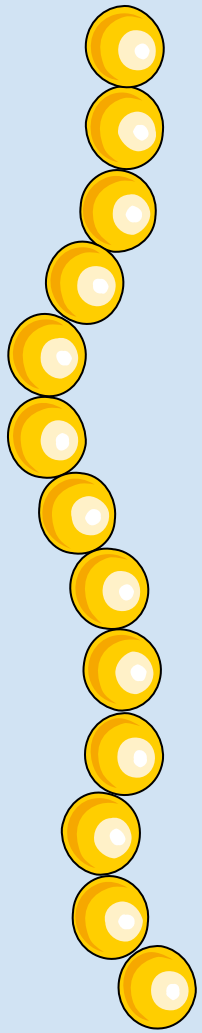

Amino Acids

MED441
KING SAUD UNIVERSITY

Revised & Reviewed by Abdulaziz & Bahammam Faye Wael Sendi

1
V1

Foundation Block - KSU

Color Index:

- Main text
- Important
- Notes
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- Girls slides'
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Editing File

Objectives

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

What are amino acids?

Amino acids are the chemical units that combine to form proteins.
Amino acids are a type of organic acids.

Amino acids that contain:

- Carboxyl group (COOH). (The functional group)
- Amino group (NH_2).

Amino acids plays central role as:

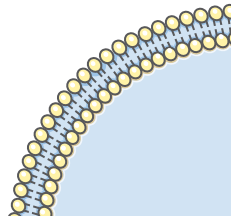
1. Building blocks of proteins.
2. Intermediates in metabolism.

There are 20 Amino acids

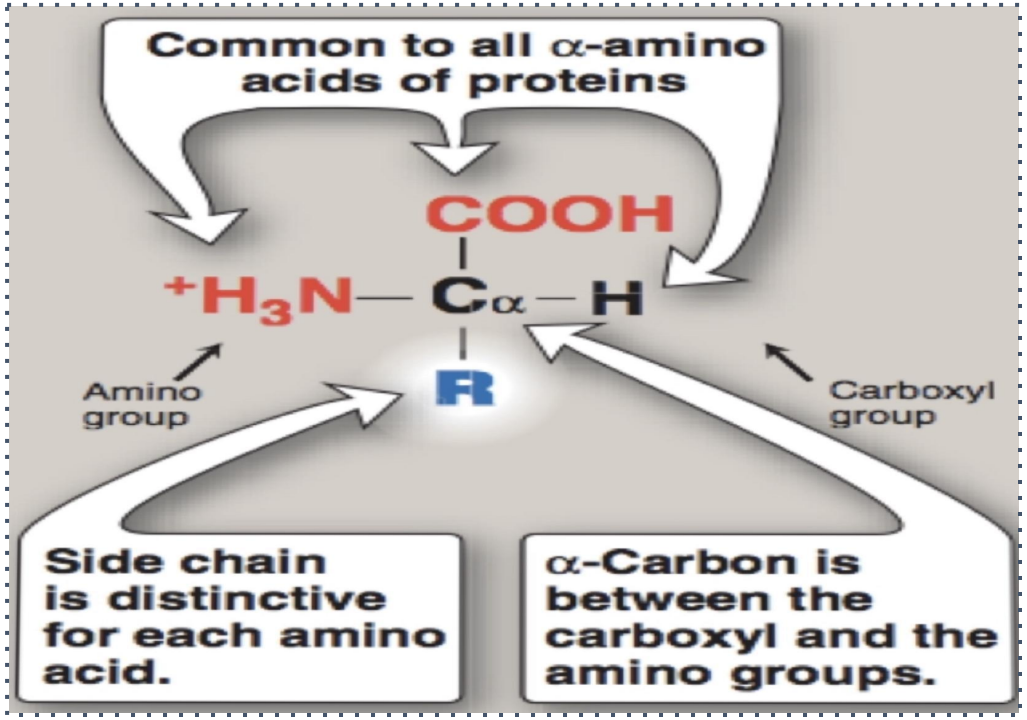
➢ Human can produce about half (11) of amino acids.
➢ The rest (9) must be supplied in the food.

- When proteins are digested or broken down, amino acids are left.

