

AMINO ACIDS AND ITS PROPERTIES

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Learning objectives

- To understand
 - the structural features of amino acids
 - the classifications of amino acids
 - the properties of amino acids

Introduction

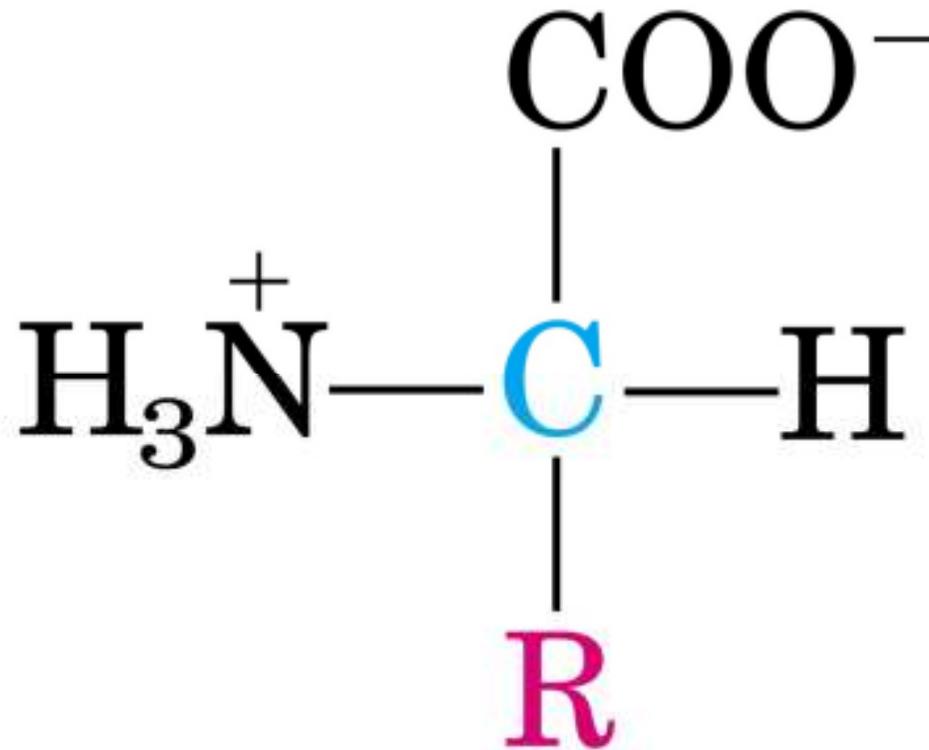
- Amino acids are the building block of protein
- There are 20 naturally occurring amino acids

In the following slides, we shall discuss about the structural features, classifications and properties of amino acids.

Structural features of Amino acids

- All 20 amino acids have common structural features
- All amino acids have an **amino group** ($-\text{NH}_3^+$), a **carboxylate** ($-\text{COO}^-$) group and a **hydrogen** bonded to the same carbon atom (the α -carbon)
- They differ from each other in their side chain called **R** group.
- R groups vary in structure, size and electric charges and influence the solubility of amino acids in water.

Structure of Amino acid



Classification of Amino Acids

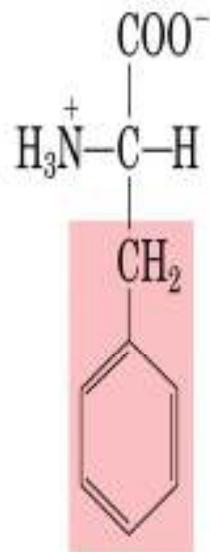
■ Nutritional

- Essential
- Non-essential

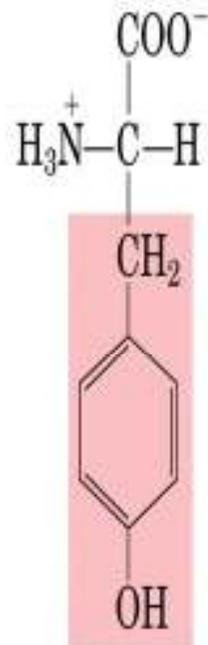
Based on R group

- Non polar aliphatic R group
- Polar uncharged R group
- Aromatic R group
- Positively charged R group
- Negatively charged R group

