جامعة الملك سعود
King Saud University

MED437
KING SAUD UNIVERSITY

BIO TEAM

Amino Acids

Don’t forget who you are, there’s a rise after a fall

Don’t lose hope and don’t quit.

Color index:
Doctors slides
Notes and explanations
Extra information
highlights

437 Biochemistry Team

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?

The Chemical units that combine to form Proteins

A type of Organic Acid that contain both a Carboxyl group (COOH) and an Amino group (NH_2)

* Chemical units= Monomers

Amino acids play central roles:

- **The building blocks of proteins.**
- **As intermediates (وسيط) in metabolism.**

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

There are 20 Amino acids

- Human can produce half of amino acids.
- The others must be supplied in the food.

General structure of amino acids

A) Hydrogen atom (H)

C) Carboxylic acid group (COOH)

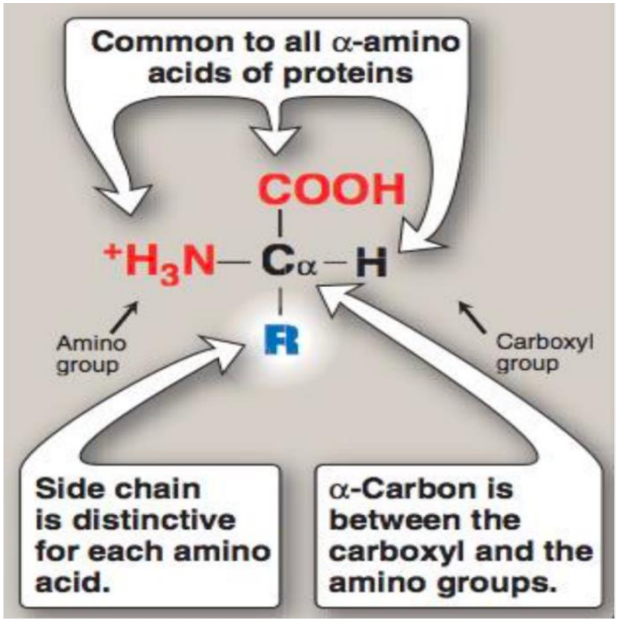
Alpha carbon that is attached to:

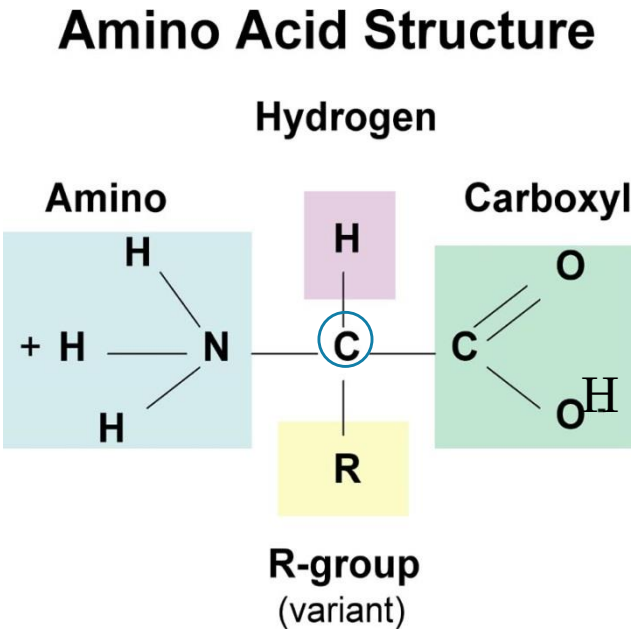
B) Side chain (R) (Which is distinctive for each amino acid and gives the amino acid a unique set of characteristics)

D) Primary Amino acid group NH_2

(except for Proline which has a secondary amino group).

Alpha Carbon: is between the Carboxyl and the Amino group.





