AMINO ACIDS CLASSIFICATION AND PROPERTIES

WHAT ARE AMINO ACIDS.

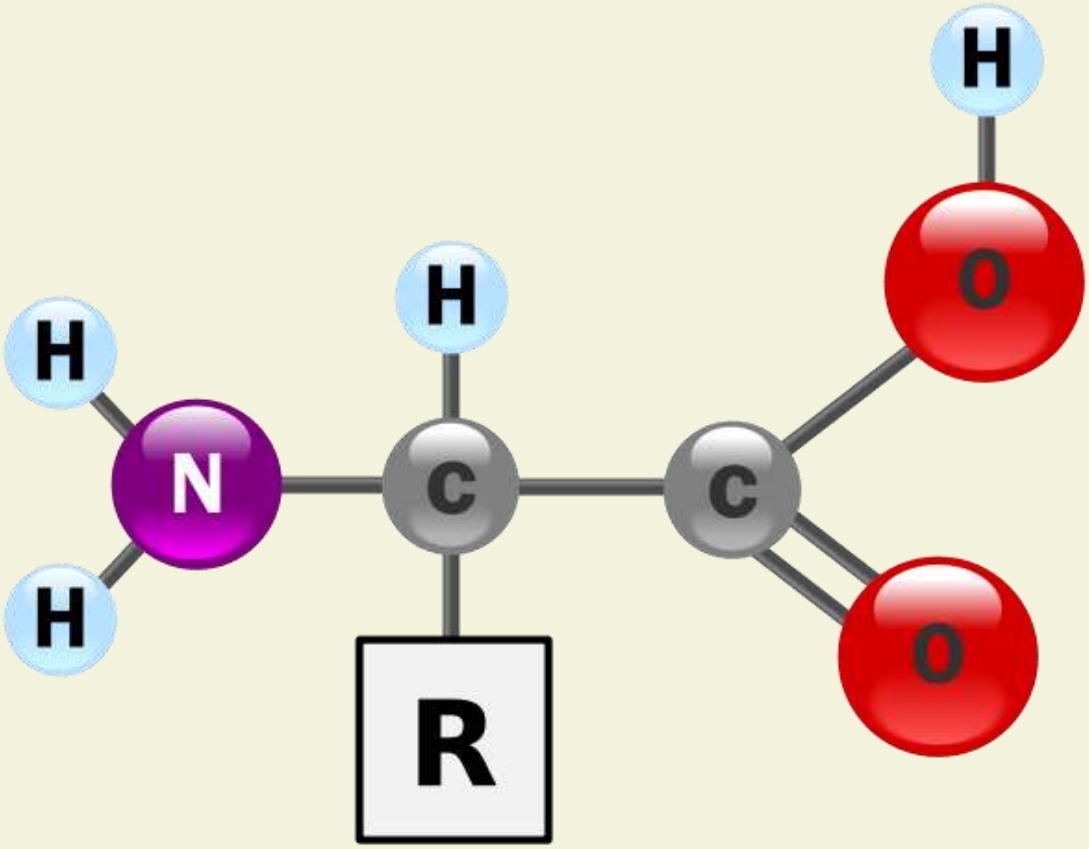
- Amino acids are organic compounds containing

  amine [- NH_2]

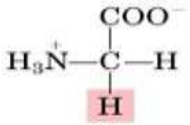
  carboxyl [-COOH]

  side chain [R group]
- The major key elements if amino acids are carbon, hydrogen, nitrogen, oxygen.
- About 500 amino acids are known (though only 20 appear in the genetic code) and can be classified in many ways

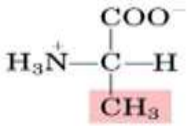
BASIC STRUCTURE[SKELETON]