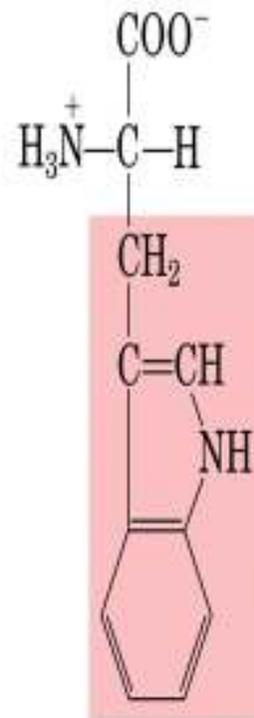
Aromatic R groups



Phenylalanine
VELS



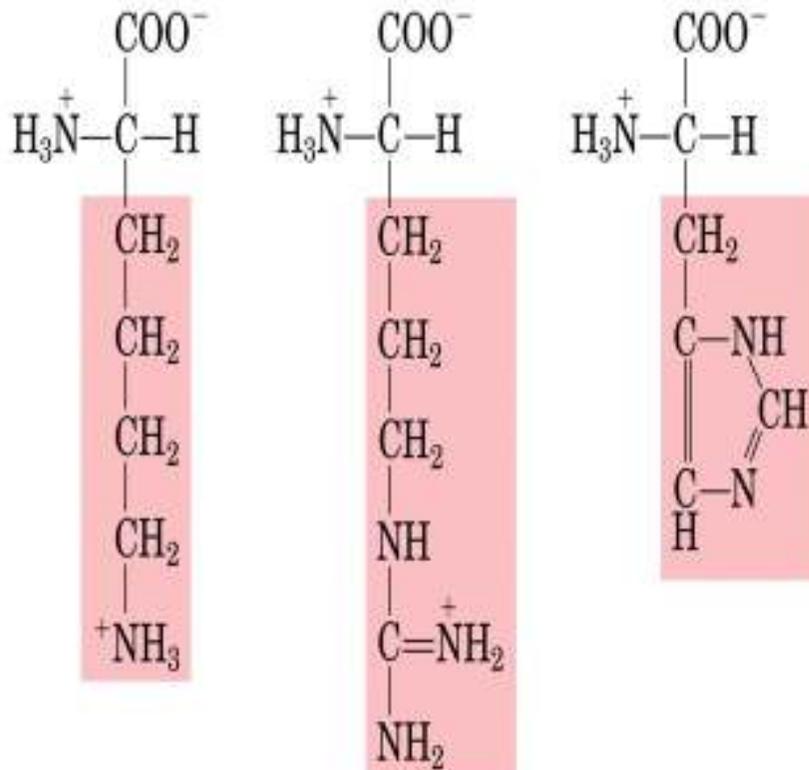
Tyrosine



Tryptophan

Their aromatic side chains are relatively nonpolar. All can participate in hydrophobic interactions. The OH group of tyrosine can form hydrogen bond and can act as an important functional group in the activity of some enzymes.

Positively charged R groups



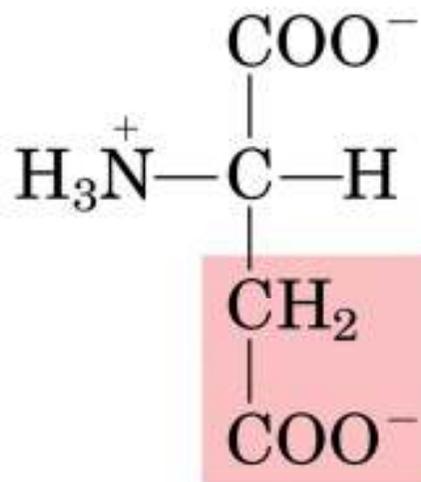
Lysine

Arginine

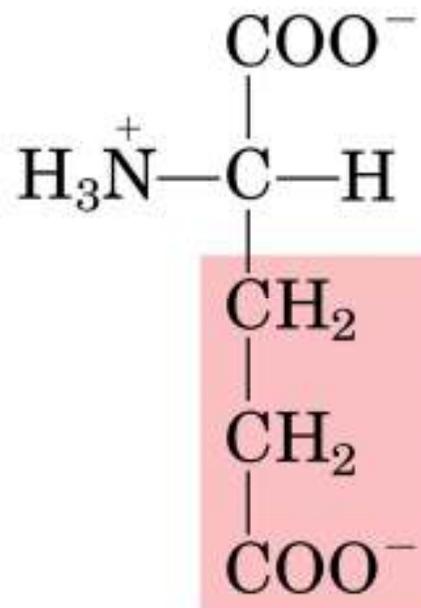
Histidine

The amino acids in which the R group have a net positive charge at pH 7.0

Negatively charged R groups



Aspartate

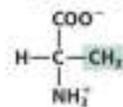


Glutamate

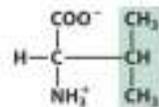
Amino acids having R group with a net negative charge at pH 7.0, with a second carboxyl group