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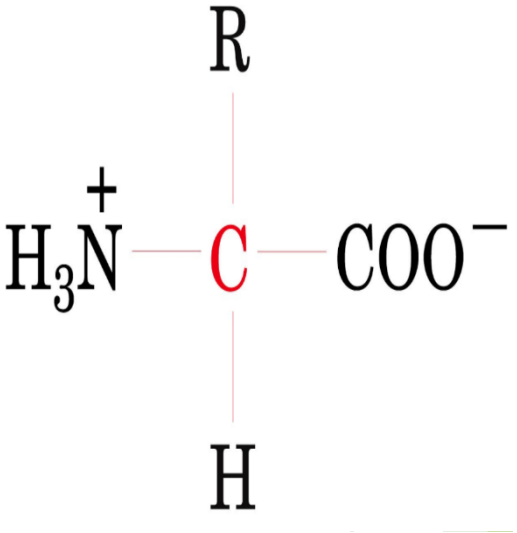
Isoelectric point (PI) and Zwitterion

➢ **Isoelectric Point (PI):**

Is the PH at which the molecule carries no net charge (neutral). (The sum of the positive charge equal the sum of the negative charge).

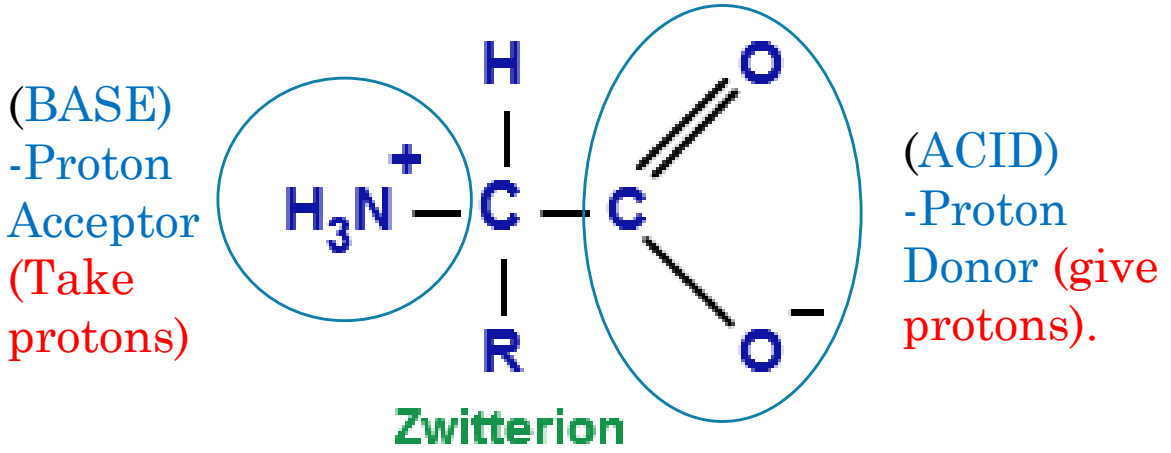


Zwitterion يعني ببساطة تصير في حالة

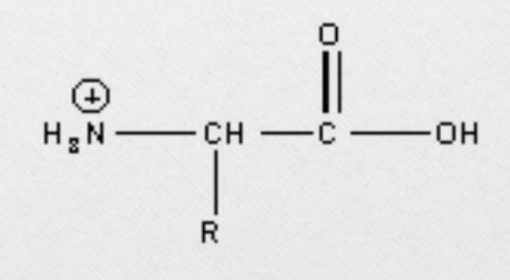
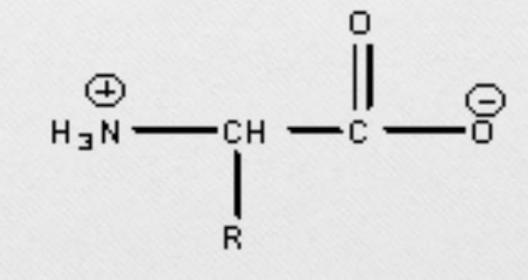
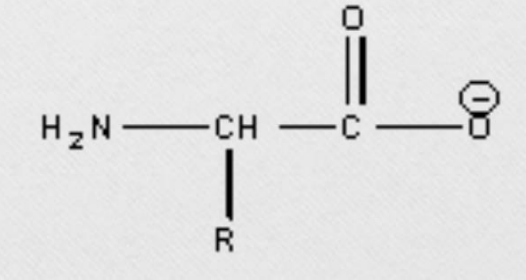
➢ **Zwitterion:**

Is a neutral Amino acid with both positive and negative electrical charges.

The sum of those charges must equal ZERO.



Zwitterions Simultaneously have both Cationic and Anionic states.

