Amino acids

Editing File

Color Index:
- Main Text (black)
- Female Slides (Pink)
- Male Slides (Blue)
- Important (Red)
- Dr’s Notes (Green)
- Extra Info (Grey)

Objectives

- What are the amino acids?
- General structure.
- Classification of amino acids.
- Optical properties.
- Derivatives of amino acids.
- Amino acid configuration.
- Non-standard amino acids.

What are Amino Acids?

Amino acids :

- Chemical units that combine to form protein, also known as (the building blocks of proteins).
- Organic acids that contain Carboxyl group (COOH) and an Amino group (NH)2. The functional group is the (COOH) since it is the strongest.

Central roles of amino acids :

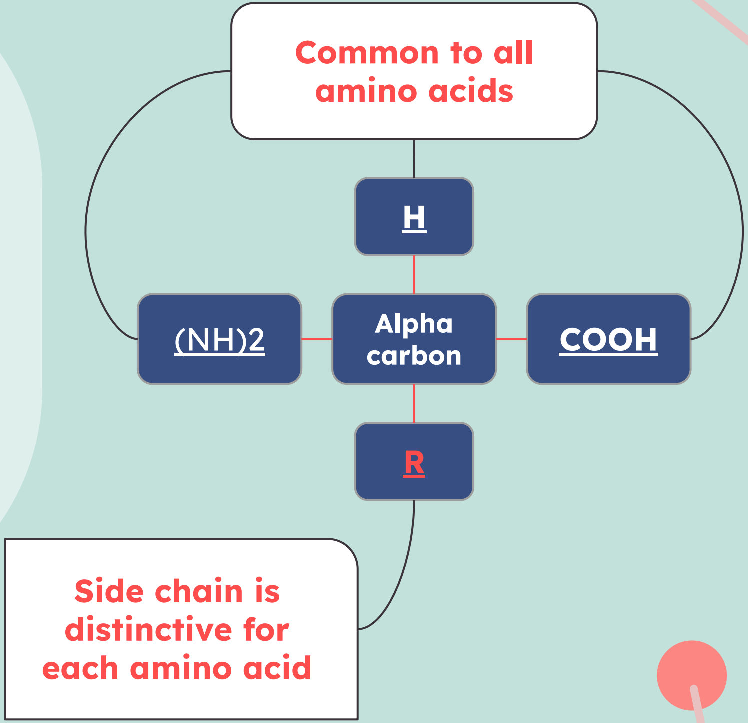
- Building blocks of proteins.
- Intermediates for metabolism.

- In the human body there are 20 amino acids:
  - Humans produce about half of the amino acid (11).
  - The rest (9) are supplied in food (human should obtain from diet).
- When proteins are digested or broken down, amino acids are left.

General Structure

- R differs in each amino acid, which gives the amino acid its unique structure, function ,and chemical nature.
- NH2 all amino acids have a primary amino group, except for **Proline** which has a secondary amino group.
- Alpha carbon : is between the carboxyl and the amino group.

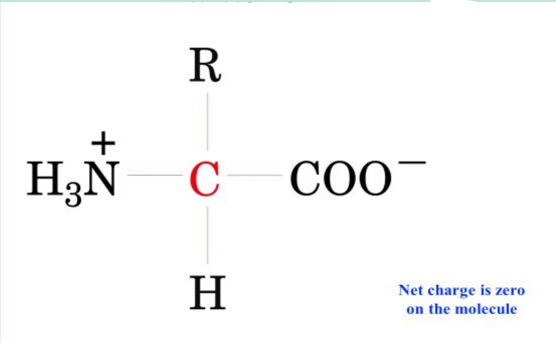
It's a carbon atom that bonded to a functional group in an organic compound.



Zwitterion

The zwitterion is a neutral amino acid with both a positive charge and a negative charge.
- Amino group has a positive charge (NH_3^+) and the carboxyl group has a negative charge (COO^-).

- Net charge on the molecule = zero
- NOTE: an amino acid with an ionized (charged) R cannot be zwitterion in neutral PH.