Structures and abbreviations of the standard amino acids

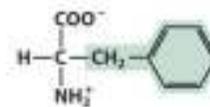
Hydrophobic amino acids



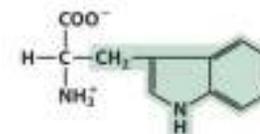
Alanine (Ala, A)



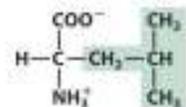
Valine (Val, V)



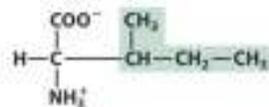
Phenylalanine (Phe, F)



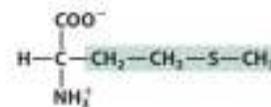
Tryptophan (Trp, W)



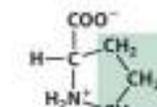
Leucine (Leu, L)



Isoleucine (Ile, I)

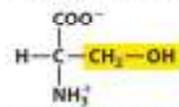


Methionine (Met, M)

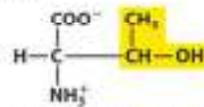


Proline (Pro, P)

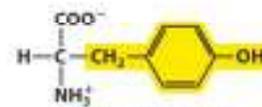
Polar amino acids



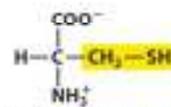
Serine (Ser, S)



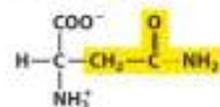
Threonine (Thr, T)



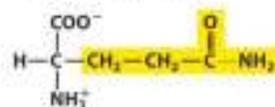
Tyrosine (Tyr, Y)



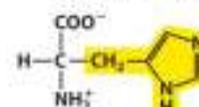
Cysteine (Cys, C)



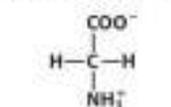
Asparagine (Asn, N)



Glutamine (Gln, Q)

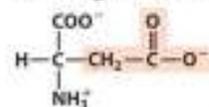


Histidine (His, H)

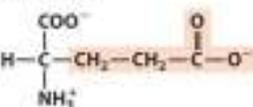


Glycine (Gly, G)

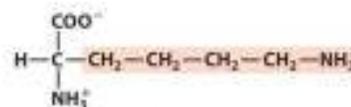
Charged amino acids



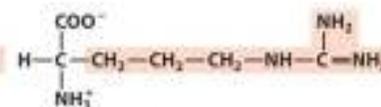
Aspartate (Asp, D)



Glutamate (Glu, E)



Lysine (Lys, K)



Arginine (Arg, R)

Nutritional Classification of Amino acids

Essential Amino Acids: Need to be supplied in daily diet

1. Lysine
2. Leucine
3. Isoleucine
4. Methionine
5. Tryptophan
6. Phenylalanine
7. Threonine
8. Valine

Nonessential Amino Acids: Need not be supplied in daily diet

- Alanine
- Asparagine
- Glycine
- Tyrosine
- Serine
- Proline
- Cysteine
- Cystine
- Histidine(essential for children)
- Glutamine(conditionally essential)
- Arginine(conditionally essential)
- Glutamate

Properties of amino acids...

