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AMINO ACIDS

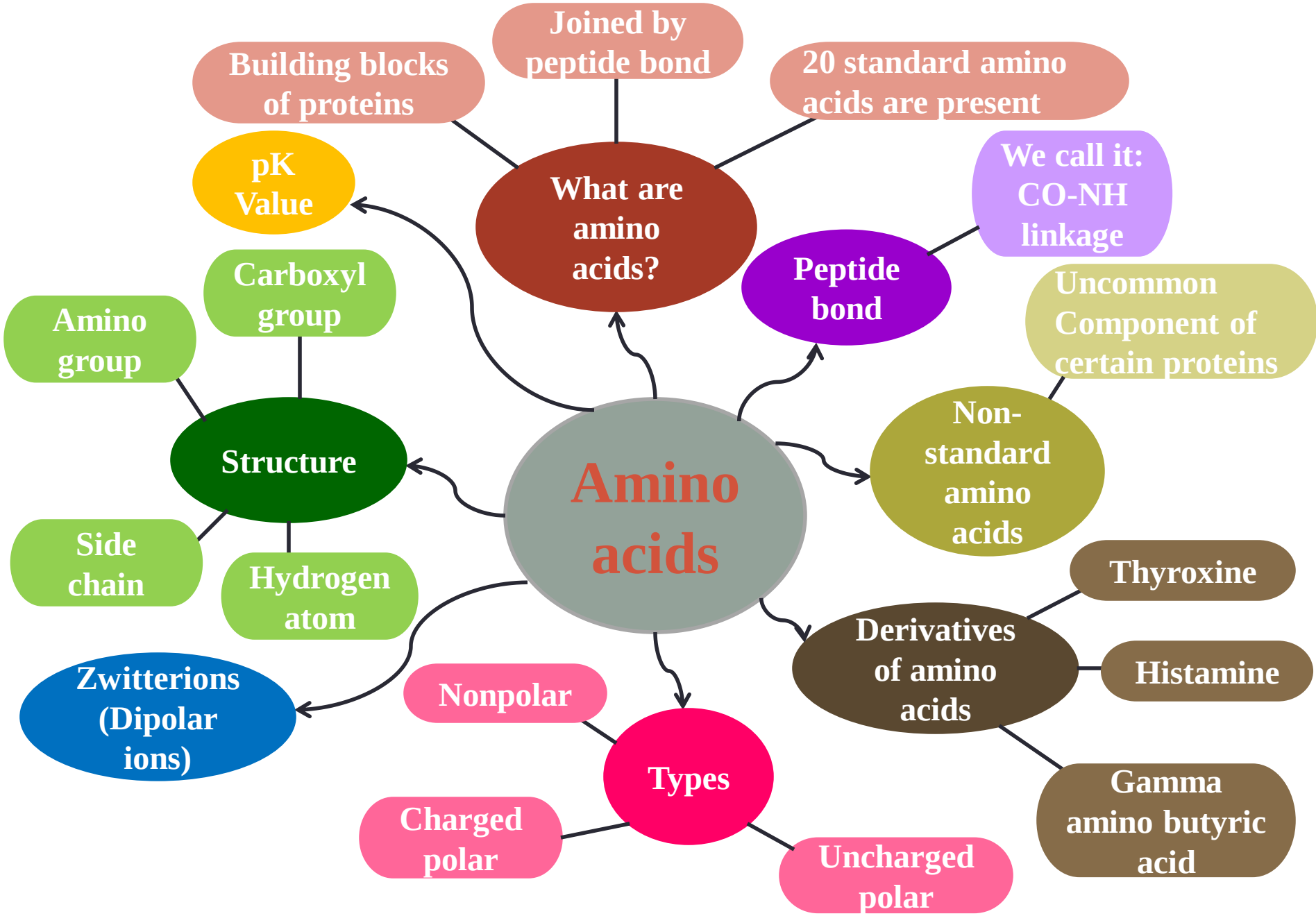
(Foundation Block)

Color Index:

- **Pink = Girls**
- **Blue = Boys**
- **Red = Important**

Objectives:

- What are amino acids?
- Structure.
- Types.
- Peptide bond: Building blocks of proteins.
- Non-standard amino acids
- Derivatives of amino acids


Amino acids
What are amino acids?
Building blocks of proteins
Joined by peptide bond
20 standard amino acids are present
pK Value
Carboxyl group
Amino group
Structure
Side chain
Hydrogen atom
Zwitterions (Dipolar ions)
Peptide bond
We call it: CO-NH linkage
Uncommon Component of certain proteins
Non-standard amino acids
Derivatives of amino acids
Thyroxine
Histamine
Gamma amino butyric acid
Types
Nonpolar
Charged polar
Uncharged polar

