PROTEINS
Classification based on biological function, Amino acids

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Learning outcomes

- Proteins
- Classification (based on biological function)
- Amino acids
- General structure,
- Zwitterion
- Amphoteric nature,
- Classification and synthesis of amino acids

PROTEINS

- Proteins are the most abundant macromolecules of the cells.
- Proteins are essential for cell structure and function.
- Proteins are of many different kinds .

Classification of proteins based on biological function

1. **Enzyme proteins** are biological catalysts e.g. RUBISCO, Catalase etc

2. **Structural proteins**

These proteins give biological structure strength and protection. For example collagen, elastin, keratin, fibroin.

3. **Transport or carrier proteins**

Hemoglobin of RBCs, Lipoproteins present in blood plasma transport lipids , Ceruloplasmin transports copper in the blood.

Classification of proteins based on biological function

4. Nutrient/ storage protein

The seeds of many plants store nutrient protein such as glycinin (Soybean), glutelin (rice) and zein (maize) . Examples of other storage proteins are egg white- ovalbumin, Milk protein- casein, ferritin of animal tissues store iron.

5. Contractile or motile proteins

Actin and myosin filamentous proteins functioning in the contractile system of skeletal muscles. Tubulin is the protein from which microtubules are made which are important components of flagella and cilia.

Classification of proteins based on biological function

6. **Defense proteins**

Immunoglobulins or antibodies of vertebrates are specialized proteins made by lymphocytes which can recognize and precipitate or neutralize invading bacteria viruses or foreign proteins from another species. Fibrinogen and thrombin blood clotting proteins that prevent loss of blood when the vascular system is injured. other examples of Defence proteins are snake venoms, bacterial toxins, and ricin (Castor).

Classification of proteins based on biological function

7. Regulatory proteins

Hormones, such as insulin regulate sugar metabolism, growth hormone of the pituitary , parathyroid hormone regulates calcium ions and phosphate transport.

The cellular response to many hormonal signals is often mediated by a class of GTP-binding proteins called G proteins.

All the proteins with very different properties and functions are made from the same basic group of 20 amino acids.

PROTEINS

- The constituent elements of proteins are carbon, hydrogen, oxygen, nitrogen, and very rarely sulfur and phosphorus also.
- Proteins consist of very long polypeptide chains having from 100 to 1000 amino acids.
- All the proteins are made up of 20 kinds of amino acids.
- **Amino acids are the building block of proteins**.