- The zwitterion is the usual form of amino acids that exists in solution.
- Depending on the pH there are two other forms: anion and cation.

- Zwitterion means hybrid because it has +ve and −ve at the same time.

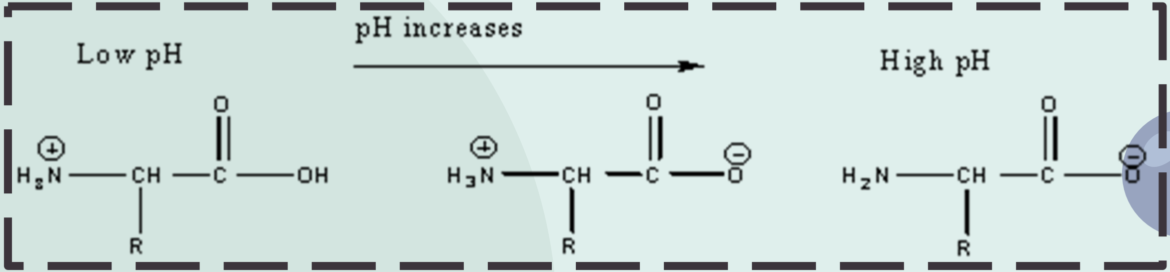
Isoelectric Point (pI)

-The pH of the medium at which the molecule <u>carries no net charge</u> (neutral) and becomes a zwitterion.

-In an **acidic** solution-**cationic**.

-In an **alkaline (basic)** solution-**anionic**.

Note : Each molecule has its own Isoelectric point depending on the side chain(R).



Isoelectric Point (pI)

We have a molecule at its isoelectric point (zwitterion) .
If we put it in an acidic or a basic solution, what will happen?

1- In an acidic solution: Low pH. Becomes Cation.
2- In a basic solution: High pH. Becomes Anion.

Cationic	Zwitterion	Anionic
Low pH (high conc. of proton H+)	pH=pI	High pH (low conc. of proton H+)
Positively Charged	No net charge	Negatively Charged
Explanation: The carboxylic acid will gain proton (Hydrogen atom) and lose its negative charge. The overall charge= +ve (Cationic)	Zwitterion is used to describe the Molecule. Isoelectric point is used to describe the pH level.	Explanation: The amino group will lose a proton (Hydrogen atom) and lose its positive charge. The overall charge= -ve (Anionic)

pK Value & The Titration Curve of Glycine

pK value (Also known as pKa or acid dissociation constant):

-pKa lets us know how strong or weak an acid is.
High pKa = Low acidity = Low concentration of protons.

-The ability of an acid (COOH) to donate a proton (H+) (dissociate).

-Amino acids with ionized R **can not** be zwitterions in neutral pH.

Titration: a process where a solution of known concentration is used donating hydrogen instead of the to determine the concentration of an unknown solution.

TEAM436: COOH is a stronger acid (low pK) than NH2, so it will donate its proton first (1st pK value = 2.2) then NH2 (higher pK) will donate afterward (2nd pK group = 9.4)

TEAM438:
- pK = measurement of the acidity of the Group
- pH: measurement of the acidity of the Solution
- When pK= pH the group starts donating hydrogen instead of the medium

Pk values

- The pK values of α-carboxylic group is in the range of 2.2.
- The pK values of α-amino group is in the range of 9.4.

Titration Curve of Glycine

◆pK1- pH at which 50% of molecules are in cation form and 50% are in zwitterion form.
At pH = pK1 = 2.3: The COOH group in Glycine has lower pk value, so it will donate its protons first to neutralize the OH- in the medium, and becomes COO. As a result, zwitterions will be formed. (Buffering action is at its max).