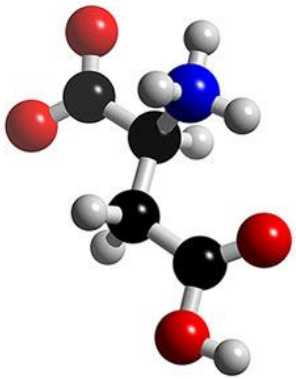
Amino Aids:

- Building blocks of proteins.

N.B: amino acids work in our body like BUFFER. it resists the change of the pH.

- Joined by **peptide bond.**
- 20 standard amino acids present in the mammalian system.

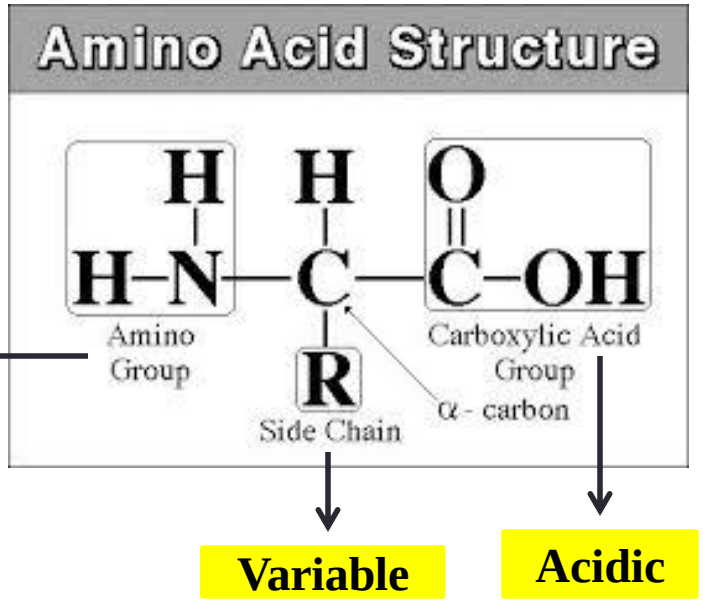
N.B: They are 19 standard amino acids and 1 Imino acid.



Structure of amino acids:

❖ Groups attached to α- carbon:

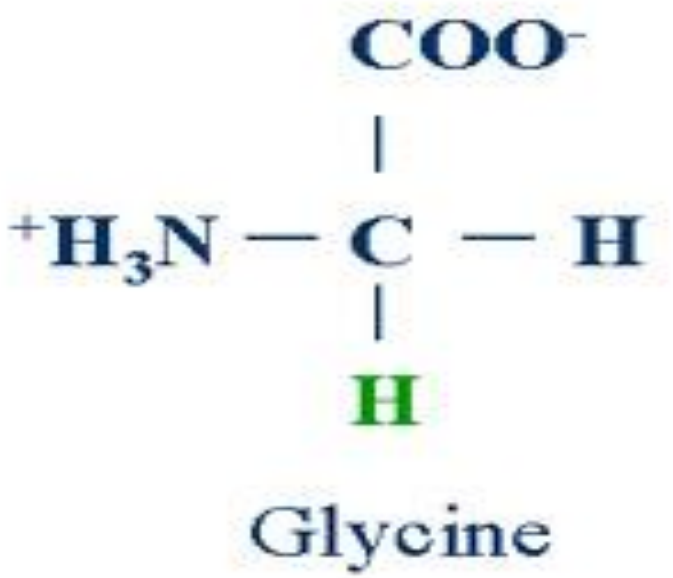
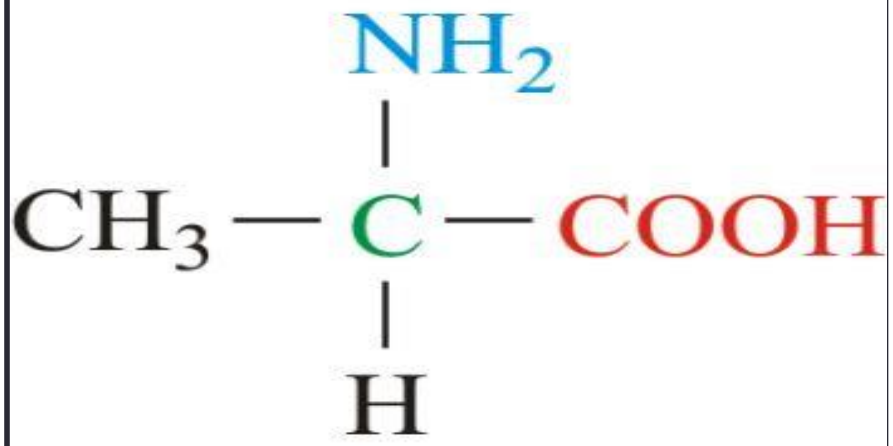
- A carboxyl group.
- An amino group.
- A side chain (R).
- A hydrogen atom.



