amino acids are highly polar in aqueous solution.
- Proton transfers from acid group to amine group to give Zwitter ion or inner salt.

- In Zwitter ion acedic nature is due to $-NH_3^+$ group and basic nature is due to $-COO^-$ group.

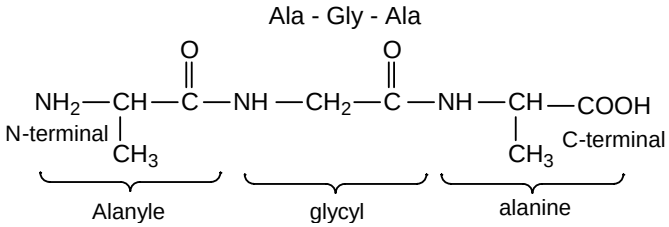


- Zwitter ion in acid medium becomes positive ion and in basic medium becomes negative ion.
- Dipolar Zwitter ion act as a neutral ion and does not migrate towards anode or cathod at a particular pH called **isoelectric point of the aminoacid.**
- Isoelectric point of the amino acid depends on the groups present in the amino acids.
- For neutral amino acids isoelectric point is in the range 5.5 to 6.3.
- Least solubility of amino acid at isoelectric point helps in the separation of different amino acids obtained from the hydrolysis of protein.
- Due to asymmetric (chiral) α-carbon all amino acids are optically active except glycine.
- In fisher projection D-form of amino acid $-NH_2$ group on the right and in L-form – NH_2 group is on the left – COOH group is on the top in both forms.

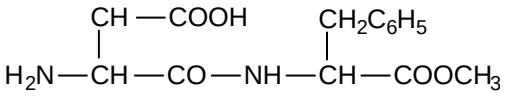


D - form **L - form**

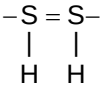
- Most of the naturally occurring amino acids are with L-configuration.
- In a polypeptides free amino group (NH_2) N-terminal residue to the left and acid group is to the right.
- Alanyl glycylalanine can be represented as



- Shorter peptides are called oligopeptides longer peptides are polypeptides.
- Proteins are polypeptides containing many amino acids molecular mass is more than 10,000.
- Polypeptides are amphoteric.
- Most of the toxins which poisonous substances present in animal and plant venoms are proteins.
- Oligopeptides are effective hormones.
- Aspertame is a dipeptides which is 160 times sweeter than sucrose.
- Aspertame is aspartyl phenylalanine methyl ester.



STRUCTURE OF PROTEINS :

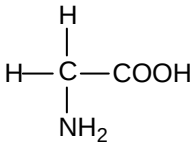
- Proteins are biopolymers of large number of amino acid linked through peptide bonds or disulphide bond.
- In disulphide linkage 
- Primary structure of amino acid gives specific sequence of amino acids in polypeptide.
- 100 amino acid units having 20 different amino acids can combine $(20)^{100}$ different ways.
- Primary structure tells us about peptide linkages and sulphide linkages.
- Primary structure is only due to covalent bond linkage.
- Secondary structure of protein or polypeptide explains shape and describes conformation of segments.
- Peptide chain folds to limit the possible conformation, to minimise number of hydrogen bonds and to avoid steric hindrance between R groups.
- Secondary structure is due to hydrogen bonds between N and O.
- The segment of the protein back bone fold either α-helix or β pleated sheet or coil conformation.
- Tertiary structure is three-dimensional arrangement of atoms in the protein.
- It explains extensive coiling or folding to produce a complex.
- Quaternary structure defines the structure resulting from the inhalations between the subunits of polypeptide chains.
- The interactions between subunits to give quarlernary structure are
  i) Hydrogen bonding
  ii) Electrostatic attraction
  iii) Hydrophobic interactions
- Sub units arrangement in space is given by quarlernary structure.
- Protein denaturation involves breaking of tertiary structure of protein.
- Proteins with weak interactive bonds can be easily denatured.
- Denaturation can be by
  i) Changing pH to disrupts hydrogen bonds.
  ii) By adding reagent like urea to form strong hydrogen bonds with urea.
  iii) Adding detergents like sodium dodecyl sulphate.
  iv) Organic solvents associates with non-polar groups to interfere with hydrophobic interactions.
  v) Heating or agitation which causes disruption of attractive forces.

AMINO ACIDS DERIVED FROM PROTEINS :

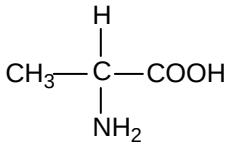
A. Neutral Amino Acids :

1. **Glycine (Gly)**

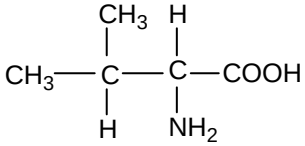
(Aminoacetic acid)



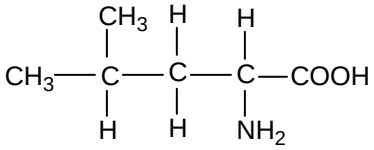
2. **Alanine (Ala)**
(α-Aminopropinoic acid)



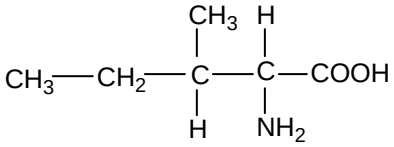
3. **Valine (Val)**
(α-Aminiosovaleric acid)