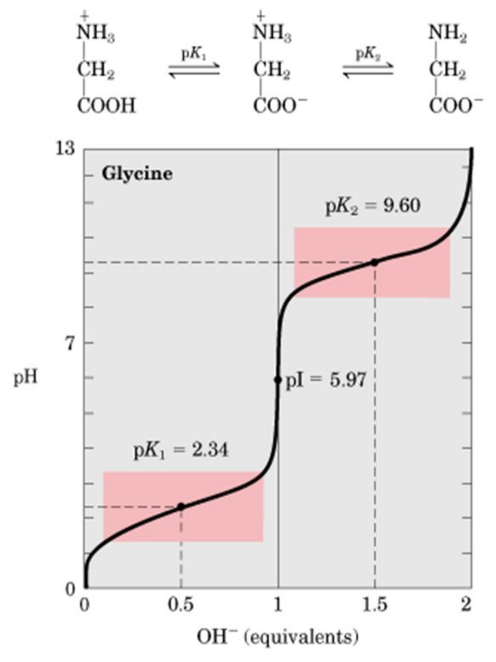
◆ pI- 100% of the molecules zwitterion net charge is zero.
At pH = pI = 5.9: All COOH became COO-, so there are no more protons to donate. 100% of molecules are zwitterions. (Buffering action at its min).

◆ pK2- pH at which 50% of molecules are in anion form and 50% are in zwitterion form.

At pH = pK2 = 9.6: The ammonia group starts donating protons, NH3 → NH2. Zwitterions will lose a positive charge, & anions are formed. (Buffering action is at its max).

◆ Buffering action is maximum around pK values and minimum at pI.

Note: all free amino acids and charged amino acids in peptide chains can serve as buffers.



Classification of Amino Acids:

Based on Body Requirements

Essential
(cannot be made in the body).

(PVT TIM HLL)
بقت تيم هال، يقال انه اسم جندي

-**P**henylalanine
-**V**aline
-**T**hreonine
-**T**ryptophan
-**I**soleucine
-**M**ethionine
-**H**istidine
-**L**eucine
-**L**ysine

Nonessential
(produced by the body).

(Glu Ala AsAs)
قلة على اساس

-**G**lutamic acid
-**A**lanine
-**A**spartic acid
-**A**sparagine

Conditional
(not essential, except in time of illness or stress).

(PGG CATS) Sounds like (Big cat)

-**P**roline
-**G**lycine
-**G**lutamine
-**C**ysteine
-**A**rginine
-**T**yrosine
-**S**erine

Classification of Amino Acids:

(According to the side chain properties [R-group])

Non polar

VIP GAP TML

-Valine
-Isoleucine
-Proline
-Glycine
-Alanine
-Phenylalanine
-Tryptophan
-Methionine
-Leucine

Un charged

STC TAG

-Serine
-Threonine
-Cysteine
-Tyrosine
-Asparagine
-Glutamine

polar

HLA--AG

Basic side chain:

-Histidine
-Lysine
-Arginine

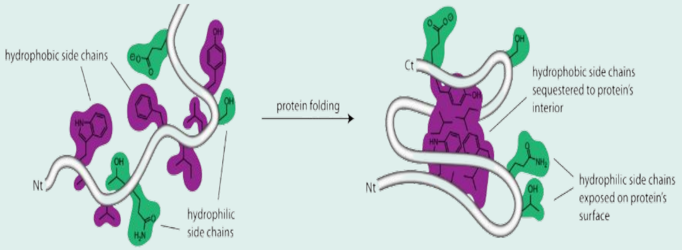
Acidic side chain:

-Aspartic acid
-Glutamic acid

1- Non-polar Amino acids:

Def: Each amino acid that does NOT: 1-bind 2-give off protons 3-participate in hydrogen and ionic bonds.. And they promote hydrophobic interactions.

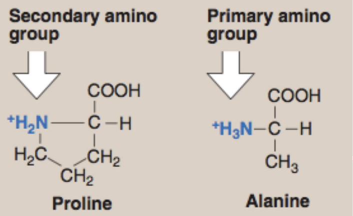
- Proteins found in hydrophilic environment (aqueous solution), the side chain (R) of the non-polar amino acids tend to cluster together and fill up the interior of the protein, which gives it its 3D shape.



TEAM442: Q- how many amino acids in the human body? We choose 19 Because proline is an imino acid.
If 19 is an option, otherwise 20

- Proteins located in hydrophobic environment, such as a membrane, the non-polar R-group are found on the surface interacting with the lipid environment to stabilize the protein.

