3

AMINO ACIDS

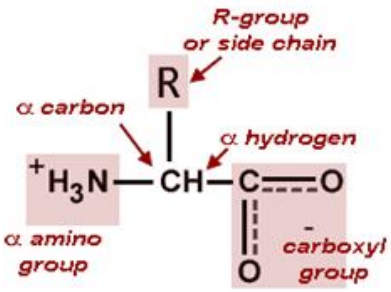
TOPICS COVERED-

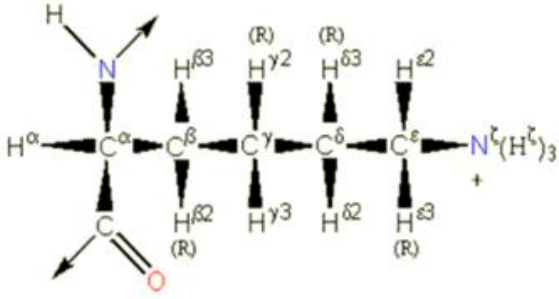
- Structure of Amino Acids and classification
- Properties of Amino acids
  - → Acid -Base Properties
  - → Optical and stereochemical properties
  - → Spectroscopic Properties

GENERAL OVERVIEW

1. Proteins are the indispensable agents of biological function and amino acids are the building blocks of proteins.
2. Proteins are polymers of amino acids with each amino acid residue joined to its neighbour by a specific type of covalent bond.
3. Amino acids are composed of an amino group, a carboxyl group, a hydrogen atom and a distinctive side chain (-R group), all bonded to the α -carbon

NOTE- In α -amino acids, the amino and the carboxyl group are attached to the same carbon. Other carbons are named $\beta,\gamma,\delta,\varepsilon$.





General Structure of α amino acids **Structure of Lysine**

STANDARD AND NON-STANDARD AMINO ACIDS

Those amino acids that are ribosomically incorporated into proteins are called **proteinogenic** or **standard** amino acids. There are 22 standard amino acids. The 20 amino acids (shown later in the classification).

NOTE- Selenocysteine and Pyrolysine are termed as the 21st and 22nd amino acids respectively.

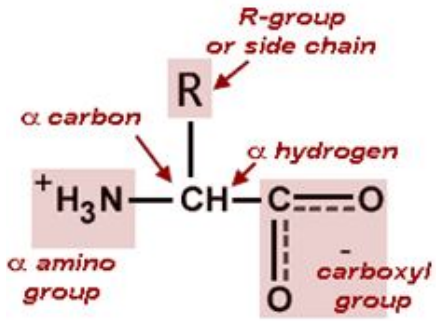
Apart from these 22 standard amino acids all other amino acids are not ribosomically incorporated into proteins. These are known as **non-standard amino acids**.

These modifications of the parent amino acids are essential for the function or regulation of the protein.

NON – STANDARD AMINO ACIDS	DERIVED FROM
4 – hydroxyproline – Found in collagen	Proline
5 – hydroxylysine	Lysine
Desmosine	Lysine
N – acetylserine	Serine
N – formylmethionine	Methionine
γ – carboxyglutamate – Found in calcium binding protein	Glutamate

Structure of Amino Acids and classification

General structure of an α -amino acid-



NOTE- this structure is common to all amino acids except proline .

The R group attached to the α -carbon atom is different in each amino acid.