From 439: Amino acids are monomers to proteins. Amino acids join together to give each protein its own unique structure and function. (Not every protein contains all of the 20 amino acids).



General structure of amino acids



The components of amino acid include a:

01 **Hydrogen atom (H)**

02 **Carboxyl group (COOH)**

03 **Side chain (R)**
Distinctive in each amino acid, which gives the amino acid its unique structure and set of characteristics.

04 **Amino group (NH2)**

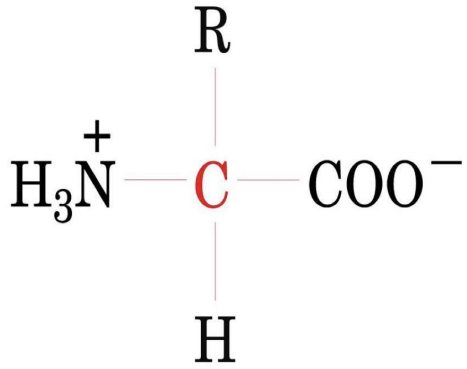
Primary Amino acid group (NH2) (except for proline which has a secondary amino group).

ALPHA CARBON: is between the carboxyl and the amino group.

Isoelectric point (Pi) and Zwitterion

Isoelectric point:

- The PH of the medium at which the molecule carries no net charge (neutral), and becomes a zwitterion.
- Each molecule has its own isoelectric point depending on the side chain (R).
- In acidic solution-cationic.
- In alkaline (basic) solution- anionic.



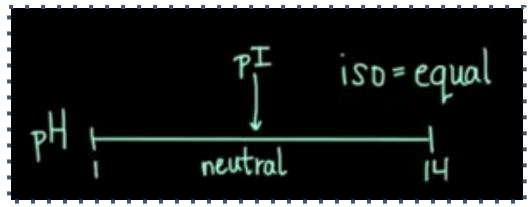
Structure of zwitterion

Net charge is zero on the molecule

Zwitterion:

- Is a neutral amino acid with both positive charge and negative charge so amino group has a positive charge (NH3 +) and the carboxyl group has a negative charge (COO-).
- The net charge=zero.
- NOTE :amino acid with an ionized (charged) R can not be zwitterion.
- The zwitterion is the usual form of amino acids exist in solution.According to the PH ,there are two other forms: anion,and cation.

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



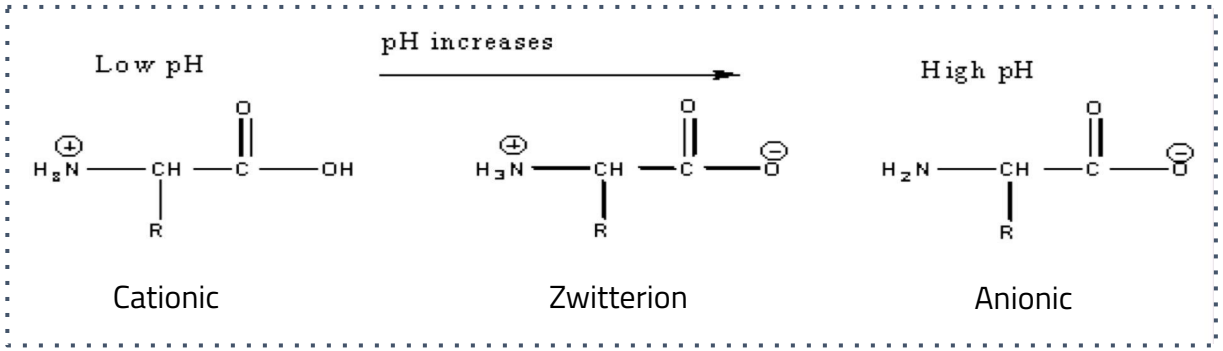
Isoelectric point (Pi) and Zwitterion Cont...

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

1- In an acidic solution: Acidic solutions have low pH. Becomes Cation.
2- In a basic solution: Basic solutions have high pH Becomes Anion.