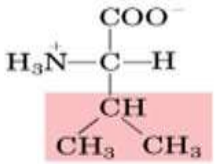
Nonpolar, aliphatic R groups



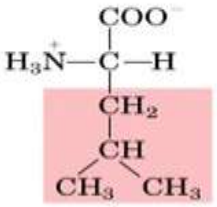
Glycine



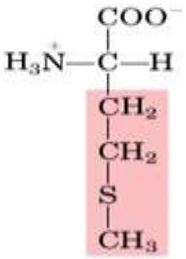
Alanine



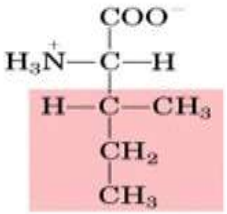
Valine



Leucine

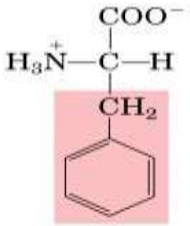


Methionine



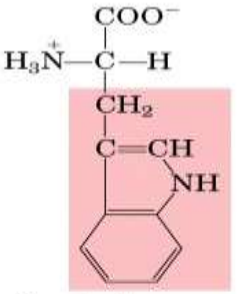
Isoleucine

Aromatic R groups



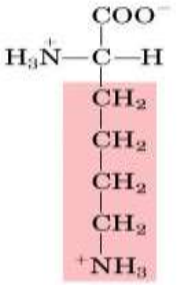
Phenylalanine

Tyrosine

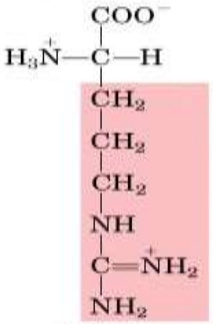


Tryptophan

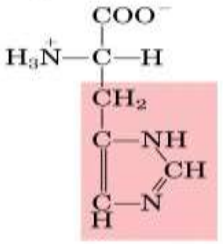
Positively charged R groups



Lysine

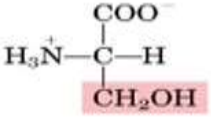


Arginine

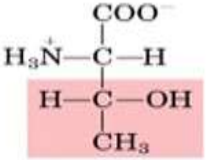


Histidine

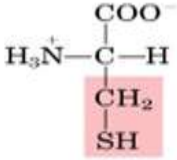
Polar, uncharged R groups



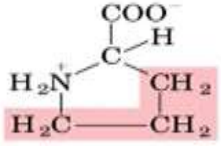
Serine



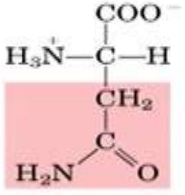
Threonine



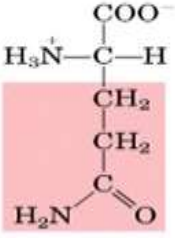
Cysteine



Proline

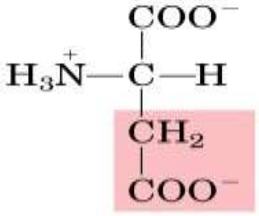


Asparagine

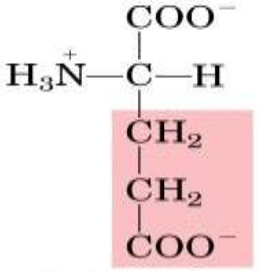


Glutamine

Negatively charged R groups



Aspartate



Glutamate

NEED FOR CLASSIFICATION

- Classification of amino acids gives the grouping between 20 acids and a basic outline for grouping.
- It makes a clear idea to pick the amino acid type
- This is much useful for biochemists for the easy understanding between each amino acids.

Classification:

Based on

- R group
- Polarity and R group
- Distribution in protein
- Nutritional requirements
- Number of amino and carboxylic groups

Based on R-Group

- Simple amino acids:

these have no functional group in their side chain.

Example: glycine, valine, alanine, leucine, isoleucine

- Hydroxy amino acids:

these have a hydroxyl group in their side chain

Eg: serine, threonine

- Sulfur containing amino acids:

  have sulfur in their side chain

Eg: cysteine, methionine

- Aromatic amino acids:

  have benzene ring in their side chain

Eg: phenylalanine, tyrosine

- Heterocyclic amino acids:

  having a side chain ring which possess at least on atom other than carbon

Eg: Tryptophan, histidine, proline

- Amine group containing amino acids:

derivatives of amino acids in which one of carboxyl group has been transformed into an amide group

Eg: Asparagine, glutamine

- Branched chain amino acids:

A **branched-chain amino acid** (BCAA) is an **amino acid** having aliphatic side-**chains** with a **branch**

Eg: leucine, isoleucine, valine

- Acidic amino acids:

  have carboxyl group in their side chain

Eg: Aspartic and Glutamic acid

- Basic amino acids:

  contain amino group in their side chain

Eg: Lysine, Arginine

- Imino acid:

  Amino **acids** containing a secondary amine group

Eg: Proline

Polarity and R Group

- Amino acids with non polar R group:

these are hydrocarbons in nature, hydrophobic, have aliphatic and aromatic groups

[aliphatic R groups]

Eg: Alanine, Valine, Leucine, Isoleucine, Proline.

