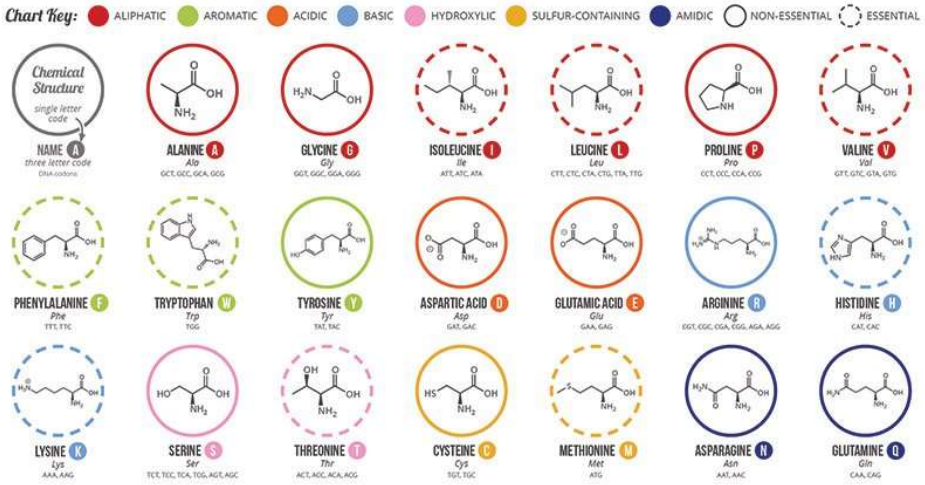
Amino Acids

- Amino acids constitute a group of neutral products clearly distinguished from other natural compounds chemically, mainly because of their ampholytic properties, and biochemically, mainly because of their role as protein constituents.
- An amino acid is a carboxylic acid-containing an aliphatic primary amino group in the α position to the carboxyl group and with a characteristic stereochemistry.
- **Proteins** are biosynthesized from 20 amino acids in a system involving strict genetic control. Thus, amino acids are the basic unit of proteins.
- More than 300 amino acids are found in nature but only 20 amino acids are standard and present in protein because they are coded by genes. Other amino acids are modified amino acids and called non-protein amino acids.
- Some are residues modified after a protein has been synthesized by posttranslational modifications; others are amino acids present in living organisms but not as constituents of proteins.



Properties of Amino acids

Physical Properties

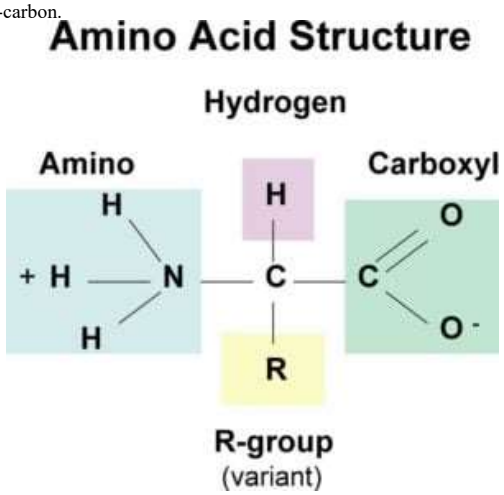
1. Amino acids are colorless, crystalline solid.
2. All amino acids have a high melting point greater than 200o
3. Solubility: They are soluble in water, slightly soluble in alcohol and dissolve with difficulty in methanol, ethanol, and propanol. R-group of amino acids and pH of the solvent play important role in solubility.
4. On heating to high temperatures, they decompose.
5. All amino acids (except glycine) are optically active.
6. Peptide bond formation: Amino acids can connect with a peptide bond involving their amino and carboxylate groups. A covalent bond formed between the alpha-amino group of one amino acid and an alpha-carboxyl group of other forming -CO-NH-linkage. Peptide bonds are planar and partially ionic.

Chemical Properties

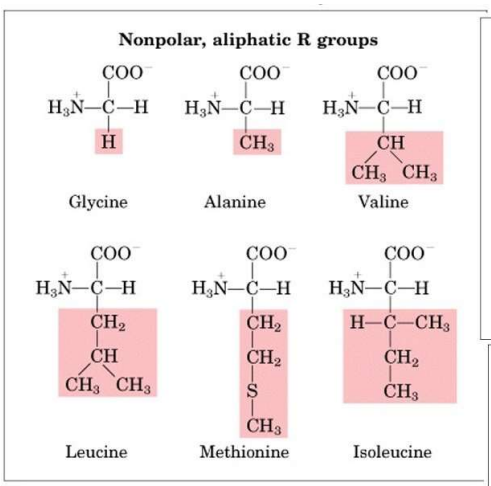
1. **Zwitterionic property**
   A zwitterion is a molecule with functional groups, of which at least one has a positive and one has a negative electrical charge. The net charge of the entire molecule is zero. Amino acids are the best-known examples of zwitterions. They contain an amine group (basic) and a carboxylic group (acidic). The -NH2 group is the stronger base, and so it picks up H+ from the -COOH group to leave a zwitterion. The (neutral) zwitterion is the usual form amino acids exist in solution.
2. **Amphoteric property**
   Amino acids are amphoteric in nature that is they act as both acids and base since due to the two amine and carboxylic group present.
3. **Ninhydrin test**
   When 1 ml of Ninhydrin solution is added to a 1 ml protein solution and heated, the formation of a violet color indicates the presence of α-amino acids.