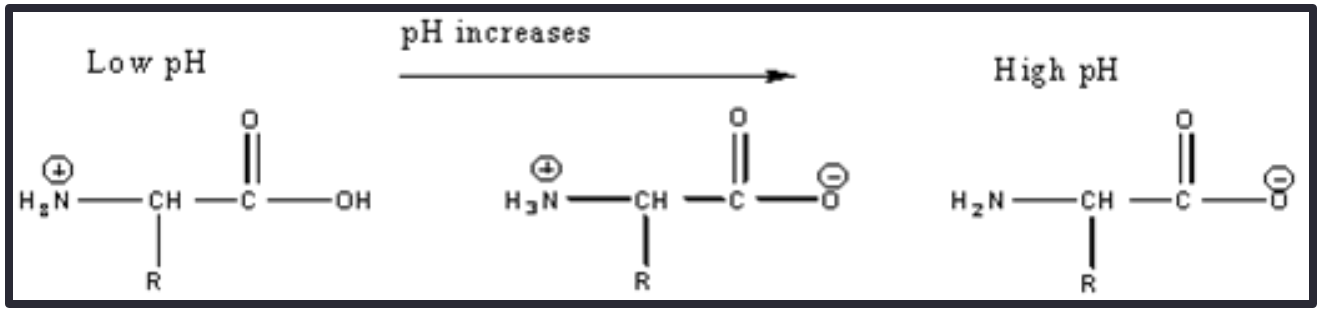
❖ Side chain groups are variable.

(These determine the different 20 standard amino acids)

Examples:

Glycine:	Alanine:
In this example we add hydrogen atom (H) to the side chain.	In this example we add methyl group (CH_3) to the side chain.
 Glycine	

Amino group and Carboxylic group can be ionized (charged).



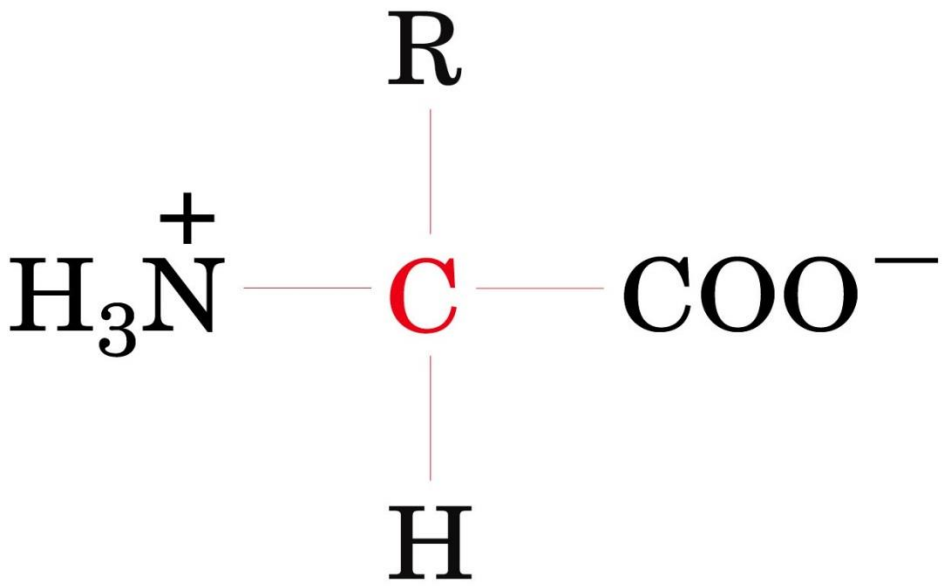
The amino and carboxylic groups of amino acids can readily ionize.

(gaining or losing a proton).

Low PH ------ high H
High PH ------ low H

Zwitterions (Dipolar Ions):

N.B: we are talking about the molecule.



Net charge is zero on the molecule.