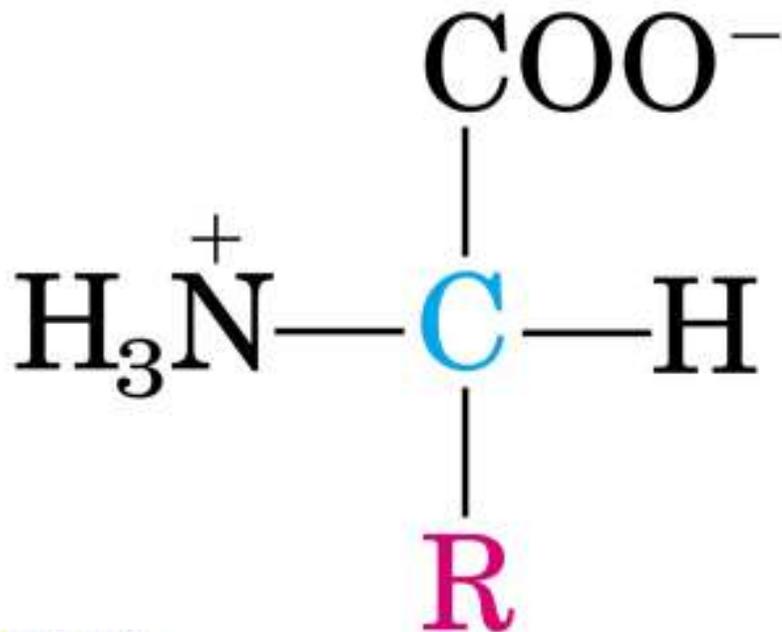
- All the amino acids except glycine have handedness (chiral)

Amino acids exist as D or L form that are nonsuperimposable mirror image of one another

- L-form naturally occurs in proteins

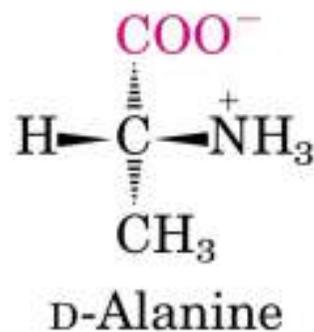
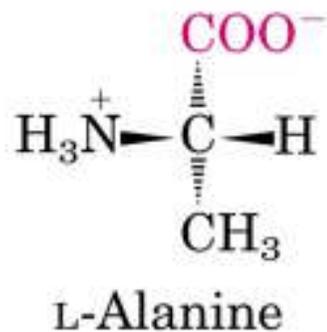
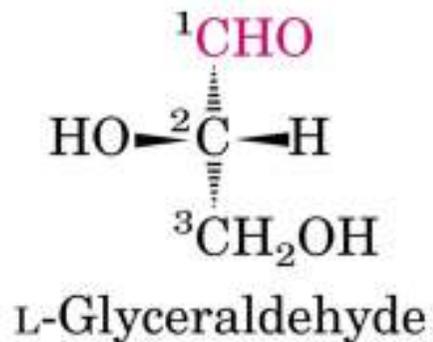


Structure of Amino acid (projection formula)



Horizontal bonds are assumed to project out of the plane of the paper, the vertical bond behind

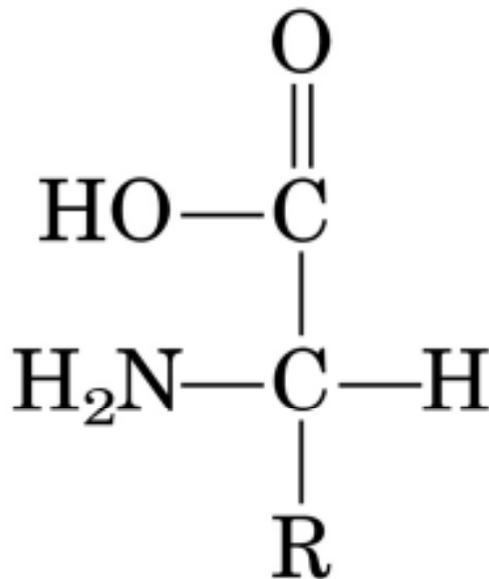
Handedness of Amino Acids



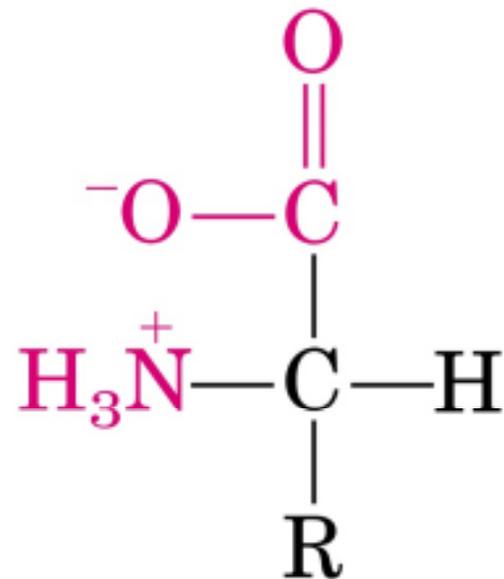
Perspective formula:
the wedge-shaped
bonds project out of
the plane of the paper
and the dashed bonds
behind it.