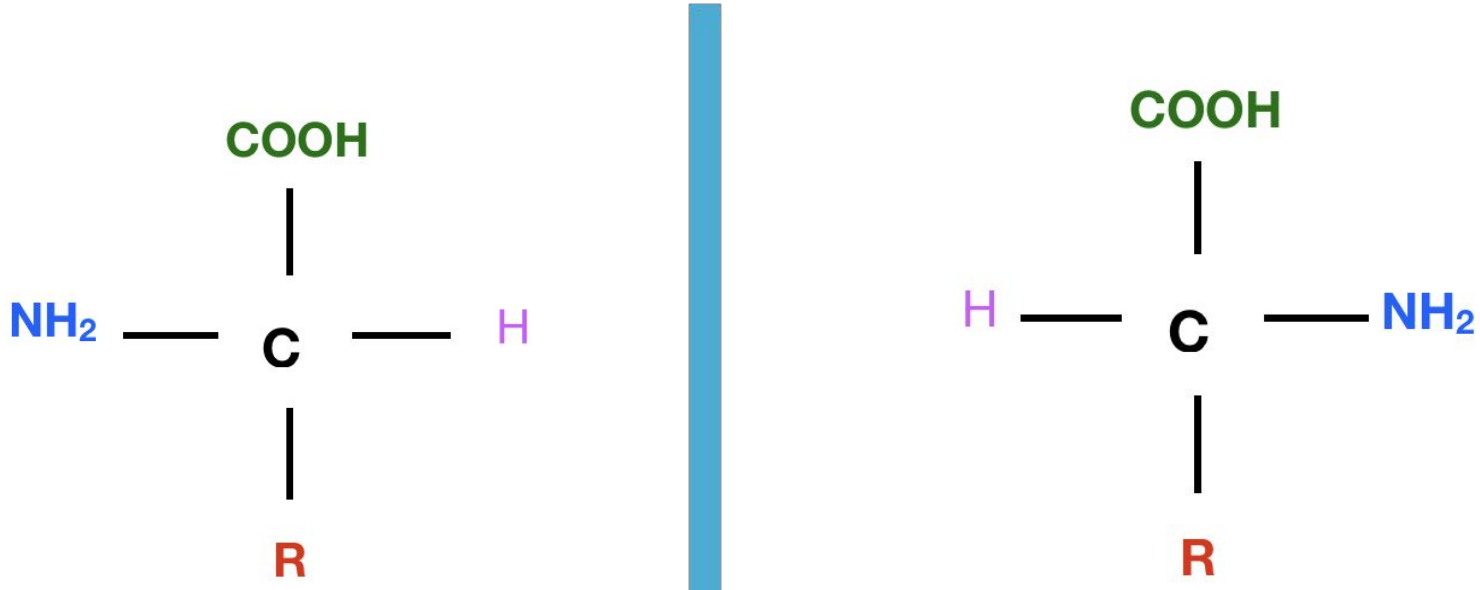
AMINO ACIDS

- Each amino acid is a nitrogenous compound containing both an amino group ($-NH_2$) and a carboxyl group (-COOH).
- R stands for the side chain that are different for each amino acid.
- There are 20 " proteinogenic" amino acids that are incorporated in proteins during translation.
- Plants also make several hundred structurally diverse, non-proteinogenic amino acids with no obvious role in protein synthesis.

L- amino acid

AMINO ACIDS

- The proteinogenic amino acids are L-α amino acids with the general structure R-CαH(NH_2)COOH. (Exception of proline which is a cyclic secondary amino acid).



