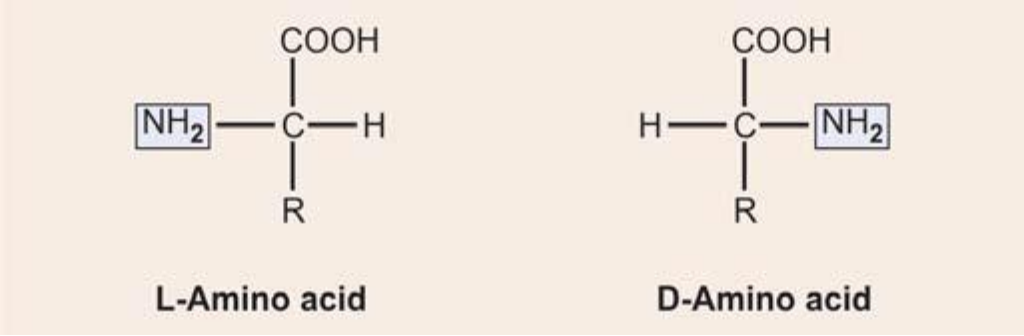
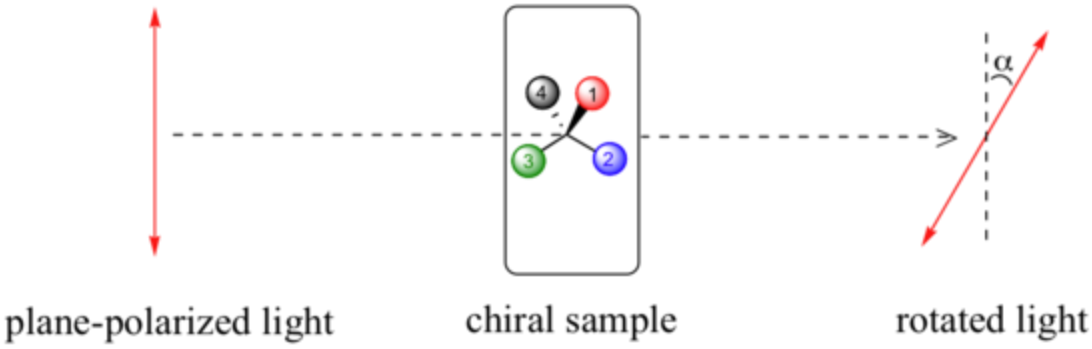
PROPERTIES OF AMINO ACIDS

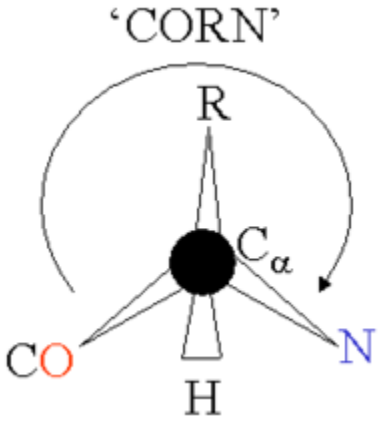
A. Isomerism: Two types of isomerism are shown by amino acids basically ***due to the presence of asymmetric carbon atom. Glycine has no asymmetric carbon atom in its structure hence is optically inactive.***