MORE EXPLANATION IN THE TABLE

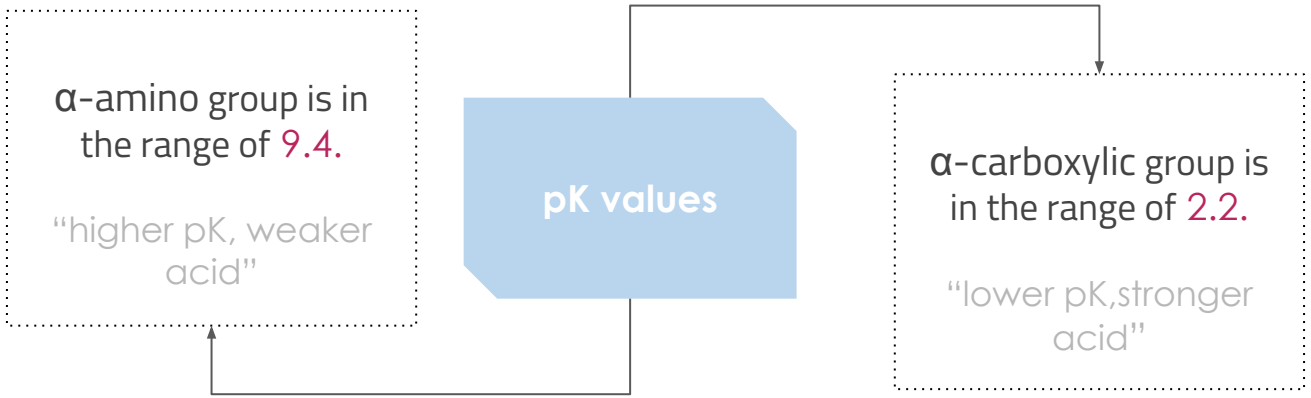
cationic:	**Zwitterion:**	**Anionic:**
Low Ph (high conc. of proton H+)	ph=Pi	High Ph (low conc. of proton H+)
Positively Charged	No net charge	Negatively Charged
explanation: The carboxylic acid will gain proton (Hydrogen atom), and lose its negative charge. The overall charge= +ve (Cationic)	**Zwitterion** 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 and titration curve of glycine

PK value:

- Also known as pKa or (acid dissociation constant)
- pKa let us know how strong or weak an acid is. **High pKa = Low acidity = Low conc of proton**
- The ability of an acid to donate a proton (dissociate)
- Amino acids with ionized R can not be zwitterions.



From (436) : carboxylic group is a stronger acids (with low pk value) than the amino group, so it will give off it's proton first (first pk value = 2.2) then the amino group (higher pk value) will donate afterward (second pk group = 9.4)

PK value and titration curve of glycine

Remember TEAM 38

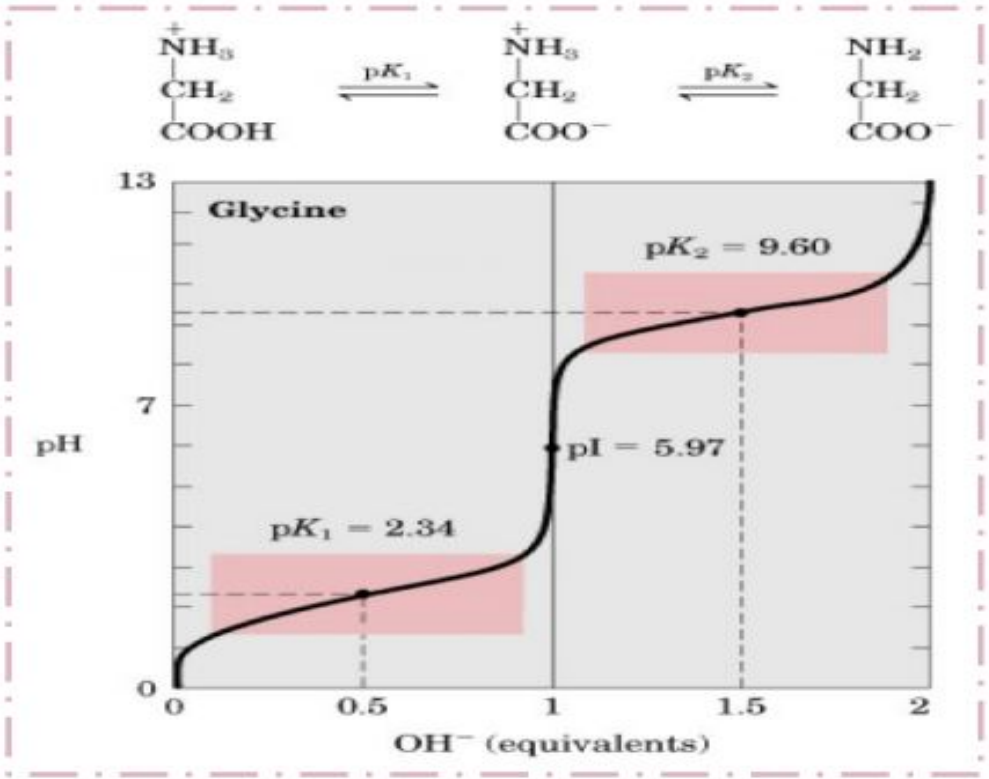
- Pk = measurement of the acidity of the GROUP
- Ph: measurement of the acidity of the SOLUTION
- When pk= ph the group starts donating hydrogen instead of the medium