Cationic	Zwitterion	Anionic
Low PH	PH=PI	High PH
Positively charged	No net charge	Negatively Charged
When put in Acidic Solution	Isoelectric point	Alkaline Solution (Basic)
		

PH increasing (adding base)

The carboxylic acid will gain a proton (Hydrogen atom) and lose its negative charge. The overall charge on the molecule is now positive (Cationic).	**Zwitterion is used to describe the molecule. Isoelectric point is used to describe the PH level.**	**The amino group will lose a proton and lose its positive charge. The negative overall charge on the molecule is now (Anionic).**

pK Value:

also known as pka or acid dissociation constant

- It is the ability of an acid to donate a proton (dissociate). Dissociate=split into smaller atoms

  pKa let us know how strong or weak an acid is .

  lower pKa mean stronger acid (علاقة عكسية)

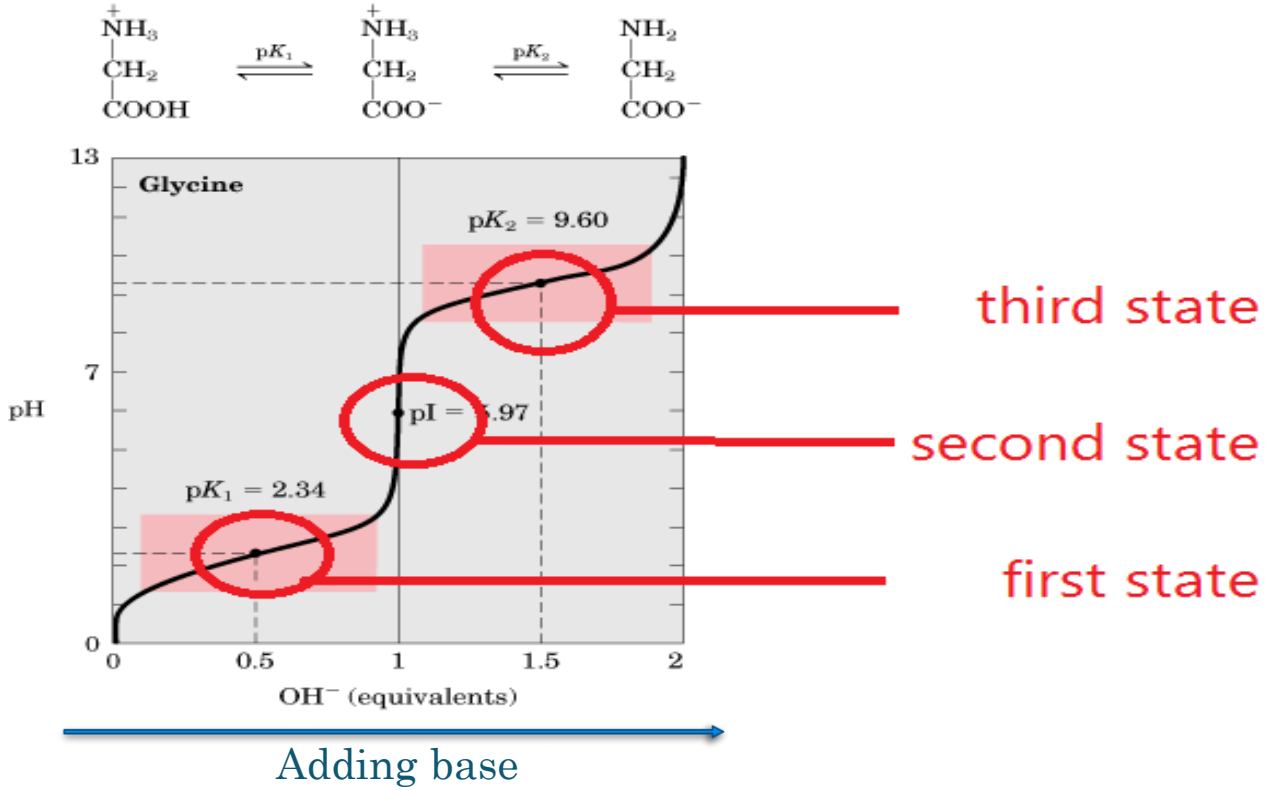
- The pK values of α-carboxylic group is in the range of 2.2. "low pK,stronger acid"

- The pK values of α-amino group is in the range of 9.4. "higher pK, weaker acid"

Dr. notes (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) .