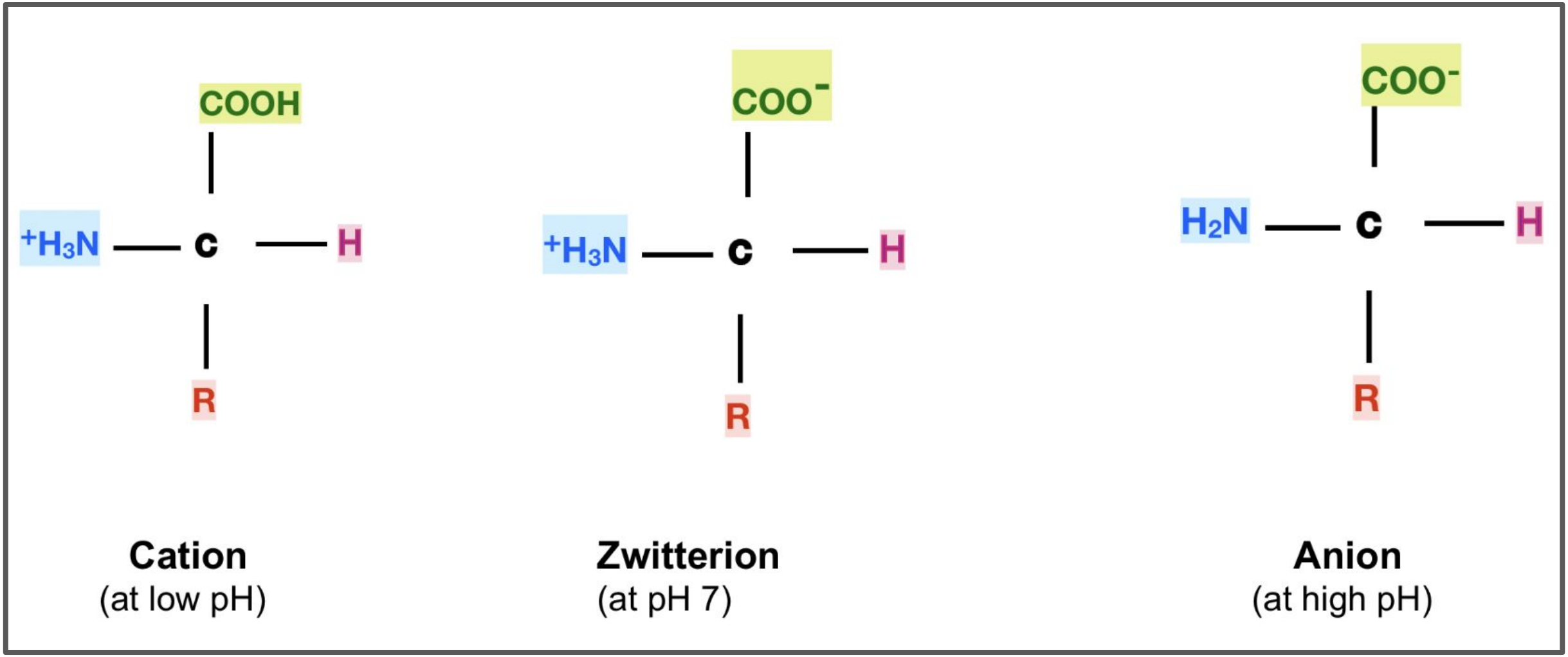
L- amino acid **D- amino acid**

AMINO ACIDS

- The first carbon of the amino acid is the part of the carboxyl group. Second carbon to which amino group is attached is called alpha (α) carbon.
- The alpha carbon of all proteinogenic amino acids (except glycine amino acid) is joined by a covalent bond to four different groups.
- Thus the alpha carbon is asymmetric or chiral in all amino acids except glycine.
- Because of this asymmetry all amino acids (except glycine) exist in two optically active forms- D forms and L forms.
- Only L- amino acids are present in proteins.

ZWITTER ION / DIPOLE ION

- At pH 7, both the carboxyl and amino groups are ionized.
- In the ionic form, the proton(H^+) migrates from the carboxyl to the amino group thus producing carboxylate (COO^-) and ammonium(NH_3^+) ions.
- A molecule having both positive and negative charges is known as zwitter ion or dipole ion.



Cation
(at low pH)

Zwitterion
(at pH 7)

Anion
(at high pH)

AMINO ACIDS ARE AMPHOTERIC IN NATURE

Amino acids are amphoteric in nature, containing an acidic and basic functional group. the acidic functional group is the ammonium ion (NH_3^+) which can donate a Proton and the basic functional group is the carboxylate ion (COO^-) which can accept a Proton.

ISOELECTRIC POINT

Isoelectric point (pI) of the amino acid is the pH at which it has no net charge.

It is the pH at which the amount of negative charge on an amino acid exactly balances the amount of positive charge.

CLASSIFICATION OF AMINO ACIDS

Amino acids are grouped into five main classes based on the properties of their R groups-