Titration curve of glycine:

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

GRAPH EXPLANATION:

- **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, and becomes 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**.



Classification of amino acids:

Body requirements:

Essential amino acids: (cannot be made by the body).

((PVT TIM HLL))
بڤت تيم هال

-Phenylalanine -Valine
-Threonine
-Tryptophan
-Isoleucine -Methionine
-Histidine
-Leucine
-Lysine

Nonessential amino acids: (produced by the body).

((Glu Ala AsAs))
قلّه علی اساس

-Glutamic acid
-Alanine
-Aspartic acid
-Asparagine

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

((PGG CATS))
Sounds like (Big cat)

-Proline
-Glycine
-Glutamine
-Cysteine
-Arginine
-Tyrosine
-Serine

Properties of side chain (R):

Polar "**uncharged**"

((STC TAG))

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

Polar " **charged** "

Basic side chain:
-Histidine (week basic)
-Lysine
-Arginine

Acidic side chain:
-Glutamic acid
-Aspartic acid

Non-polar

PGAV PIL TM
(بجاف بيل تم) ولد عم بڤت تيم هال.

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

Non polar amino acids:

- Each amino acids does not bind or give off protons or participate in hydrogen or ionic bonds.
- These amino acids promote hydrophobic interaction.
- Non polar amino acids in proteins found in aqueous solution, the side chains of the non polar amino acids tend to **cluster** together in the interior of the protein.

Locations of **non polar** amino acids in proteins:

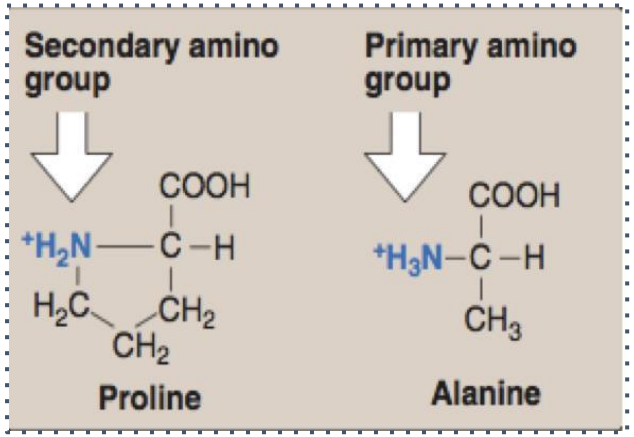
In proteins found in aqueous solution hydrophilic (polar environment)

The non polar R-groups fill up the interior of the folded protein and help give it its 3D shape.

In proteins located in hydrophobic environment (non polar), such as a membrane.

The non polar R-groups are found on the outside surface of the protein,interacting with lipid environment to stabilize protein structure.