[Aromatic groups]

Eg: Phenylalanine, Tryptophan, Methionine(sulfur)

- Amino acids with polar but uncharged R Group:

these amino acids are polar and possess neutral pH value.

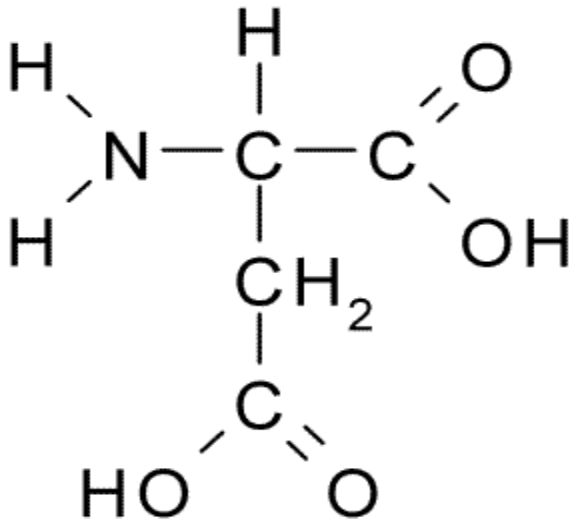
Eg: Glycine, Serine, Threonine, Cysteine, Tyrosine, Glutamine, Asparagine.

- <u>Negatively charged amino acids:</u>

their side chain [R Group] contain extra carboxyl group with a dissociable proton.

And renders electrochemical behaviour to proteins

Eg: Aspartic acid and Glutamic acid



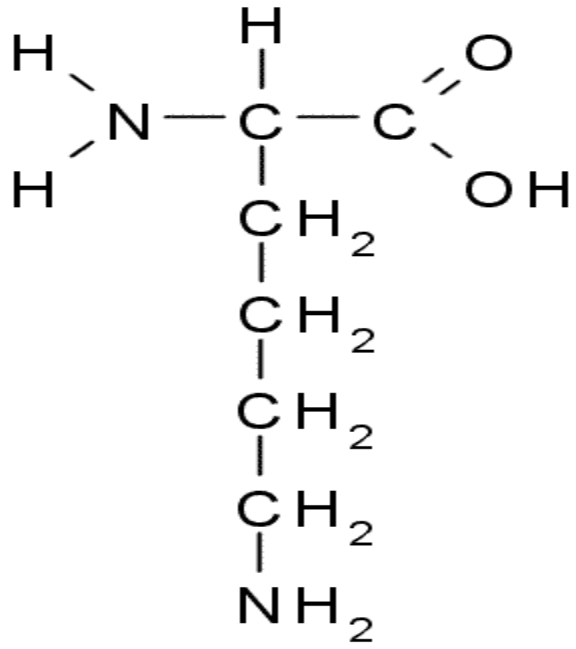
Aspartic acid

- <u>Positively charged amino acid:</u>

  their side chain have extra amino group

Rendering **basic** nature to protein,

Eg: Lysine, Arginine, Histidine.



Lysine

Distribution in protein:

- Standard protein amino acids:

  the amino acids that are used to form proteins,

recognized by ribozyme autoaminoacylation systems

Eg:
Histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine

- Non standard protein amino acids:

these amino acids are not required to build proteins.

have a vital role as metabolic intermediates.

Eg. Hydroxyproline, Hydroxylysine, Carboxyglutamate, Diaminopimelate.

- Non standard non protein amino acid:

These are the derivative of amino acids and have role in metabolism.

Eg: Alpha amino butyrate, Citruline, Ornithine, beta-alanine.

Based on nutritional requirements:

- Essential amino acids:

Essential amino acids cannot be made by the body.