- The structure of the proline amino acid differs from the other nonpolar amino acids that the side chain of proline and its α-amino group form a ring structure (an imino group).



Note: Each amino acid has α-carboxyl and a primary α-amino group (except for proline which is an imino acid that has a secondary amino group).

2- Uncharged Amino acids:

Def: Amino acids that have zero net charge at neutral PH.

*it has the potential to become charged if there is change in PH.

- The side chains of cysteine and tyrosine can lose a proton (H+) at an alkaline PH (high PH).
- Serine, threonine ,and tyrosine contain a polar hydroxyl group (OH) that can form hydrogen bonds.

-The side chains of asparagine and glutamine each contain a carbonyl group and an amide group. Both can participate in hydrogen bonds.

TEAM439: Histidine (pk~6) is a weak base and there for in neutral pH it carries a neutral charge, (zwitterion form).

3- Polar Amino acids:

- Amino acids that are charged and it has 2 types:

1- Amino acids with acidic side chains:

- Aspartic and glutamic acids are proton donors.
- At neutral PH, these amino acids are fully ionized (negatively charged), so they are called aspartate and glutamate.

2- Amino acids with basic side chains:

- Histidine, lysine ,and arginine are proton acceptors.
- At neutral PH, lysine and arginine are fully charged (positively charged).

Optical properties

Asymmetric
(optically active)

The **α-carbon** is attached to four **different** chemical groups, and They rotate the plane of polarized light in a polarimeter.

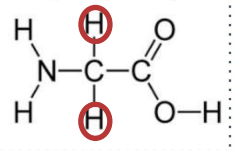
All mammalian amino acids are optically active except glycine.

Symmetric
(optically inactive)

The **α-carbon** is **not** attached to four **different** chemical groups

The only symmetric .amino acid is glycine

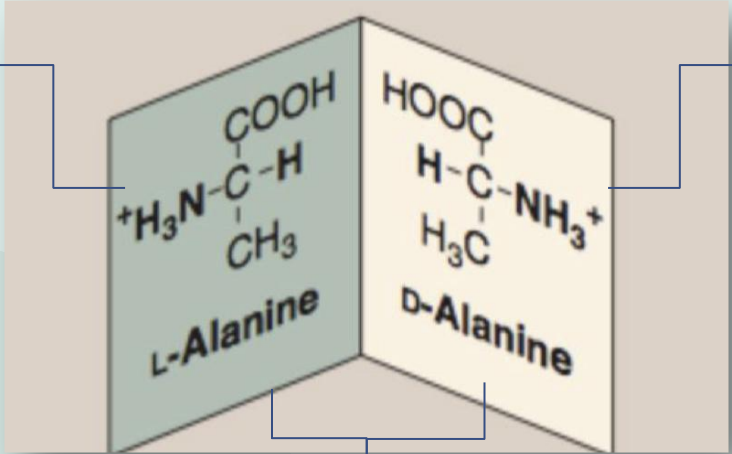
Glycine (symmetric)



Amino Acids Configuration

L-Amino acids: rotate polarized light to the Left.

- All mammalian amino acids are found in L-configuration.