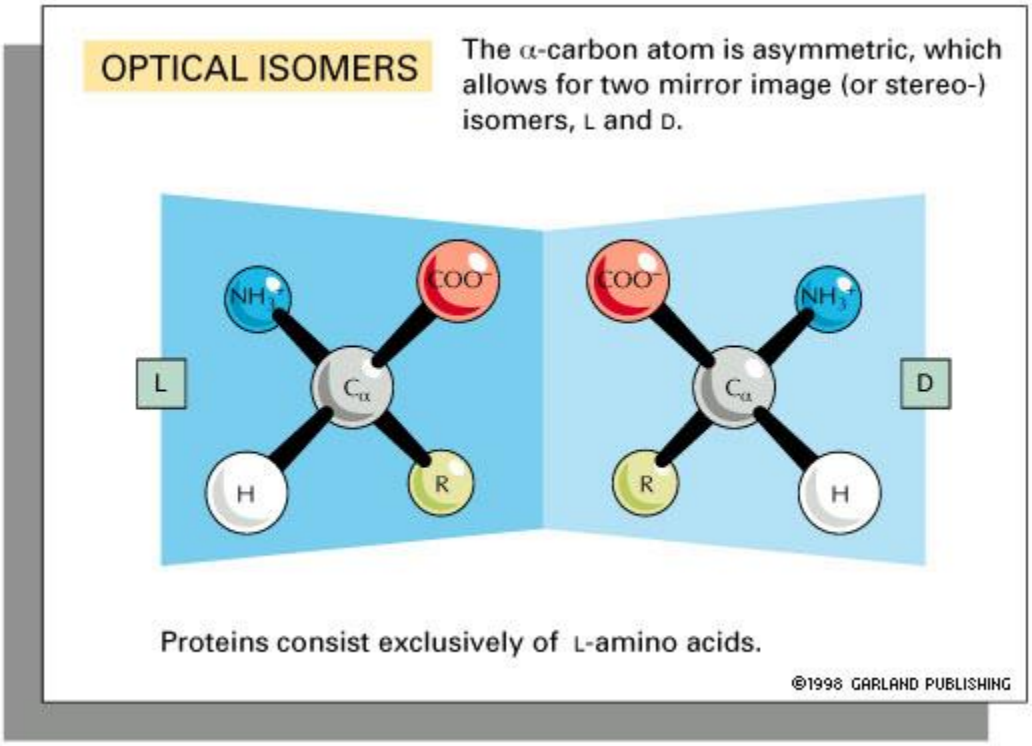
(a) Stereoisomerism: All amino acids except glycine exist in D and L isomers. In D-amino acids– NH2 group is on the right hand while in L-amino acids it is oriented to the left. It is the same orientation of – OH group of the central carbon of glyceraldehyde. Natural proteins of animals and plants generally contain L-amino acids. D-amino acids occur in bacteria.



(b) Optical Isomerism: All amino acids except glycine have asymmetric carbon atom. Few amino acids like isoleucine and threonine have an additional asymmetric carbon in their structures. Consequently all but glycine exhibit 'optical' activities and rotate the plane of plane polarized light and exist as dextrorotatory (d) or laevorotatory (l) isomers. Optical activity depends on the pH and side chain.


α
plane-polarized light
chiral sample
rotated light


'CORN'
R
Cα
CO
N
H


OPTICAL ISOMERS
The α-carbon atom is asymmetric, which allows for two mirror image (or stereo-) isomers, L and D.
L
D
Proteins consist exclusively of L-amino acids.
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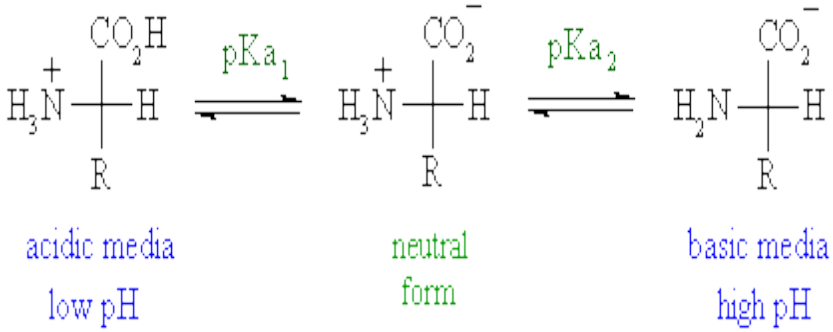
B. Amphoteric Nature and Isoelectric pH: The -NH2 and -COOH groups of amino acids are ionizable groups. Further, charged polar side chains of few amino acids also ionize. Depending on the pH of the solution these groups act as proton donors (acids) or proton acceptors (bases). This property is called as amphoteric and therefore amino acids are called as ampholytes. At a specific pH the amino acid carries both the charges in equal number and exists as dipolar ion or "Zwitterion". At this point the net charge on it is zero, i.e. positive charges and negative charges on the protein/amino acid molecule equalizes. The pH at which it occurs without any charge on it is called pI or isoelectric pH. On the acidic side of its pI amino acids exist as a cation by accepting a proton and on alkaline as anion by donating a proton.