Properties of Amino Acids...

- Amino acids form internal salts called zwitterions
- In the pure solid state and in aqueous solution near neutral pH, amino acids exist almost completely as zwitterions



Nonionic
form



Zwitterionic
form



Properties of Amino Acids...

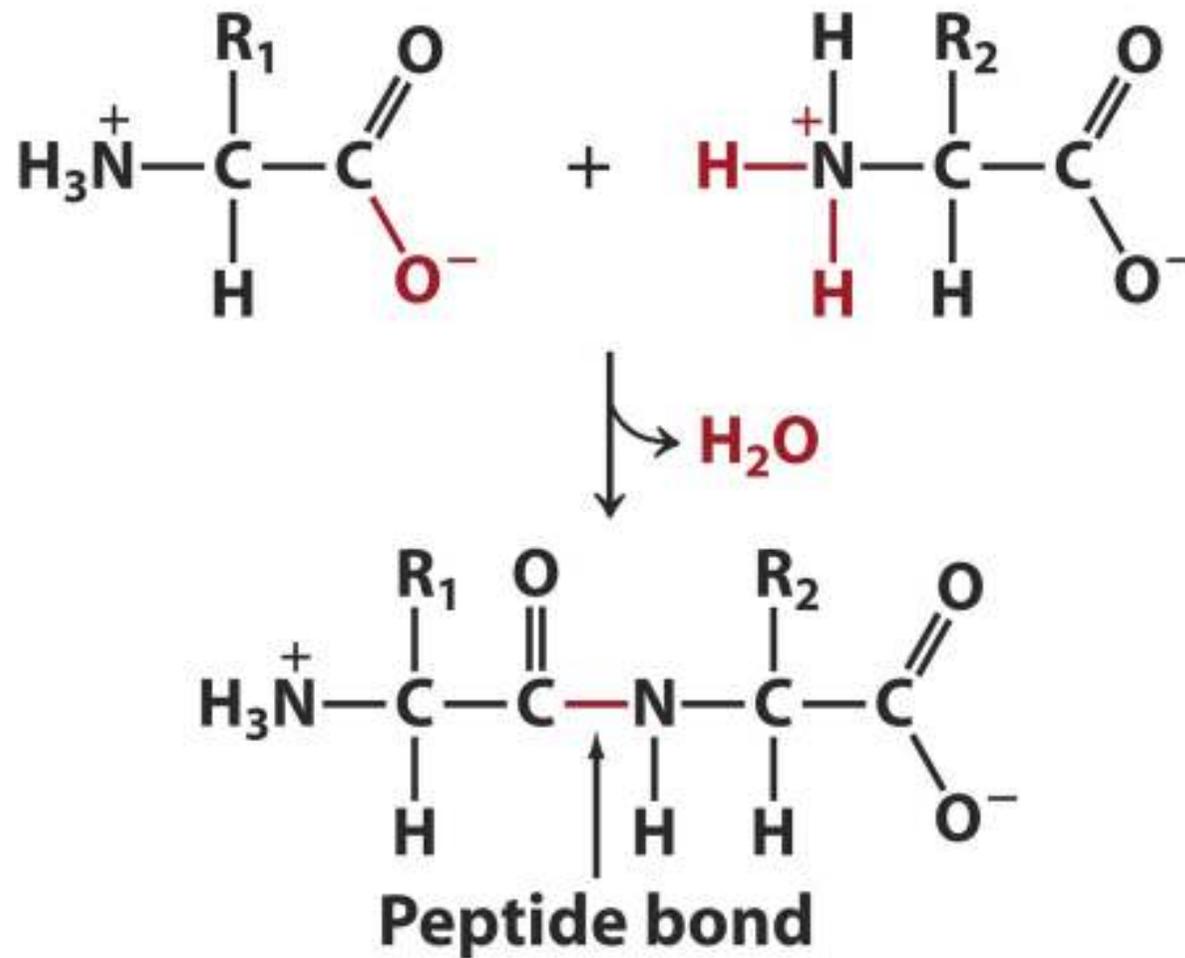
- In zwitterions of amino acids with uncharged side chain, the +ve and –ve Charges cancel one another
- Amino acids in which the +ve and –ve charges are balanced is at its isoelectric point
- The pH at which this balancing occurs is isoelectric pH
- An amino acids is least soluble at its isoelectric pH
- Increases solubility at lower pH as well as at higher pH