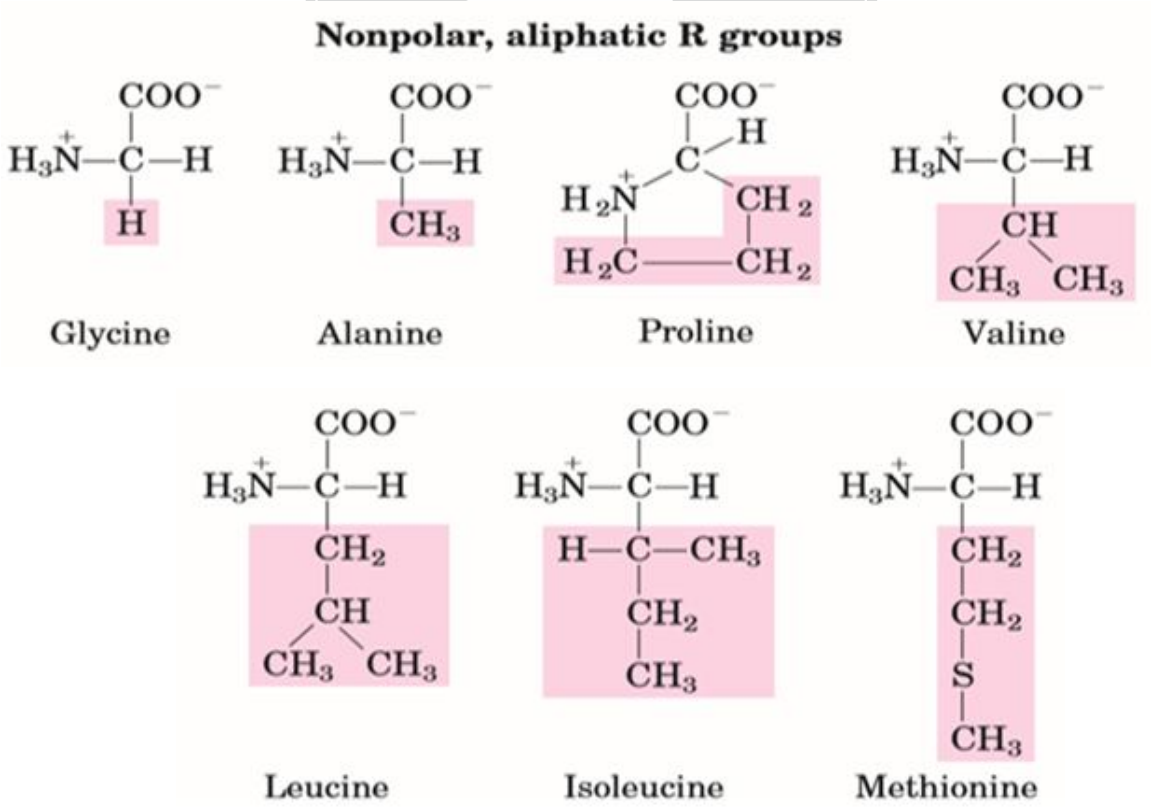
The C_α carbon is tetrahedral in nature.

CLASSIFICATION: Amino Acids Can Be Classified by R Group.

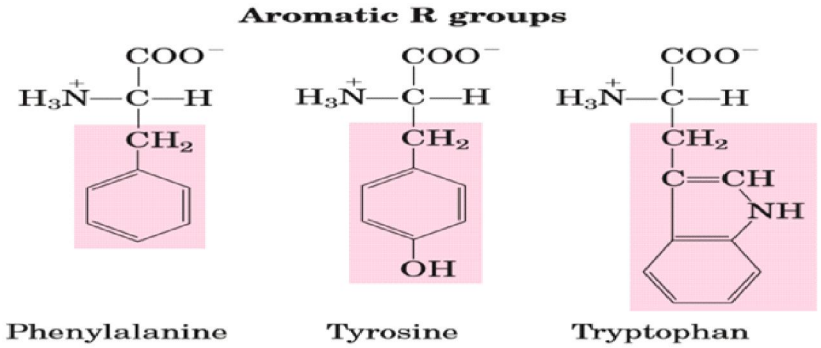
Amino acids are classified into five types on the basis of the polarity and charge (at pH 7) of their R groups.

- **Nonpolar**

Aliphatic R Groups-The R groups in this class of amino acids are nonpolar and hydrophobic. The side chains of alanine, valine, leucine, and isoleucine tend to cluster together within proteins, stabilizing protein structure by means of hydrophobic interactions. **Glycine** has the simplest structure. Although it is formally nonpolar, its very small side chain makes no real contribution to hydrophobic interactions. **Methionine** has a nonpolar thioether group in its side chain. **Proline** has an aliphatic side chain with a distinctive cyclic structure.