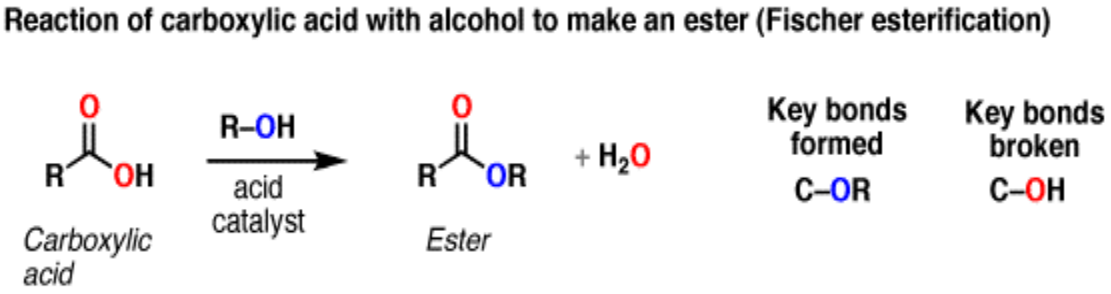


C. Physical Properties: They are colorless, crystalline substances, more soluble in water than in polar solvents. Tyrosine is soluble in hot water. They have high melting point usually more than 200°C. They have a high dielectric constant. They possess a large dipole moment.

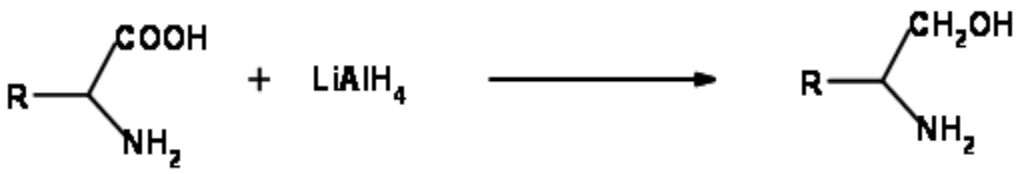
D. Chemical Properties

I. Due to Carboxylic (—COOH) Group

1. Formation of esters: They can form esters with alcohols. The COOH group can be esterified with alcohol. Treatment with Na_2CO_3 solution in cold releases the free ester from ester hydrochloride.



2. Reduction to amino alcohol: This is achieved in presence of lithium aluminum hydride.



3. Formation of amines by decarboxylation: Action of specific amino acid decarboxylases, dry distillation or heating with $Ba(OH)_2$ or with diphenylamine evolves CO_2 from the —COOH group and changes the amino acid into its amine. ***In vivo***, the amino acids can be decarboxylated by the enzyme ***decarboxylase*** and forms the corresponding amines.