Isoelectric point (pI):

N.B: we are talking about the pH of the solution where the zwitterions is present.

- The pH at which the molecule carries no net charge.
- In acidic solution-cationic.
- In alkaline solution-anionic.

Higher pH: anionic (-): alkaline solution.
Lower pH: cationic (+): acidic solution.

pK Value:

(pKa or Acid Dissociation Constant)

- It is the ability of an acid to donate a proton (dissociate).

pK: is the pH when the molecule gives it‘s proton.

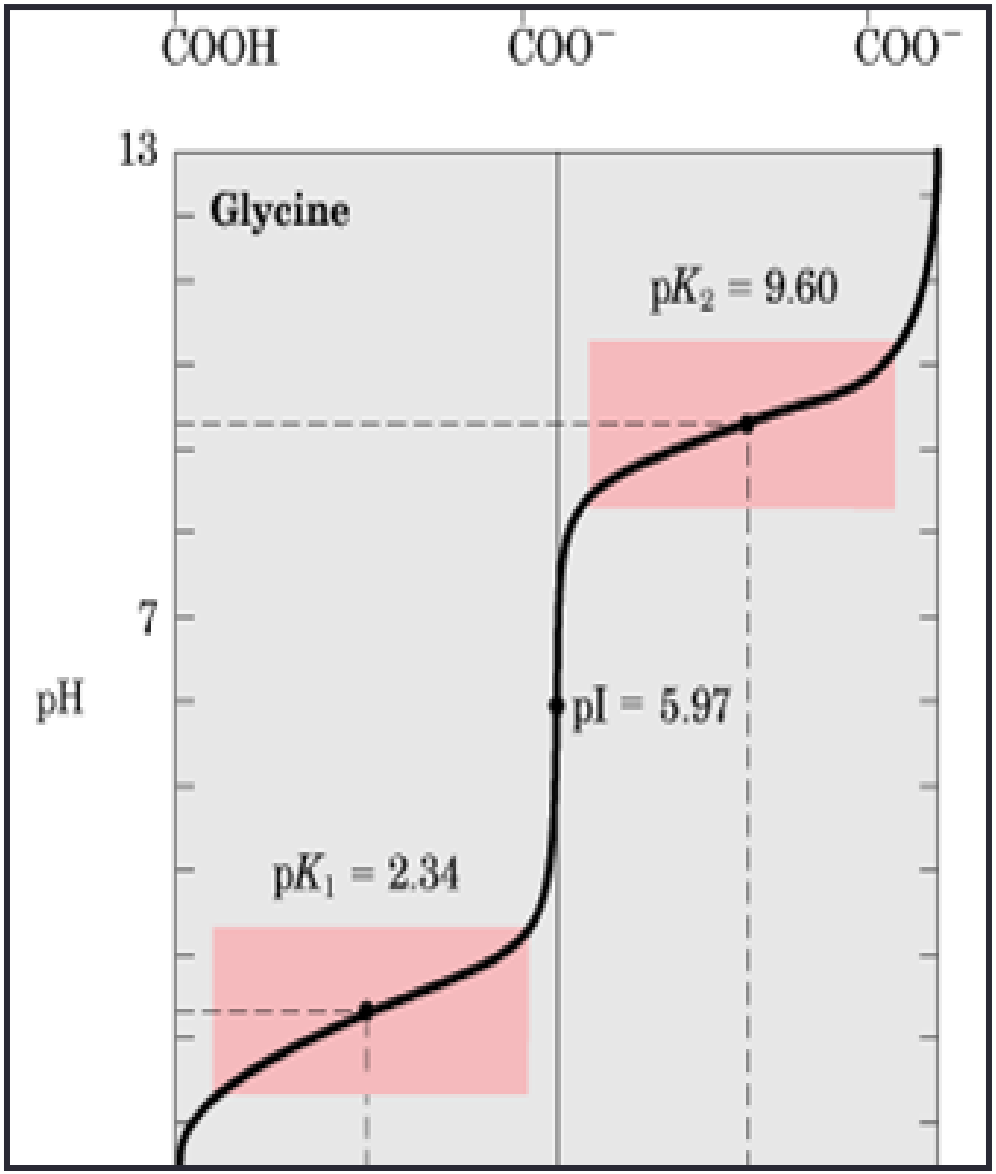
In other words: the ability of an acid to donate a proton. (How fast it dissociates).

- Carboxylic group: range of 2.2 **(it gives proton even in low pH).**
- Amino group: range of 9.4 **(you have to rise the pH so it can give proton).**

Titration Curve of Glycine:

- Acting as a **buffer**: the solution tries to resist a change in pH.
- Buffering action is **maximum** around pK and **minimum** at PI.