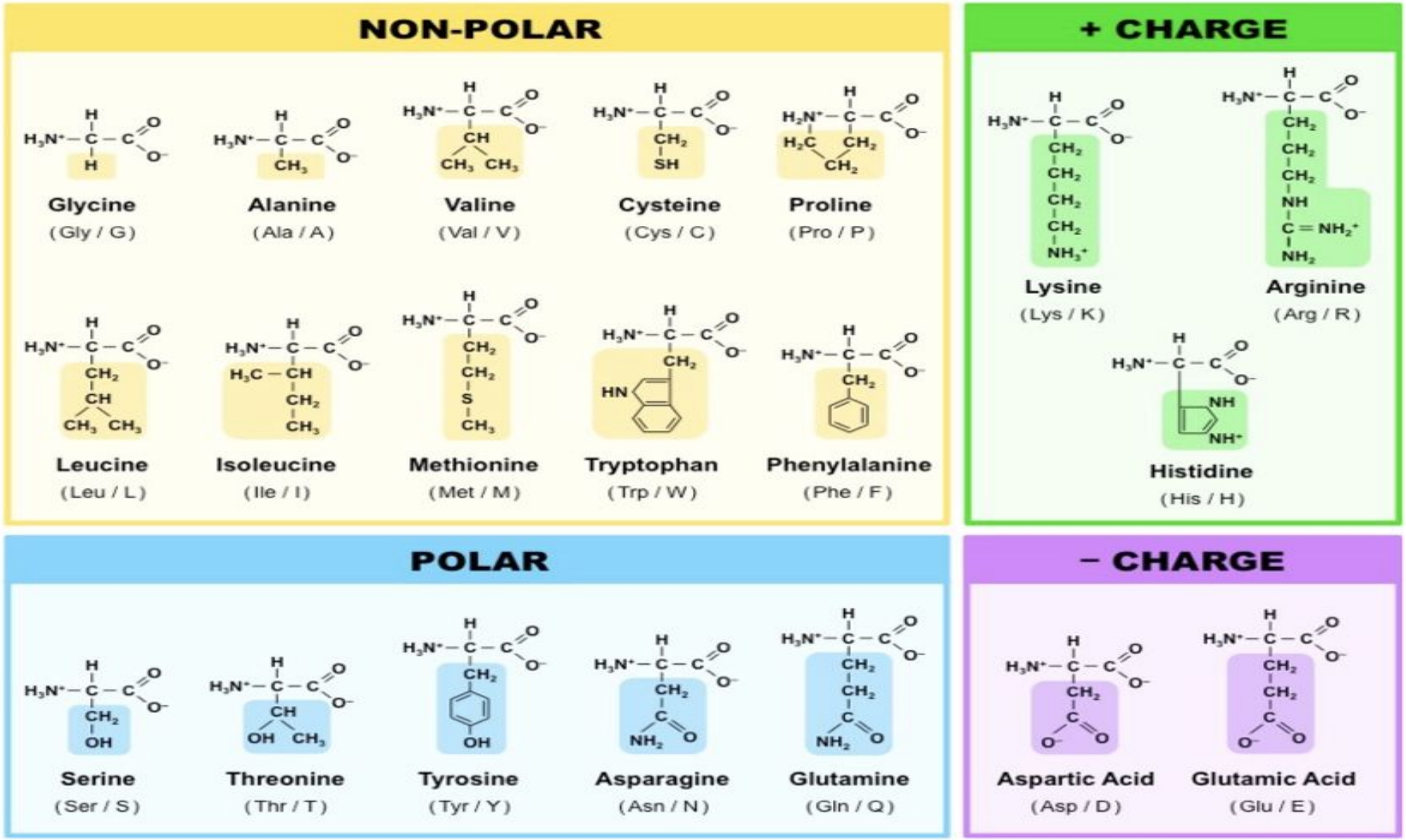
1.Nonpolar aliphatic R groups

2. Aromatic R groups

3. Polar uncharged R groups

4.Positively charged(basic) R groups

5.Negatively charged(acidic) R groups



https://onlinesciencenotes.com/amino-acids-general-properties-and-classification/

Amino Acid	Three Letter Code	One Letter Code
Alanine	Ala	A
Arginine	Arg	R
Aspartic Acid	Asp	D
Asparagine	Asn	N
Cysteine	Cys	C
Glutamic Acid	Glu	E
Glutamine	Gln	Q
Glycine	Gly	G
Histidine	His	H
Isoleucine	Ile	I
Leucine	Leu	L
Lysine	Lys	K
Methionine	Met	M
Phenylalanine	Phe	F
Proline	Pro	P
Serine	Ser	S
Threonine	Thr	T
Tryptophan	Trp	W
Tyrosine	Tyr	Y
Valine	Val	V

https://wou.edu/chemistry/courses/online-chemistry-textbooks/ch450-and-ch451-biochemistry-defining-life-at-the-molecular-level/chapter-2-protein-structure/

Amino acid synthesis:

In plants they are synthesized from an organic acid (mostly free α keto acids) produced during glycolysis and Krebs cycle and inorganic nitrogen.

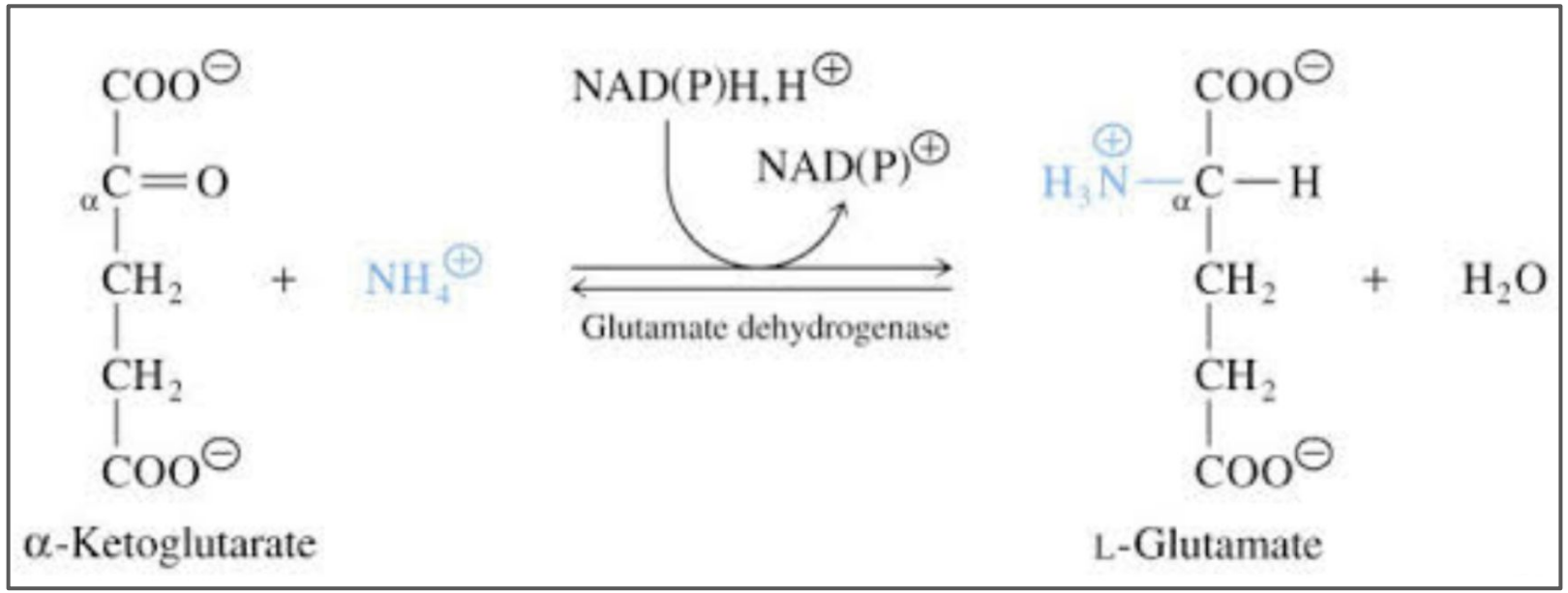
The α keto acid is similar to the amino acid with the exception of oxygen instead of an amino group attached to the Alpha carbon.