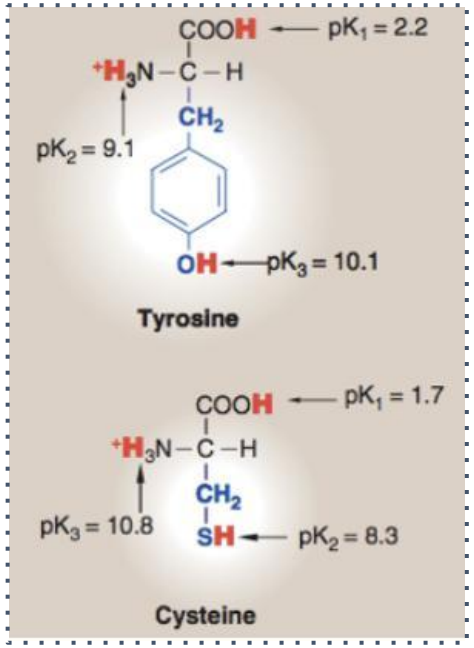
- The structure of proline amino acid differs from other non polar amino acids that the side chain of proline and its α-amino group form a ring structure (an imino group). So if we have a question says: how many amino acids in the human body? We choose **19** Because proline is an **i**mino acid. **If 19 is an option, otherwise 20.**
- All the amino acids have primary amino group, except proline has secondary amino group (an imino group).



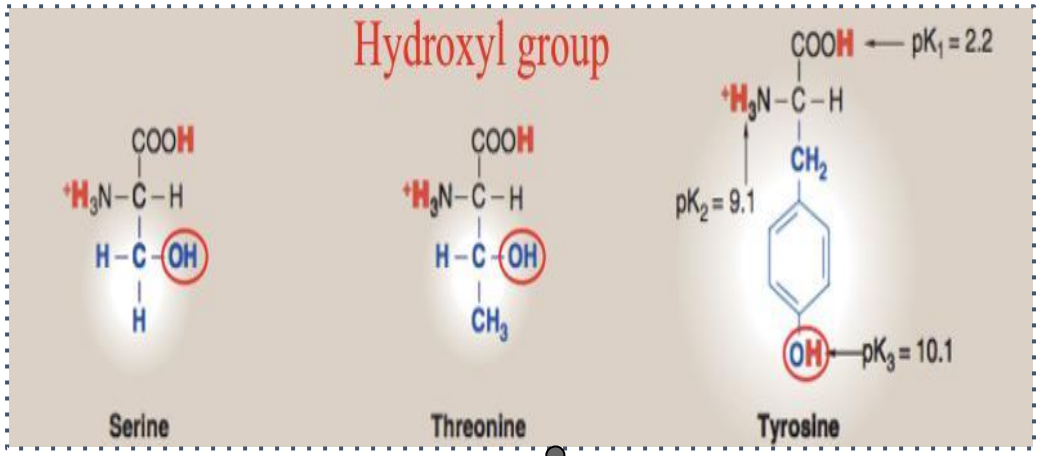
Uncharged amino acids:

- Uncharged amino acids=zero net charge at neutral PH.

  However:



1-The side chains of Cysteine and Tyrosine can lose a proton at an alkaline pH (high pH).