- **pK1**: **carboxylic group**: pH at which 50% is cation and 50% is zwitterion.
- **pK2**: **amino group**: pH at which 50% is anion and 50% is zwitterion.



Classification on the basis of side chain:

Three major types of amino acids:

Nonpolar	Uncharged polar	Charged polar
(won't mix, side chain doesn't bind or give off protons)	zero net charge at normal pH. (if we change pH they can become charged)	Acidic amino acid – on -R Basic amino acid + on -R
Hydrophobic (Does not love H) 	Hydrophilic (Loves H) 	Polar Acidic: (have a negative charge on the R-group) (2 types) Aspartic acid , Glutamic acid
Examples: Glycine, Alanine, Valine, Leucine, Isoleucine, Methionine, Phenylalanine, Tryptophan and Proline. Proline is an Imino acid. (because it has a secondary amino group NH2)	Examples: Serine, Threonine, Asparagine, Glutamine, Tyrosine and Cysteine.	Polar Basic: (have a positive charge on the R-group) (3 types) Histidine , Lysine , Arginine

Peptide Bond:

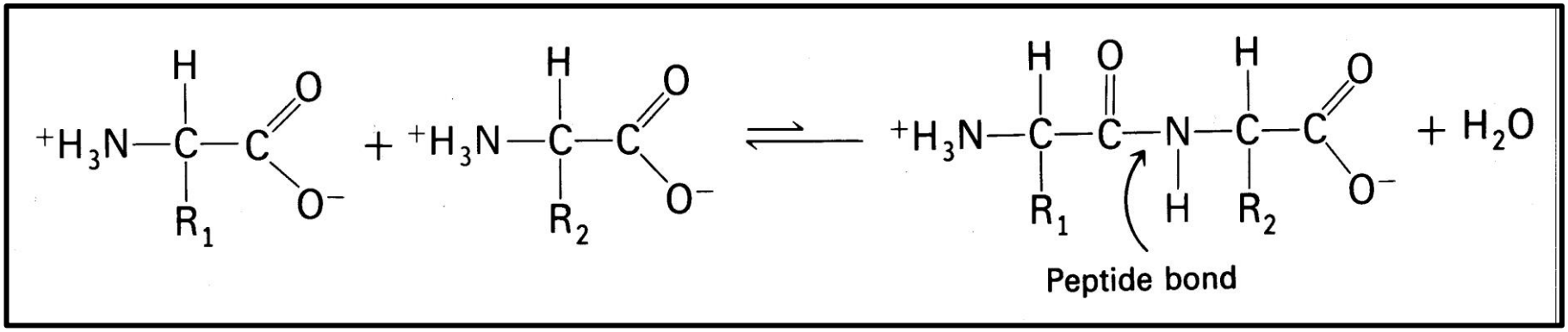
- Amino acids can be polymerized to form chains.
- Amino acids are joined together in a chain by peptide bond (CO-NH linkage)
- α-carboxyl group of one amino acid reacts with α-amino group of another amino acid.

2 amino acid: dipeptide, **3 amino acid:** tripeptide, **4 amino acid:** tetrapeptide, **up to 10 amino acid:** oligo peptide

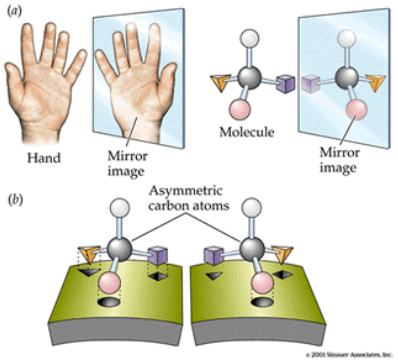
10-50 amino acid: polypeptide, **more that 50 amino acid:** proteins.

N.B: Peptide bond

- **Amino acids** makes **2** bonds but the one at the end makes **1** bond.
- **Free amino group:** amino terminus, **N-terminus.**
- **Free carboxylic group:** carboxyl terminus, **C-terminus.**



Optical activity:



- All amino acids optically active except glycine.
  - They rotate the plane of polarized light in a polarimeter.

- Optically active molecules are asymmetric:
  - They are not superimposable on their mirror image.
  - Asymmetric means α-C is bonded to four different groups.

N.B: **We say a molecule is optically active when it is able to change the direction of the light.**

- Glycine contains two hydrogen atoms on α-C.
- The α-C of glycine is not asymmetric.
- Therefore glycine is optically inactive.