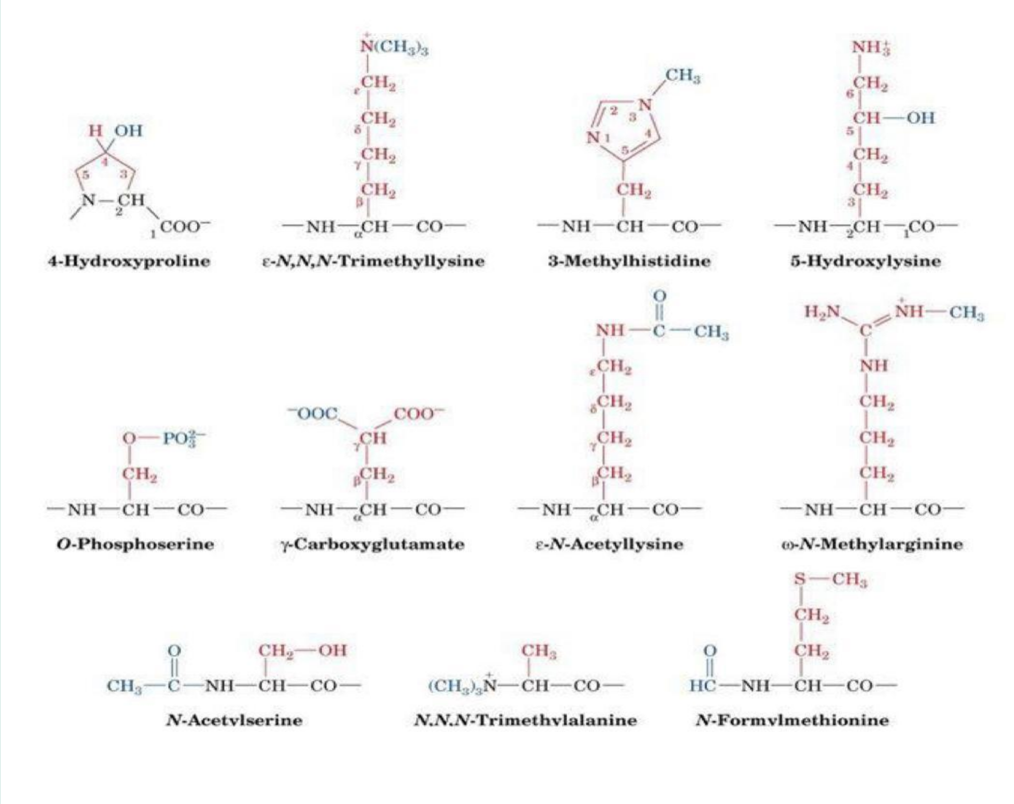
D-Amino acids: rotate polarized light to the Right.

- D-amino acids are found in antibiotics ,plants and in cell wall of microorganisms.

Both L and D forms are chemically the same.

Non-standard Amino Acids

- Apart from the 20 standard Amino Acids there are a vast number of Non-standard amino acids that are a modified version of the standard amino acid.
- **Exam question example: Which of the following is a modified or Non-standard amino acid? (MCQ)**
- **You don't have to memorize them if you know the standard Amino acid.**



Amino Acids Derivatives

- Neurotransmitters:

Gama amino butyric acid (GABA) → **Derived from** → Glutamic acid

Dopamine → **Derived from** → Tyrosine

-Important Thyroid Hormone:

Thyroxine → **Derived from** → Tyrosine

-Mediator for Allergic Reaction:

Histamine → **Derived from** → Histidine

Quizlet

Click here

Click here

Take Home Messages

- Each amino acid has an α-carboxyl and a primary α-amino group (except for proline, which is an imino acid).
- At physiological pH, the α-carboxyl is dissociated.
- Each amino acid also contains 20 distinctive side chains and the chemical nature of this side chain determines the function of the amino acid.
- All free amino acids and charged amino acids in peptide chains, can serve as buffers.
- Buffering action of proteins is maximum around pK values and minimum at isoelectric point.
- All mammalian amino acids are optically active except glycine.
- All mammalian amino acids are found in L-configuration.

Biochemistry Team

Yasser Almutairi

Alanoud Alnajawi

Lura Almusaeeb

Ahmad Addas

Hossam Alhussain

Faisal Alomran

Abdullah Alzoom

Abdulrahman Almalki

Ziyad Alenazi

Ziyad Bukhari

Tariq Alshumrani

Talal Alrobaian

Mohammed Almurshid

Essam Nawaf

Abdullah Almutlaq

Ghala Alyousef

Huda Bassam

Manar Alqahtani

Marwa Fal

Jenan Al-Sayari

Rahaf Aldawood

Mays Altokhais

Shaden Alotaibi

Aljawharah Alyahya

Norah Albahdal

Ghaida Alotaibi

Ghida Alkahtani

Lama Alhayan

Shaden Alshammari

Team Med444