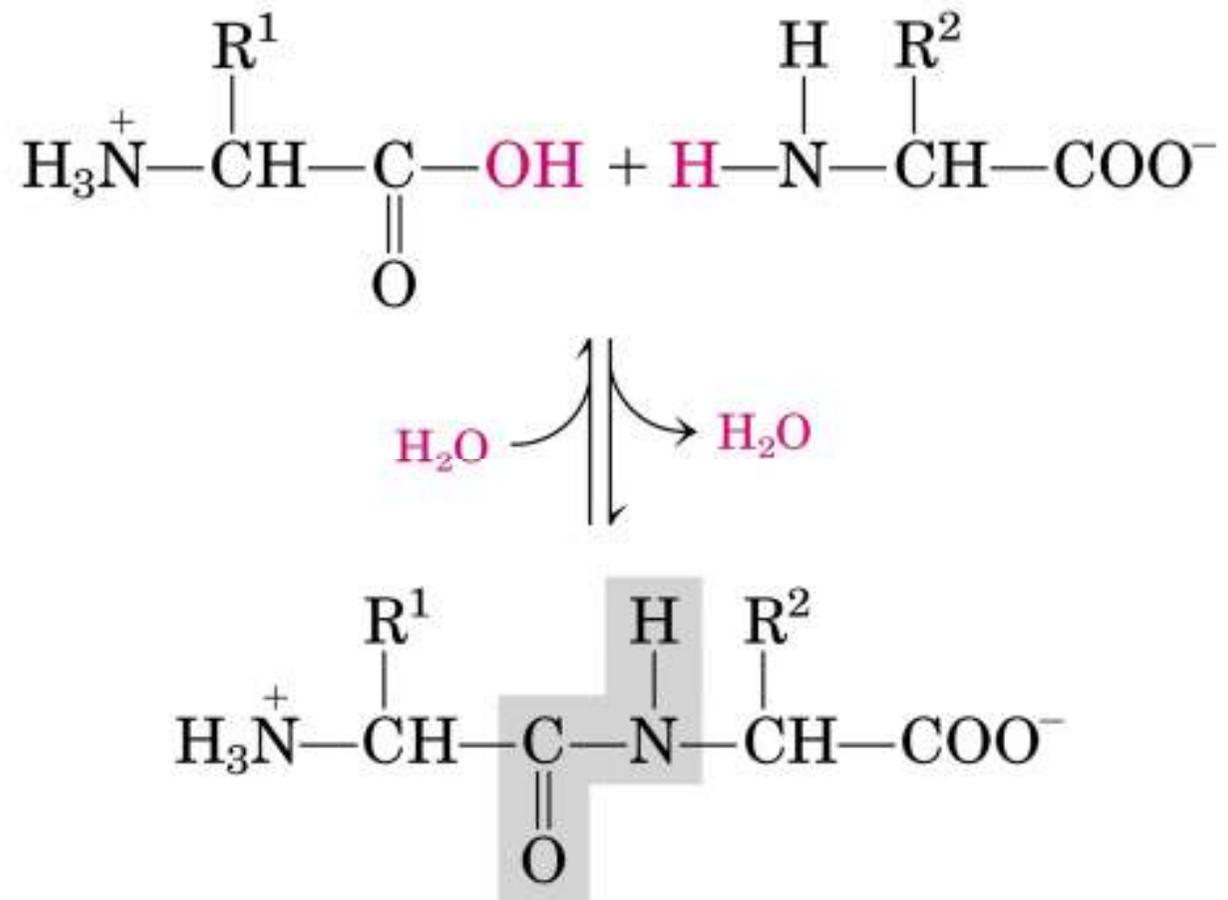
Properties of Amino Acids

- Amino Acids are linked to form **peptide**
- The condensation of the carboxylic group of one amino acid with the amino group of another amino acid releases a water molecule and forms a **peptide bond** or **peptide link**