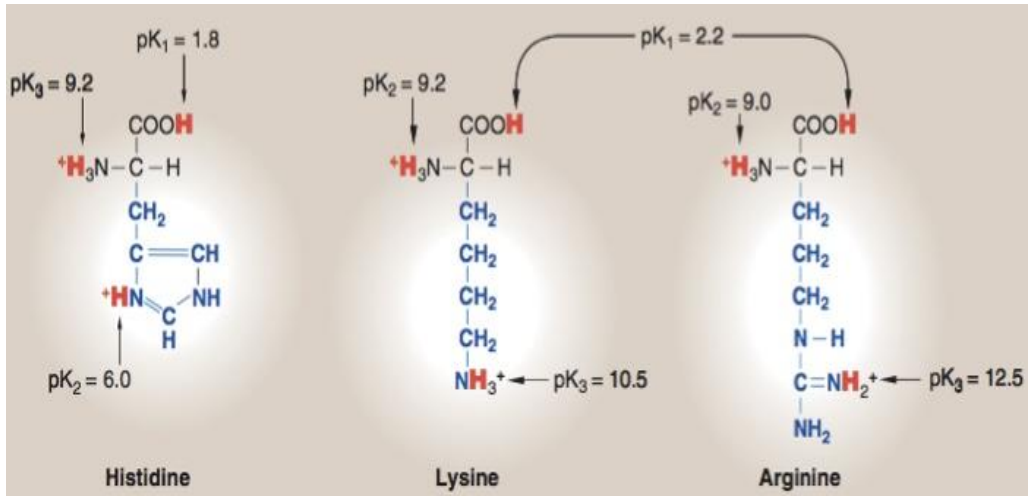


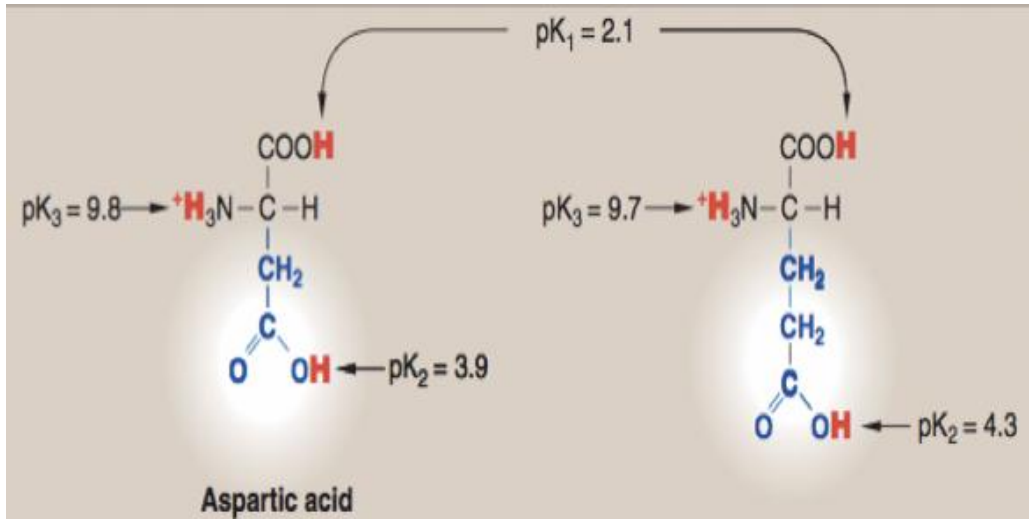
2- Serine, Threonine and Tyrosine each contain a polar hydroxyl group that can participate in hydrogen bond formation.

3- The side chains of Asparagine and Glutamine each contain a carbonyl group and an amide group,both of which can also participate in hydrogen bonds.

Polar (charged) amino acids:

Amino acids with acidic side chains:	Amino acids with basic side chains:
❖ **Aspartic** and **Glutamic** acids are proton **donors.** (حمض يمنح بروتون)	❖ **Histidine**,**Lysine** and **Arginine** are proton **acceptors.** (قاعدة تستقبل بروتون)
❖ At neutral pH, these amino acids are fully ionized (negatively charged). So, they are called aspartate and glutamate.	❖ At neutral pH, Lysine and Arginine are fully ionized (positively charged). ❖ MED439: Histidine (Pk around 6) is a weak base and therefore when fully ionized it carries a neutral charge, (Zwitterion form)





Optical properties:

Asymmetric:

Optically **active** amino acids.

The α-carbon is attached to four different chemical groups.

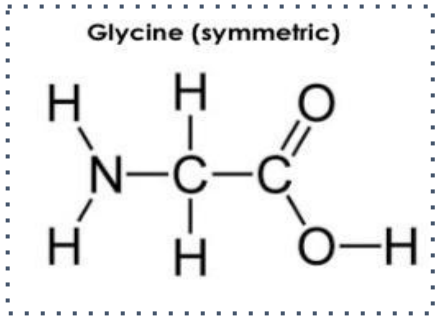
- e.g. All mammalian (الثدييات) amino acids are optically active except glycine.
- They rotate the plane of polarized light in a polarimeter.