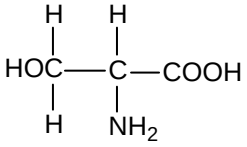
4. **Leucine (Leu)**
(α-Aminoisocaproic acid)



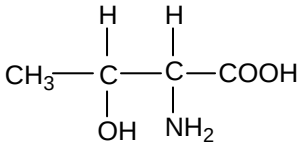
5. **Isoleucine (Ileu)**
(α-Amino-β-methylvaleric)



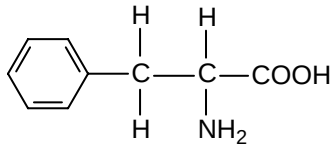
6. **Serine(Ser)**
(α-Amino-β-hydroxypropionic acid)



7. **Threonine (Thre)**
(α-Amino-β-hydroxybutyric acid)

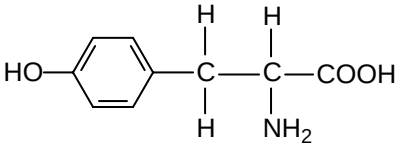


8. **Phenylalanine (Phe)**
(α-Amino-β-phenylpropionic acid)



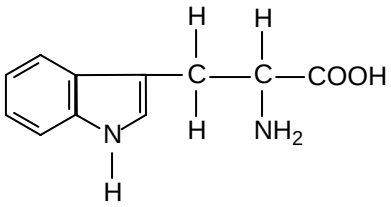
9. **Tyrosine (Tyr)**

(α-Amino-p-hydroxyhydrocinnamic acid)



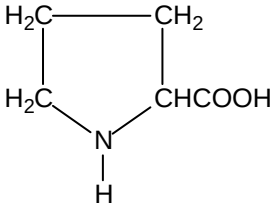
10. **Tryptophan (Try)**

(α-Amino-β-(3-indolyl) propionic acid)



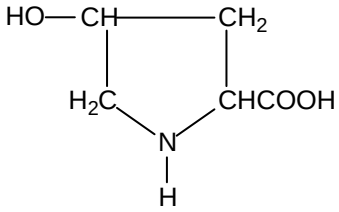
11. **Proline (Pro)**[1]

(2-Pyrrolidine carboxylic acid)



12. **Hydroxyproline (Hpro)**[1]

(4-Hydroxy-2-pyrrolidine carboxylic acid)

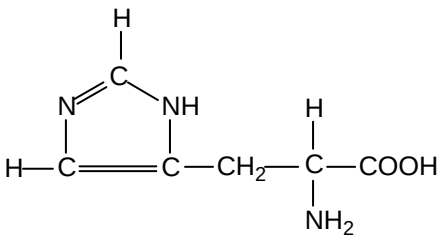


[1]Proline and hydroxyproline are *imino acids*. The nitrogen atom, although joined to the α-carbon, is part of a ring. An imino nitrogen bears only one hydrogen atom but can still take part in the formation of proteins.

B. Basic Amino Acids:

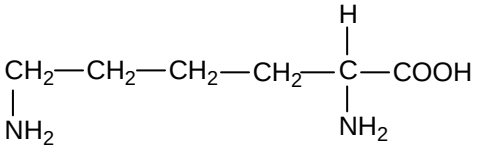
13. **Histidine (His)**

(α-Amino-β-4-imidazolylpropionic acid)



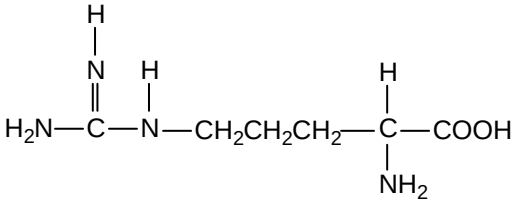
14. **Lysine (Lys)**

(α, ε-Diaminocaproic acid)



15. **Arginine (Arg)**

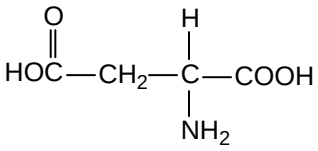
(α-Amino-δ-guanidinovaleric acid)



C. Acidic Amino Acids :

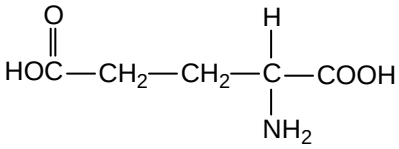
16. **Aspartic acid (Asp)**

(Aminosuccinic acid)



17. **Glutamic (Glu)**

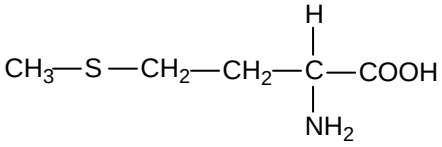
(α-Aminoglutaric acid)



D. Sulfur-Containing Amino Acids :

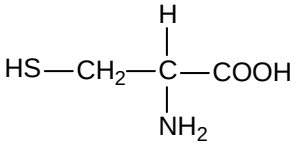
18. **Methionine (Met)**

(α-Amino-γ-methylthiobutyric acid)



19. **Cysteine (Cys)**

(α-Amino-β-mercaptopropionic acid)



20. **Cystine (Cys-Scy)**

- 