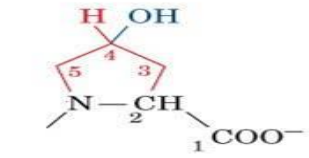
D and L amino acids:

- They are chemically the same.

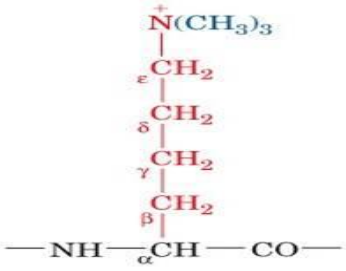
	L-Amino acids	D-Amino acids
	Rotate polarized light to the left.	Rotate polarized light to the right.
Found in:	1. Natural amino acids.	1. Antibiotics, (Like: Gramicidin-S, Actinomycin-D and Valinomycin). 2. Plants Bacterial cell walls.

Non-standard amino acids:

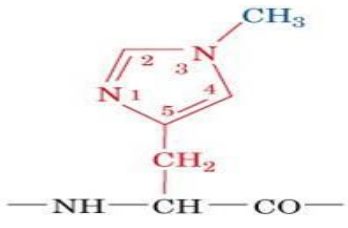
- Some uncommon amino acid residues that are components of certain proteins.



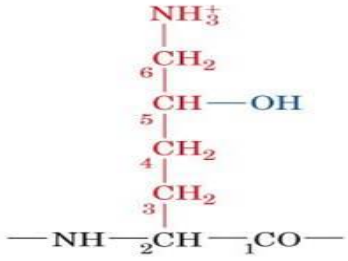
4-Hydroxyproline



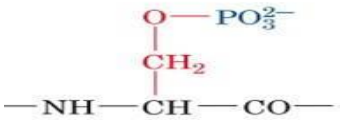
ε-*N*,*N*,*N*-Trimethyllysine



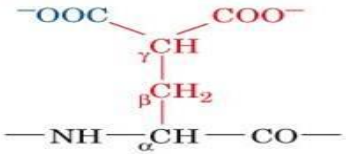
3-Methylhistidine



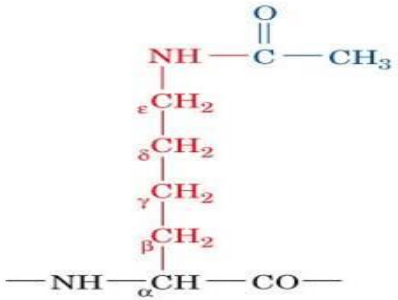
5-Hydroxylysine



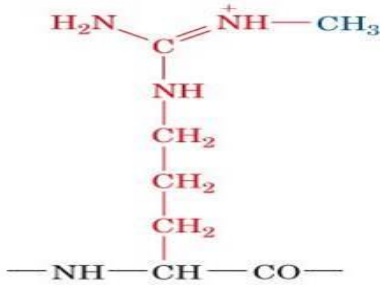
O-Phosphoserine



γ-Carboxyglutamate



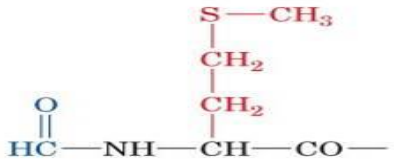
ε-*N*-Acetyllysine



ω-*N*-Methylarginine

N-Acetylserine

N,*N*,*N*-Trimethylalanine



N-Formylmethionine

Amino acid derivatives of importance:

❖ Neurotransmitters:

- Gamma amino butyric acid (GABA) → glutamic acid.
- Dopamine → thyrosine.

❖ Mediator of allergic reactions:

- Histamine → histidine.

❖ Thyroid Hormone:

- Thyroxine → Tyrosine.

Summary

- **pK: is the pH when the molecule it gives it‘s proton.**
- **pI:** The pH at which the molecule carries no net charge.
- **Classification of amino acids:**
  - Nonpolar (9 amino acids).
  - Uncharged polar (6 amino acids).
  - Charged polar (5 amino acids).
- All amino acids **optically active** except glycine.
- **L-amino acids** Rotate polarized light to the left.
  - **Found in: Natural amino acids.**
- **D-amino acids** Rotate polarized light to the right.
  - **Found in: Antibiotics and plants bacterial cell walls.**
- **Amino acid derivatives of importance:**
  - **Neurotransmitters.**
  - **Mediator of allergic reactions.**
  - **Thyroid Hormone.**

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