Titration curve of glycine

Titration is the slow addition of one solution of a known concentration (called a titrant) to a known volume of another solution of unknown concentration until the reaction reaches neutralization
"تسمى المعايرة، وتستخدم عادة لمعرفة تركيز محلول حمضي معين غير معلوم تركيزه بإضافة محلول قاعدي آخر معلوم التركيز

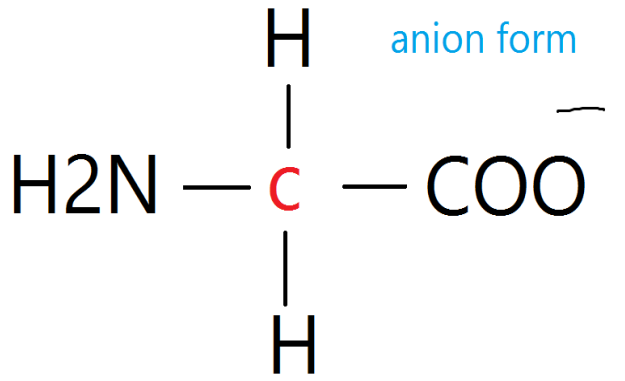


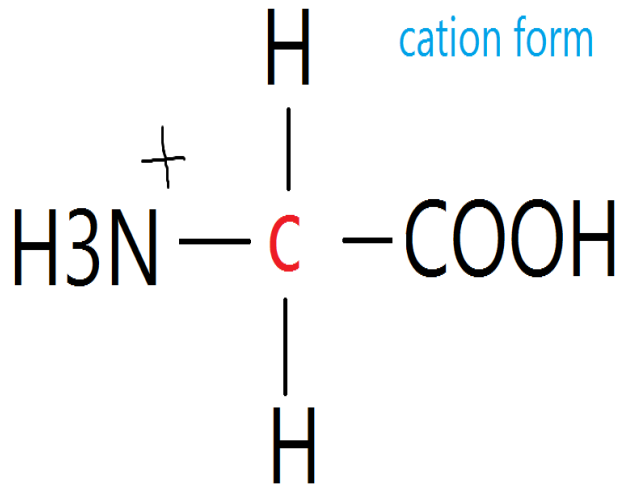
dr. notes (436) :
- zwitterion the amino acid itself that has no net charge.
- If the side chain contains an ionized group, in this case the amino acid is not a zwitterion.
- Buffer is a solution resists change in pH when an acid or base is added into it.
- At physiological pH,(7.3) the a-carboxyl and a- amino groups are dissociated.
- All free amino acids and charged amino acids in peptide chains,(protiens) can serve as buffers.

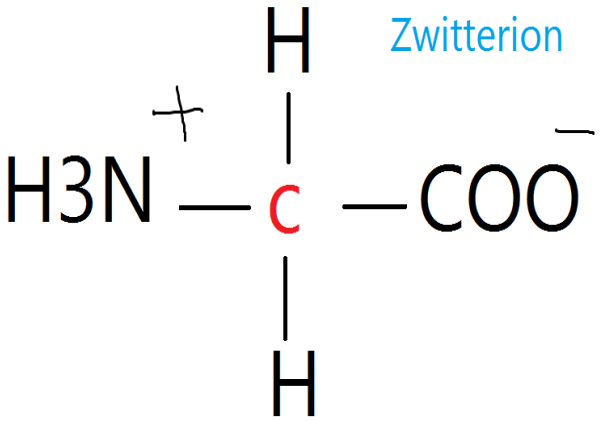
First state pK1 : pH=2.3
COOH group in glycine has lower pk then it will start donating its H first and become COO-
50% of the molecules are in cation form (net charge is positive)
And 50% are in zwitterion (net charge is zero)
the buffering will be at its max .

Second state PI : pH=5.9
All COOH groups donated their H
100% of the molecules zwitterion net charge is zero
the buffering will be at its minimum .

Third state pK2 : pH=9.6
At this level the ammonia group start donating its H and become NH2
50% of the molecules are in anionic form (net charge is negative)
And 50% are in zwitterion (net charge is zero)
the buffering will be at its max.