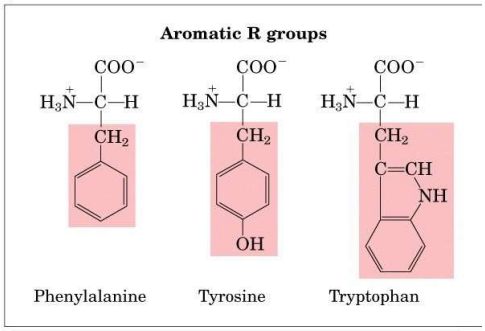
Structure of Amino acids

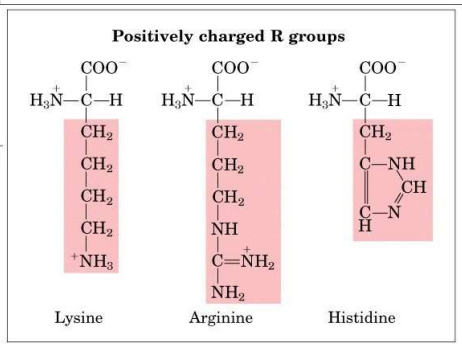
- All 20 of the common amino acids are alpha-amino acids. They contain a carboxyl group, an amino group, and a side chain (R group), all attached to the α-carbon.

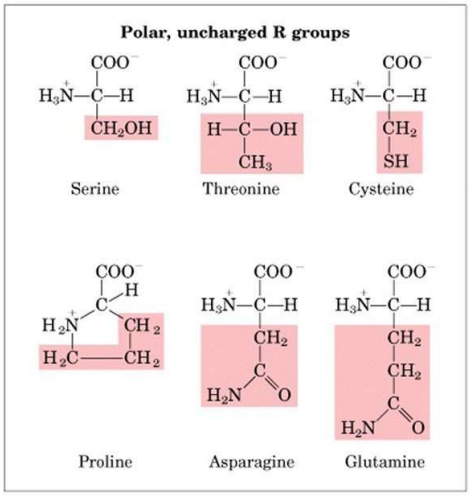


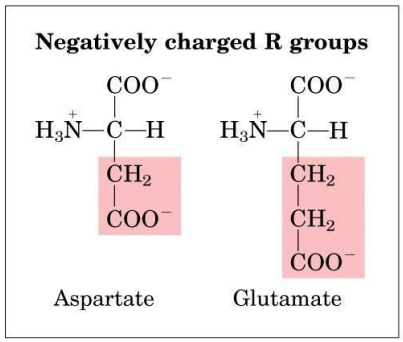
Classification of amino acids on the basis of R-group











1. **Nonpolar, Aliphatic amino acids**: The R groups in this class of amino acids are nonpolar and hydrophobic. Glycine, Alanine, Valine, leucine, Isoleucine, Methionine, Proline.
2. **Aromatic amino acids:** Phenylalanine, tyrosine, and tryptophan, with their aromatic side chains, are relatively nonpolar (hydrophobic). All can participate in hydrophobic interactions.
3. **Polar, Uncharged amino acids:** The R groups of these amino acids are more soluble in water, or more hydrophilic, than those of the nonpolar amino acids, because they contain functional groups that form hydrogen bonds with water. This class of amino acids includes serine, threonine, cysteine, asparagine, and glutamine.
4. **Acidic amino acids:** Amino acids in which R-group is acidic or negatively charged. Glutamic acid and Aspartic acid
5. **Basic amino acids:** Amino acids in which R-group is basic or positively charged. Lysine, Arginine, Histidine

Classification of amino acids on the basis of nutrition

Essential	Conditionally Non-Essential	Non-Essential
Histidine	Arginine	Alanine
Isoleucine	Cystine	Asparagine
Leucine	Glutamine	Aspartate
Lysine	Glycine	Glutamate
Methionine	Proline	Serine
Phenylalanine	Tyrosine	
Threonine		
Tryptophan		
Valine		

1. **Essential amino acids (Nine)**
   Nine amino acids cannot be synthesized in the body and, therefore, must be present in the diet in order for protein synthesis to occur.
   These essential amino acids are histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine.
2. **Non-essential amino acids (Eleven)**
   These amino acids can be synthesized in the body itself and hence not necessarily need to be acquired through diet.
   Arginine, glutamine, tyrosine, cysteine, glycine, proline, serine, ornithine, alanine, asparagine, and aspartate.
   3. Conditionally

Functions of Amino acids

1. In particular, 20 very important amino acids are crucial for life as they contain peptides and proteins and are known to be the building blocks for all living things.
2. The linear sequence of amino acid residues in a polypeptide chain determines the three-dimensional configuration of a protein, and the structure of a protein determines its function.
3. Amino acids are imperative for sustaining the health of the human body. They largely promote the:
   Production of hormones
   • Structure of muscles
   • Human nervous system's healthy functioning
   • The health of vital organs
   • Normal cellular structure

4. The amino acids are used by various tissues to synthesize proteins and to produce nitrogen-containing compounds (e.g., purines, heme, creatine, epinephrine), or they are oxidized to produce energy.
5. The breakdown of both dietary and tissue proteins yields nitrogen-containing substrates and carbon skeletons.
6. The nitrogen-containing substrates are used in the biosynthesis of purines, pyrimidines, neurotransmitters, hormones, porphyrins, and nonessential amino acids.
7. The carbon skeletons are used as a fuel source in the citric acid cycle, used for gluconeogenesis, or used in fatty acid synthesis.