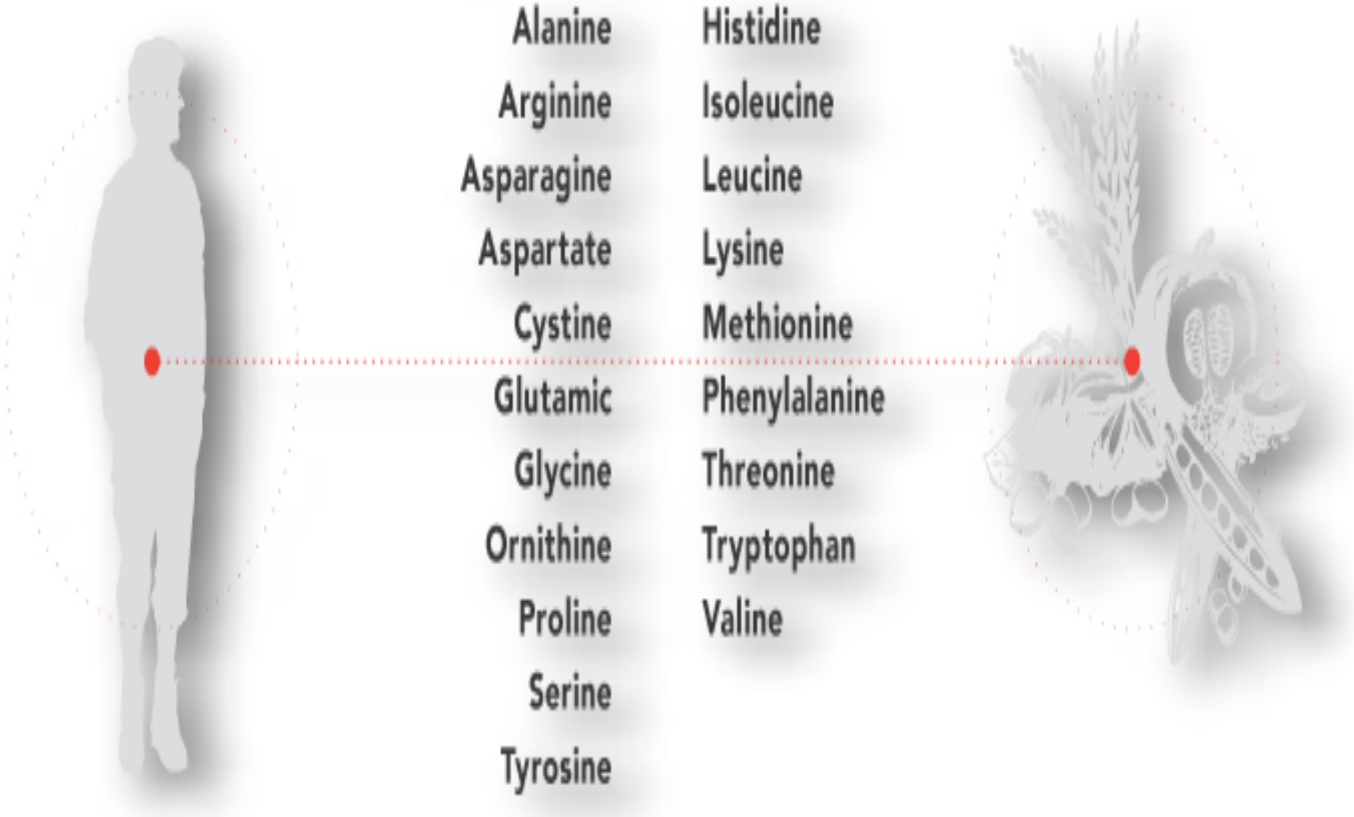
As a result, they must come from food.

The **essential amino acids** are: Arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine.

- Non essential amino acids:

An **amino acid** that can be made by humans and so is essential to the human diet.

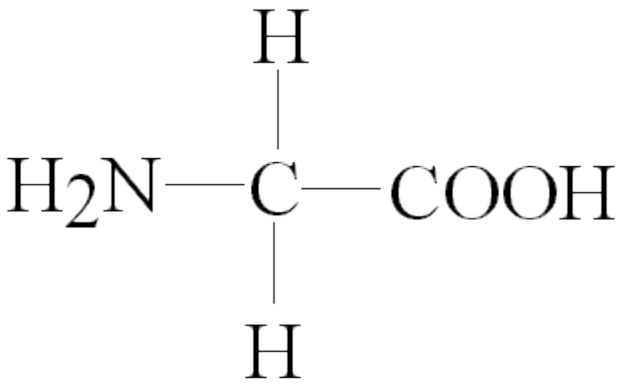
The **nonessential amino acids**: Alanine, asparagine, aspartic acid, cysteine, glutamic acid, glutamine, glycine, proline, serine, and tyrosine.