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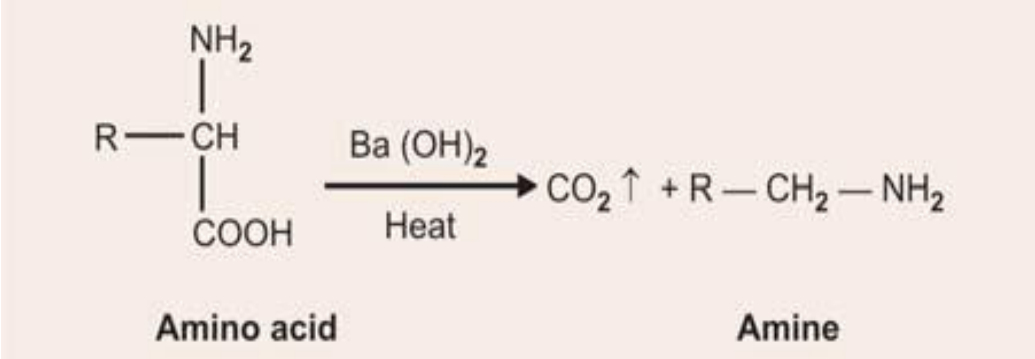
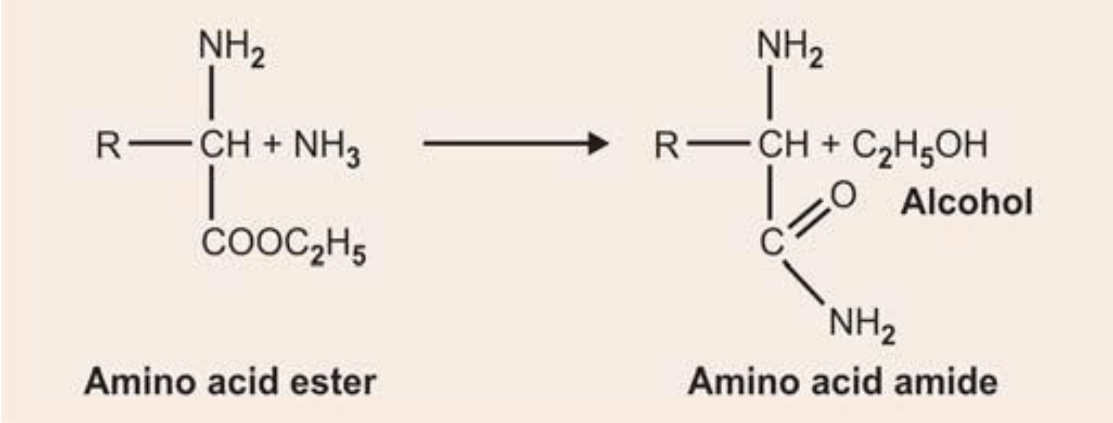
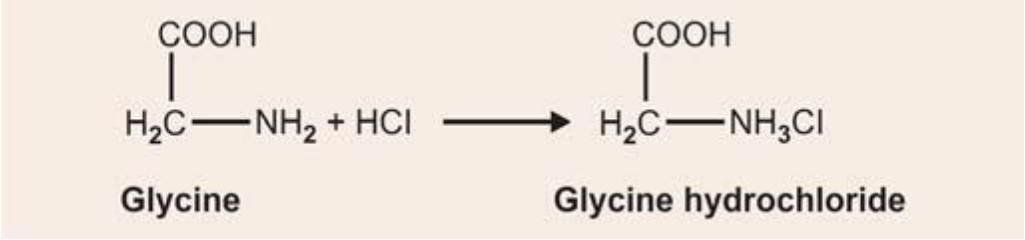


4. Formation of amides: Anhydrous NH3 may replace alcohol from its combination with an amino acid in an amino acid ester so that an amide of amino acid and a molecule of free alcohol is produced