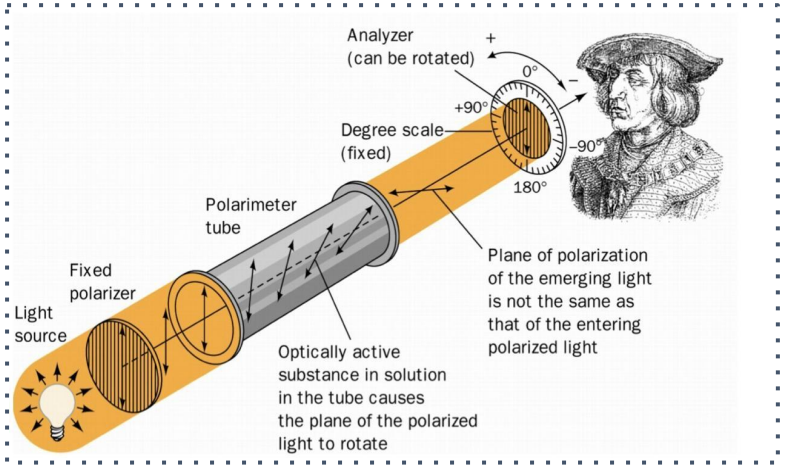
Symmetric:

Optically **inactive** amino acids

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

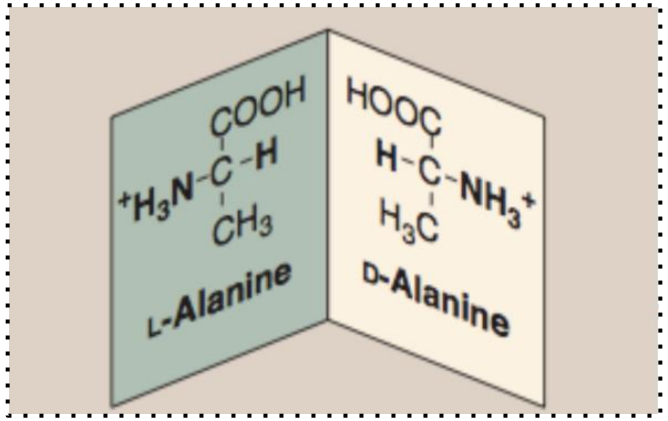
e.g. Glycine





Amino acids configuration:

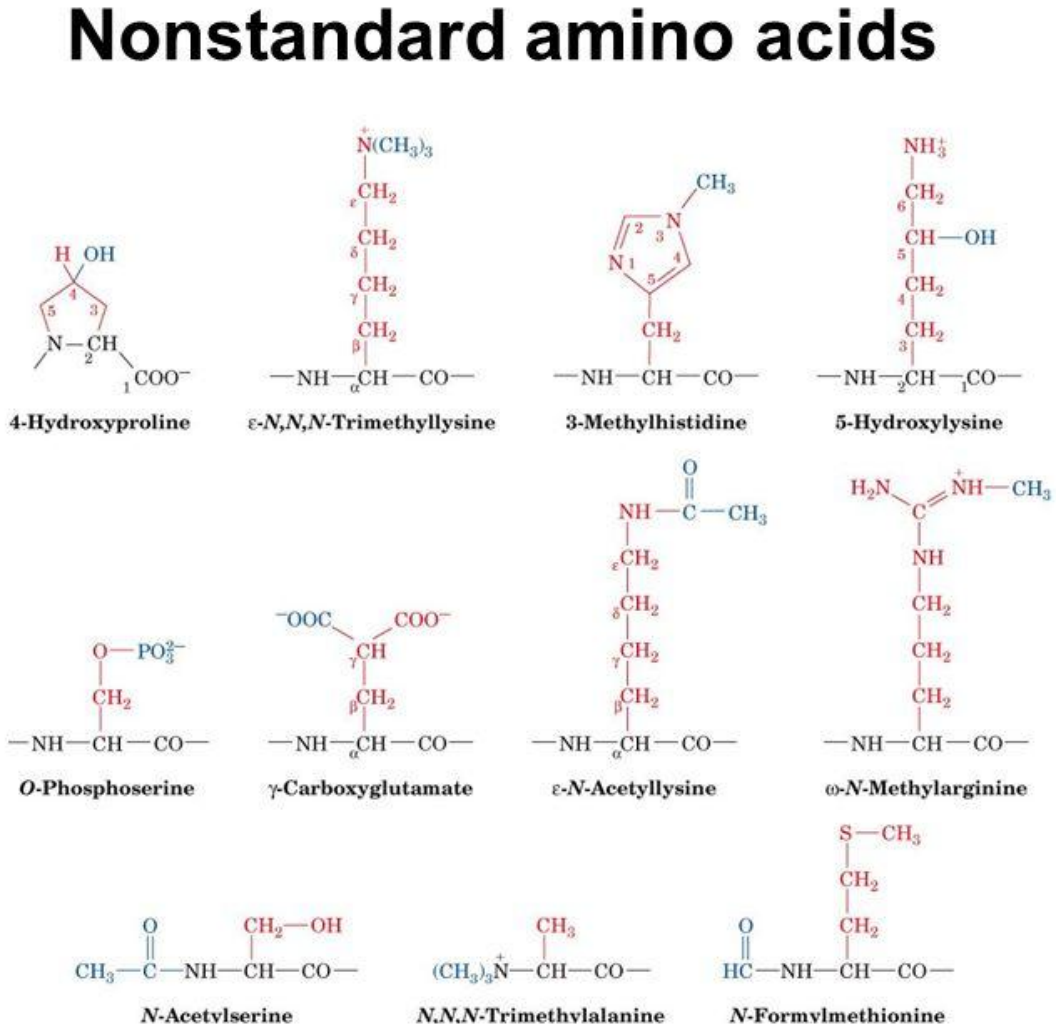
L-Amino acids:	D-Amino acids:
Rotate polarized light to the left.	Rotate polarized light to the right.
Both L and D forms are chemically same.	
All mammalian amino acids are found in L-configuration.	D-amino acids are found in antibiotics,plants and in cell wall of microorganisms.