There are two ways of amino acid biosynthesis by which nitrogen can be Incorporated into Alpha keto acids:

1. Reductive amination
2. Transamination

1. Reductive amination

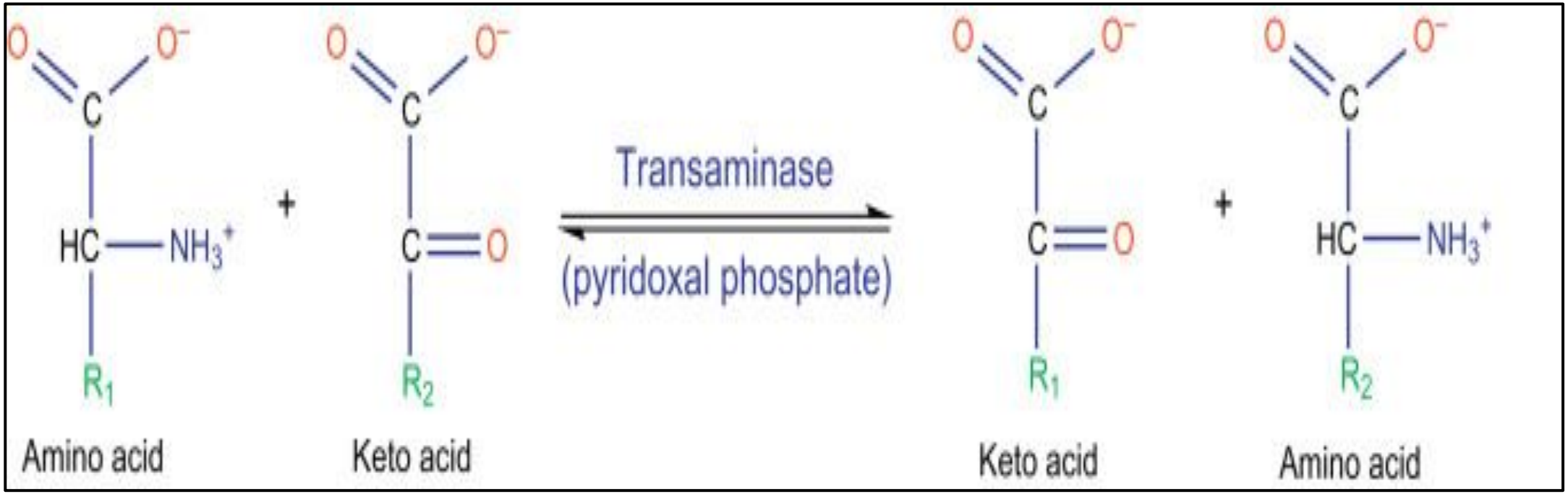
The conversion of inorganic nitrogen (NH_3) into organic nitrogen (amino acid), where amination and reduction at the Keto group of organic acid take place, is called reductive amination. it is the primary pathway of amino acid biosynthesis.



1. Alpha ketoglutaric acid + NH_3 ⇄ Glutamic acid
2. Oxaloacetic acid + NH_3 ⇌Aspartic acid
3. Fumaric acid + NH_3 ⇌Aspartic acid
4. Pyruvic acid + NH_3 ⇌Alanine

2. Transamination

The transfer of amino group (NH_2) of amino acid to the carbonyl group of a keto acid is called transamination. about 17 amino acids are synthesized from glutamic acid by transamination.



Let’s revise

1. Classify proteins on the basis of their biological functions.
2. What is a zwitterion?
3. Give the classification of amino acids.
4. Differentiate between transamination and reductive amination.
5. Write a note on peptide bond and its characteristics.

BOOKS RECOMMENDED :