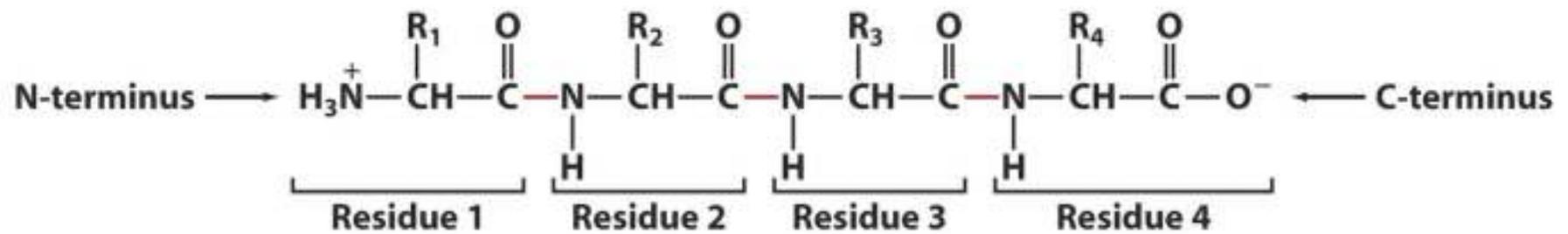
Condensation reaction



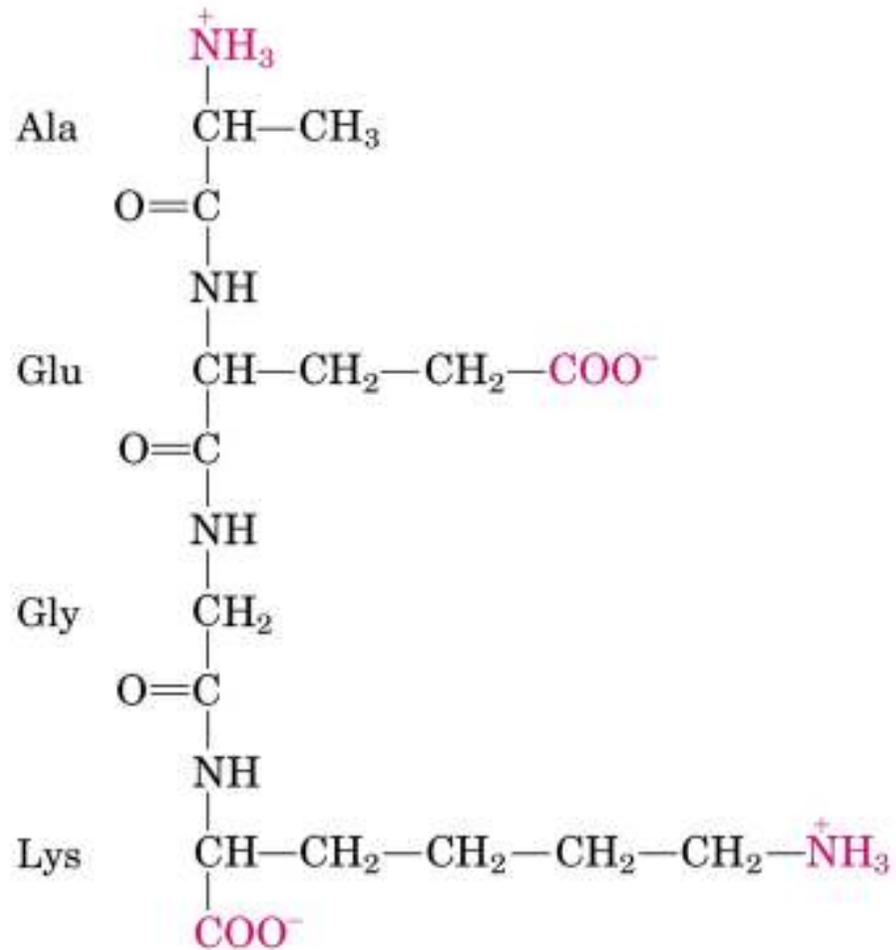
Formation of a peptide bond



Amino acid residues



Peptide Bond



References

1. Dr.A.C.Deb, Fundamentals of Biochemistry, Pg 61-69.
2. Robert K. Murray, Daryl K. Granner, Peter A. Mayes, Victor W. Rodwell, Harper's Biochemistry, 24th Edition, 23-31.