II. Properties Due to Amino (–NH2) Group

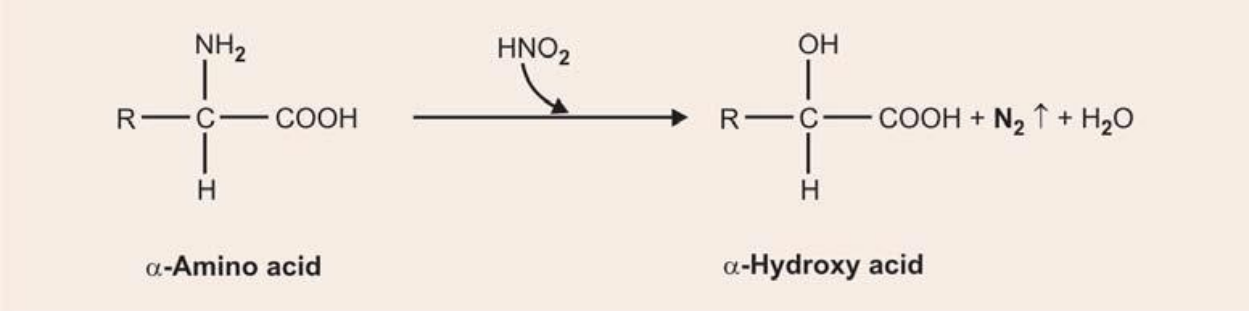
1. ***Salt formation with acids:*** The basic amino group reacts with mineral acids such as HCl to form salts like hydrochlorides



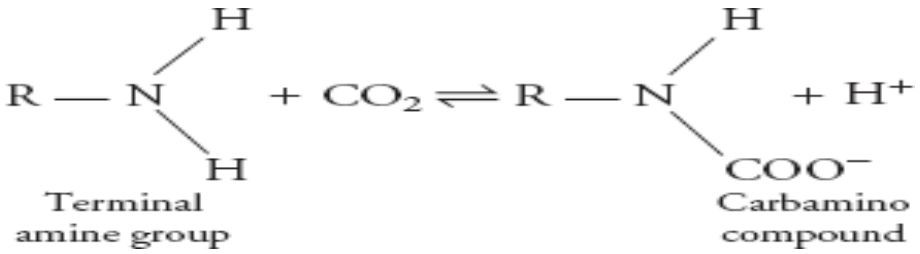
2. Formation of acyl derivatives hippuric acid is an acyl glycine formed by the conjugation of benzoic acid with glycine**. This is one of the mechanisms of detoxication in which glycine is used and this also forms the basis of one of the liver function tests. Where** hippuric acid is a normal component of urine and is typically increased with increased consumption of phenolic compounds (tea, fruit juices)

3. Oxidation: Potassium permanganate or H2O2 oxidises the NH2 group and converts the amino acid into imino acid which reacts with water to form NH3 and α-ketoacid.

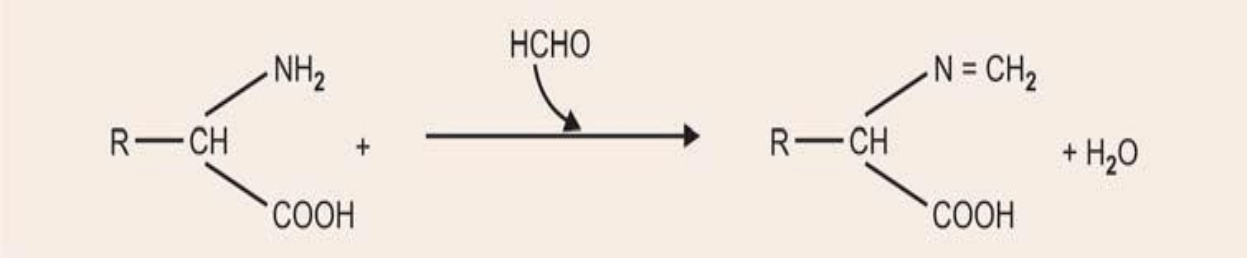
4. Reaction with HNO2: Like other primary amines, the amino acids **except proline and hydroxyproline** react with HNO2 (nitrous acid) libering N2 from NH2 group.



5. Reaction with CO2: The amino acid anion present in an alkaline solution may react with CO2 through NH2 group to form a carbaminoacid anion.



6. Reaction with formaldehyde: Formaldehyde reacts with the-NH2 group to form a methylene compound.



III. Properties of Amino acids Due to Both NH2 and COOH Groups

In addition to the property of reacting with both cation and anion, the amino acids form chelated, co-ordination complexes with certain heavy metals and other ions. These include Cu++, Co++, Mn++ and Ca++.