NON ESSENTIAL
Alanine
Arginine
Asparagine
Aspartate
Cystine
Glutamic
Glycine
Ornithine
Proline
Serine
Tyrosine
ESSENTIAL
Histidine
Isoleucine
Leucine
Lysine
Methionine
Phenylalanine
Threonine
Tryptophan
Valine

On basis of number of amino and carboxylic groups:

Monoamino- monocarboxylic amino acids

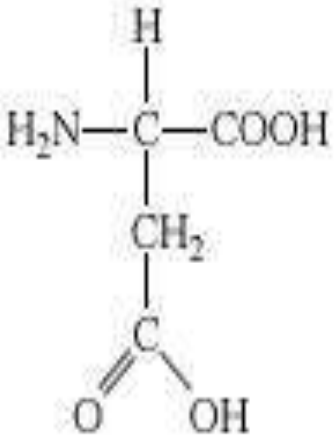
- glycine, alanine
- proline
- phenylalanine
- methionine
- serine, threonine



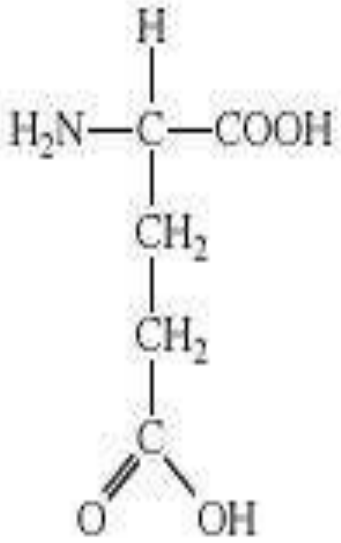
glycine

- Monoamino-dicarboxyli amino acid:

Aspartic and glutamic acid



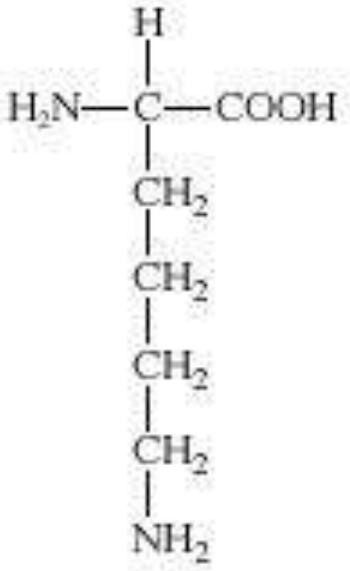
aspartic acid
(Asp, D; Asx or B)



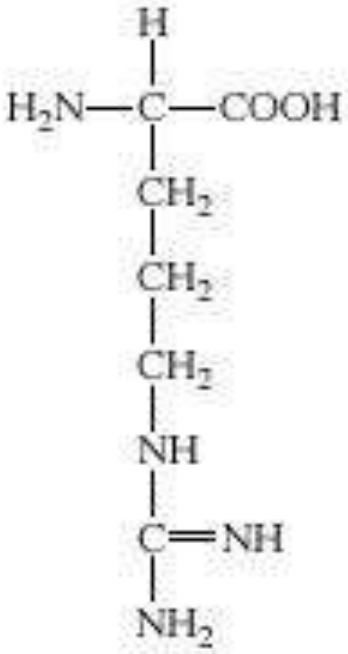
glutamic acid
(Glu, E; Glx or Z)

- <u>Diamino-monocarboxylic amino acids:</u>

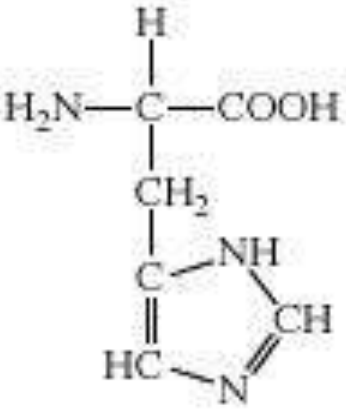
  Lysine, arginine, histidine.



lysine
(Lys, K)



arginine
(Arg, R)



histidine
(His, H)

Properties : Physical

- Colourless
- Crystalline in nature
- Tasteless[tyrosine], sweet[glycine, alanine]
- Melting point above 200•C
- Soluble in polar solvent and Insoluble in non polar solvent
- Have absorbance at 280nm

- Mol wt: 100 – 50,000Dt
- All amino acids possess optical isomers due to the presence of asymmetric α-carbon atoms.
- Some are structurally stable and sterically hindered [Glycine]
- Amino acids [proteins]posses enzymatic activities
- Amino acids exhibit colloidal nature and denaturing property