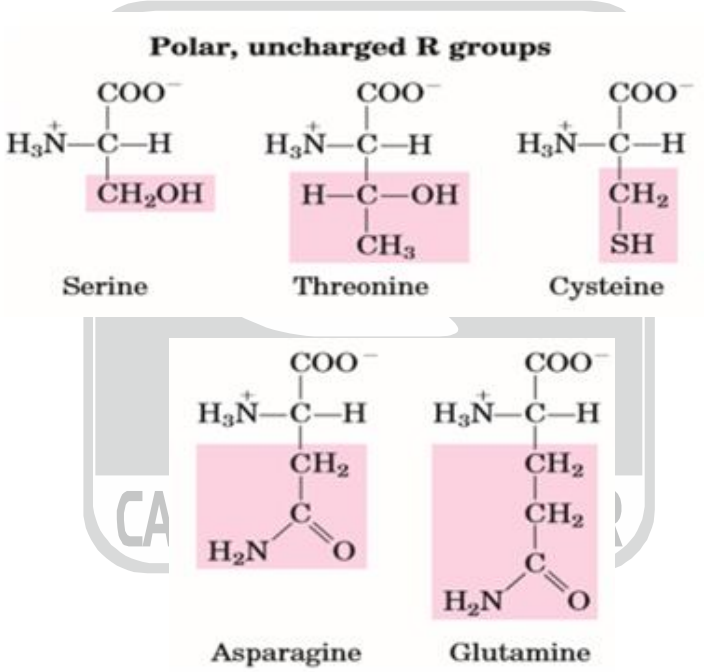


Aromatic R Groups- Phenylalanine, tyrosine, and tryptophan, with their aromatic side chains, are relatively nonpolar (hydrophobic).



Polar :-

Uncharged R Groups-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.



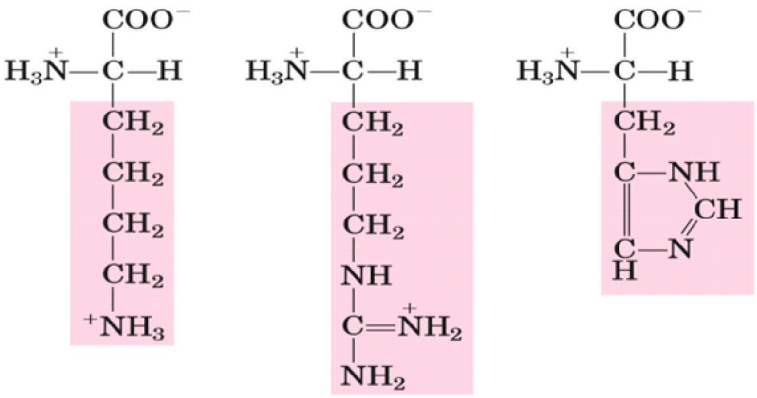
Polar

Charged R Groups-

Positively Charged (Basic) R Groups- Their side chain has a positive charge at pH 7. It includes

- Lysine, which has a **second primary amino group** at the ε-position on its aliphatic chain;
- Arginine, which has a positively charged **guanidino** group.
- Histidine, which has an **imidazole** group. Histidine is the only common amino acid having an ionizable side chain with a pK_a near neutrality. In many enzyme-catalysed reactions, a His residue facilitates the reaction by serving as a proton donor/acceptor. Thus, it can show buffering reactions at physiological pH.

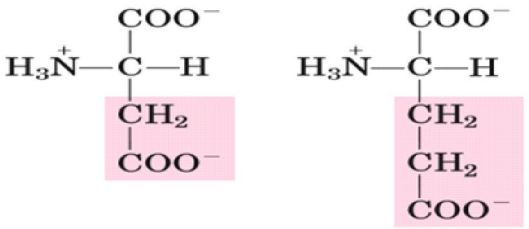
Positively charged R groups



Lysine Arginine Histidine

Negatively Charged (Acidic) R Groups-The two amino acids having R groups with a net negative charge at pH 7.0 are aspartate and glutamate, each of which has a second carboxyl group.

Negatively charged R groups

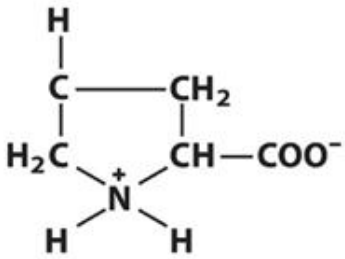


Aspartate Glutamate

NOTE-

- Only glycine lacks a chiral C_α because of the side group -H. Since C_α is bonded to the same group, the C_α is achiral in glycine
- All amino acids have a primary amino group except for proline which has a secondary amino group. It has an imino group. This imino group provides proline with some special properties as shown below:

Proline



-Has a distinctive ring structure.
-Allows for less flexibility in polypeptide regions containing proline as the secondary imino group of proline is held in a more rigid conformation.
-Found often in bends of folded protein chains.