Non-standard amino acids:

غير ال٢٠ (أو بالأصح ١٩) الأحماض الأمينية في غير ها زيادة تتكون من خلال التعديل على الاحماض الامينية الاساسية.

- Apart from the twenty standard amino acids, there are a vast number of "non-standard" amino acids.
- These nonstandard amino acids are usually formed through modifications to standard amino acids.



Amino acids derivatives:

Name:	Derivative of:	Role:
Dopamine	Tyrosine	Neurotransmitters
Thyroxine		An important thyroid hormone.
Histamine	Histidine	The mediator of allergic reactions
Gamma Amino Butyric Acid (GABA)	Glutamic acid	Neurotransmitters

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 and the α- amino group is protonated.
- All free amino acids and charged amino acids in peptide chains, can serve as buffers.
- Each amino acid also contains twenty distinctive side chains and the chemical nature of this side chain determines the function of the amino acid.
- 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

Quiz

Q1: Amino acids are building blocks of							
A	carbohydrates	B	nucleic acids	C	lipids	D	proteins
Q2:Positively charged basic amino acids are							
A	lysine and arginine	B	Lysine and asparagine	C	Glutamine and arginine	D	Lysine and glutamine
Q3: The Maximum buffering action is at							
A	Pk1	B	Pk2	C	A and B	D	Isoelectric point
Q4: Proline has a ……. amino group							
A	Primary	B	secondary	C	tertiary	D	quaternary
Q5: dopamine is a derivative from							
A	glutamic acid	B	Tyrosine	C	thyroxine	D	arginine

Answer Key: 1) D 2) A 3) C 4)B 5)B

Q6:Give examples of Acidic amino acids?

Q7: Enumerate the nonessential amino acids?

Q8:Amino acids with hydroxyl groups are?

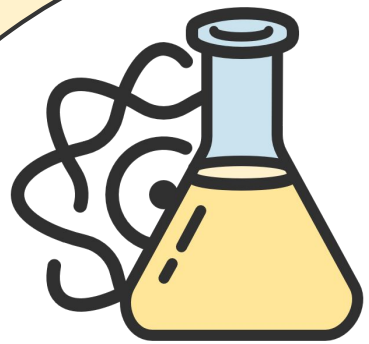
Answer:

Q6: Aspartate and glutamate

Q7: Glutamic acid and Alanine, Aspartic acid, Asparagine

Q8:serine,threonine,and tyrosine.

Revised & Reviewed by Abdulaziz & Bahamman Faye Wael Sendi



Biochemistry 441

Girls

Boys

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Reema Alrashedi
Wareef Almousa
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Fay Alluhaidan
Sarah Alhamlan
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