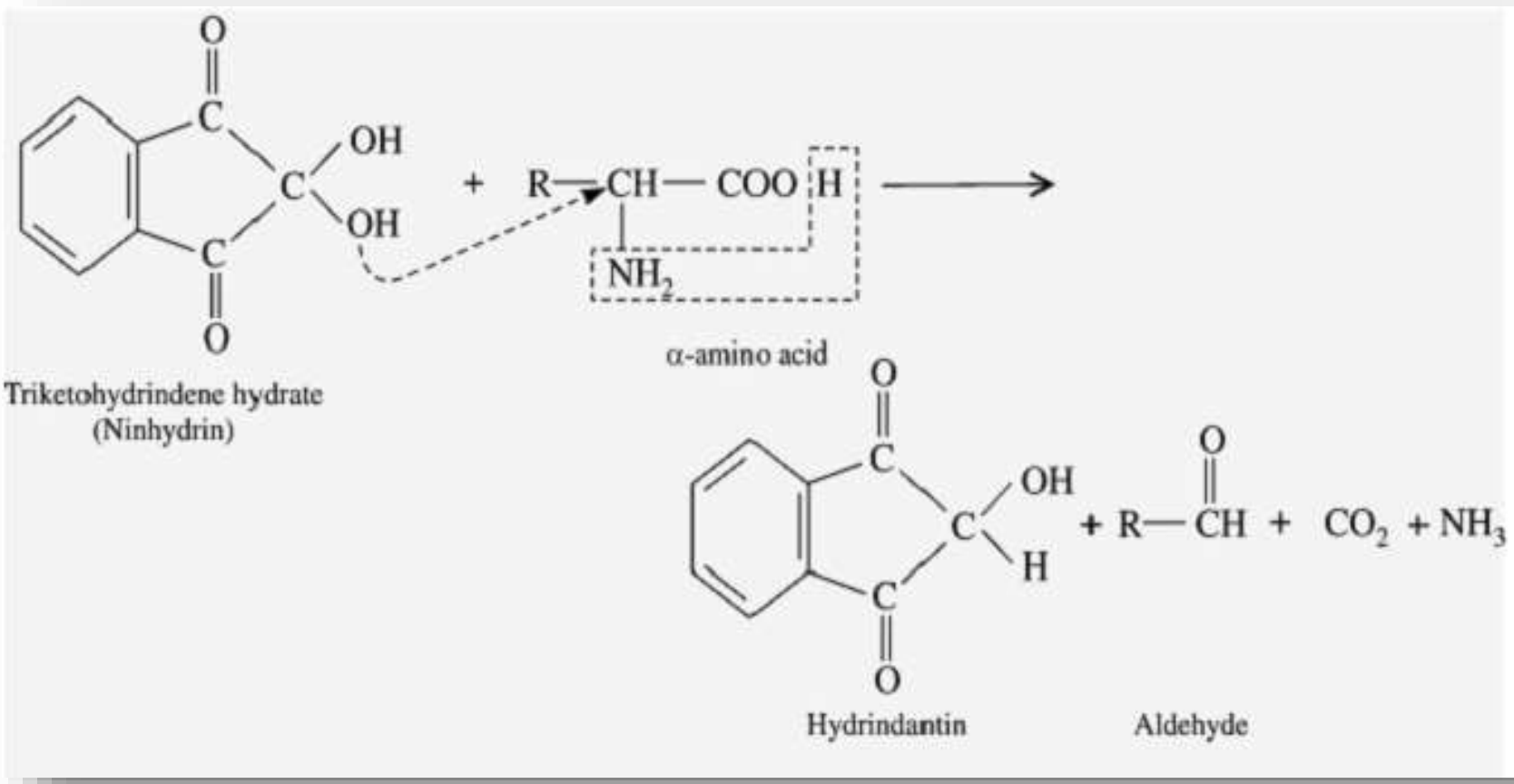
Chemical properties

- **<u>Decarboxylation:</u>**

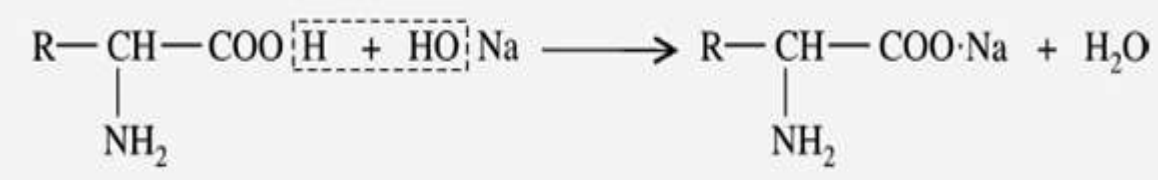
The amino acids will undergo decarboxylation to form the corresponding “amines”. Thus amines are produced

- **Histidine** → Histamine + CO_2
- **Tyrosine** →Tyramine + CO_2
- **Lysine** →Cadaverine + CO_2

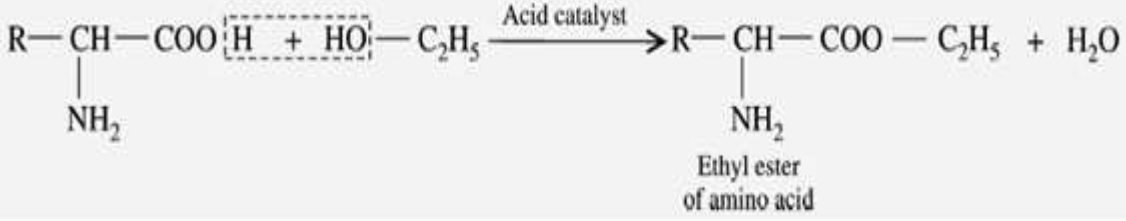
- Reaction with Ninhydrin:



- **Reaction with Alkalies (Salt formation):**
- The carboxyl group of amino acids can release a H^+ ion with the formation of Carboxylate (COO^-) ions.



- **Reaction with Alcohols (Esterification) :**
- the amino acids is reacted with alcohol to form, “Ester”. The esters are volatile in contrast to the form amino acids.



- **Reaction with DANSYl Chloride:**

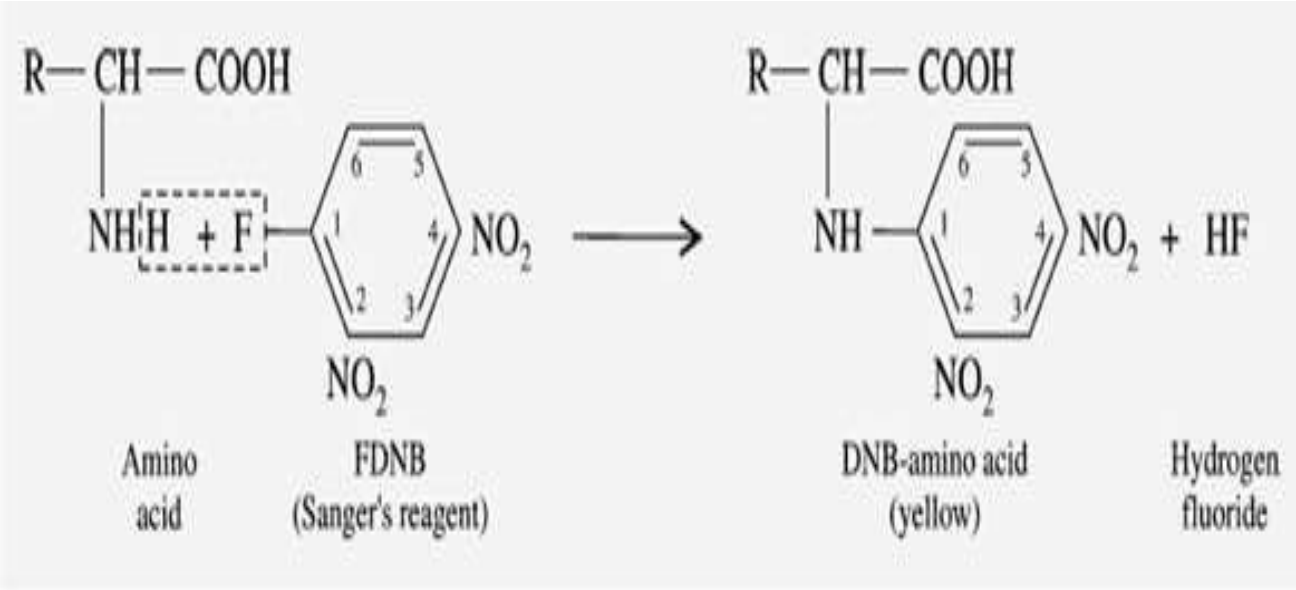
DANSYl chloride means “Dimethyl Amino Naptha Sulphonyl Chloride”.

When the amino acid reacts with DANSYl chloride reagent, it gives a “Flourescent DANSYl derivative

- **Reaction with acylating agents (Acylation):**

When the amino acids react with “Acid chloride” and acid anhydride in alkaline medium it gives “pthaloyl amino acid

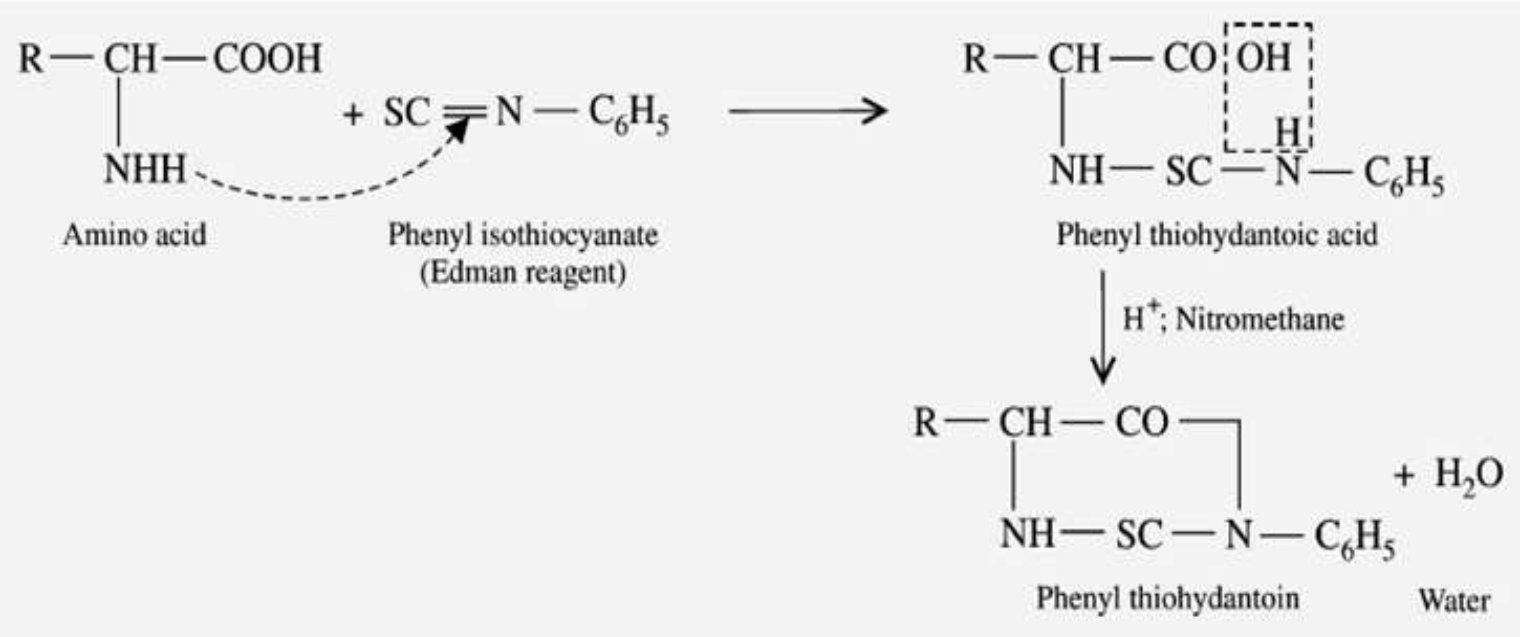
- **Reaction with Sanger's reagent:**
- "1-flouro-2,4-dinitrobenzene" is called Sanger's reagent (FDNB).sanger's reagent reacts with α-amino acid to produce Yellow coloured derivative, DNB-amino acid.



- **<u>Reaction with Edmann's reagent:</u>**

Edmann's reagent is **"phenylisothiocyanate"**. When amino acids react with Edmann's reagent

it gives "***phenyl thiohydantoic acid***" finally it turns into cyclized form "*Phenyl thiohydantoin*" (Edmann's derivative).



- Reference :

➢ Dr. J.L. Jain – Fundamentals of Biochemistry by Chand publications, New Delhi.