Classification Of Amino Acids

*أسماء
الاحماض تحفظ
مع تصنيفها*

1-Body requirement

essential

cannot be produced by the body

phenylalanine
Valine
Threonine
Tryptophan
Isoleucine
Methionine
Histidine
Leucine
lysine

PVT TIM HALL

non essential

produced by the body

Glutamic acid.
Alanine
Asparagine
Aspartic acid

Glu Ala AsAs
قله على اساس

conditional

not essential except in time of illness or stress

Proline
Glutamine
Glycine
Cysteine
Arginine
Tyrosine
Serine

PGG CATS
“Big cats”

2-properties of the side chain

Non-Polar

hydrophobic

Uncharged

Zero net charge at neutral pH

Polar

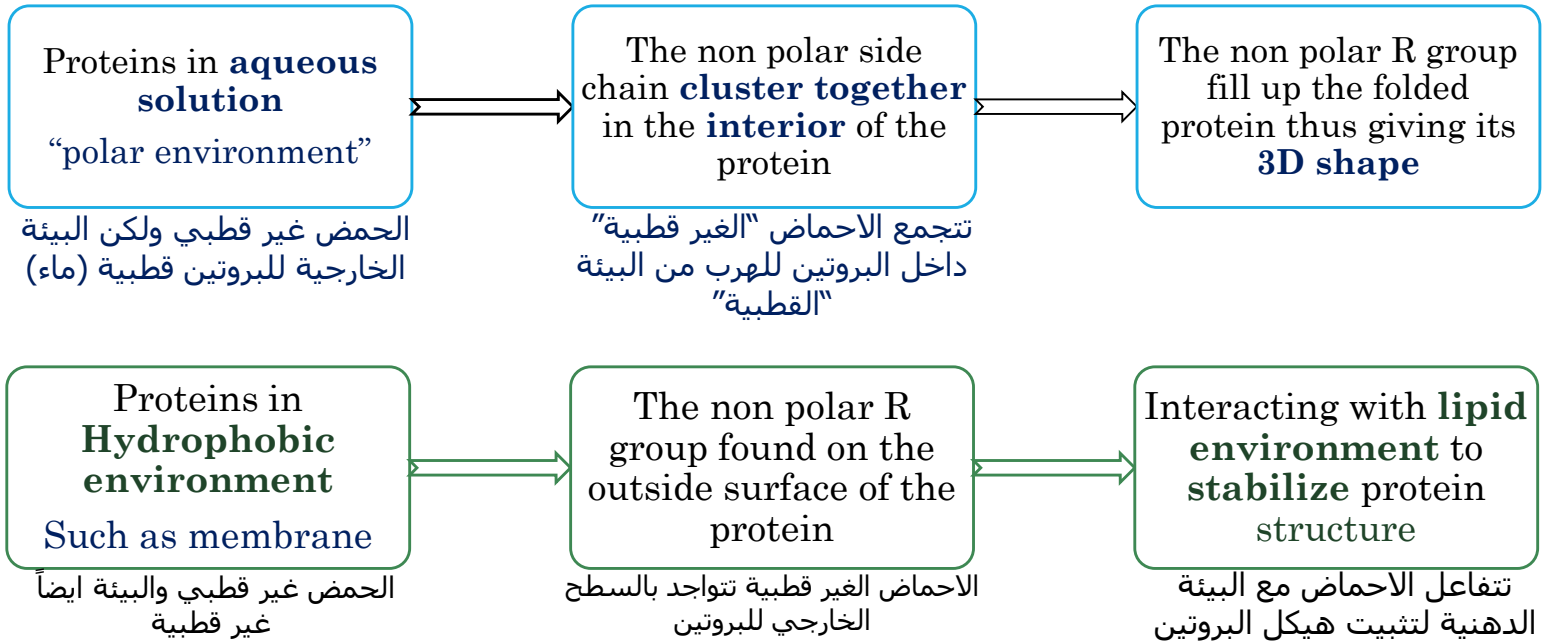
1-With acidic side chain

2-With basic side chain

Non Polar

- Each amino acid **does not bind** or **give off protons** or **participate in hydrogen or ionic bonds.**
- They promote **hydrophobic interactions**

LOCATION OF NON POLAR AMINO ACIDS IN PROTEINS :

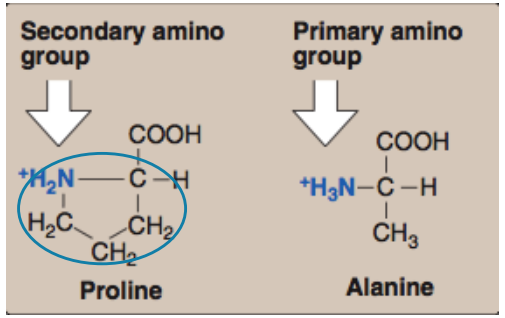


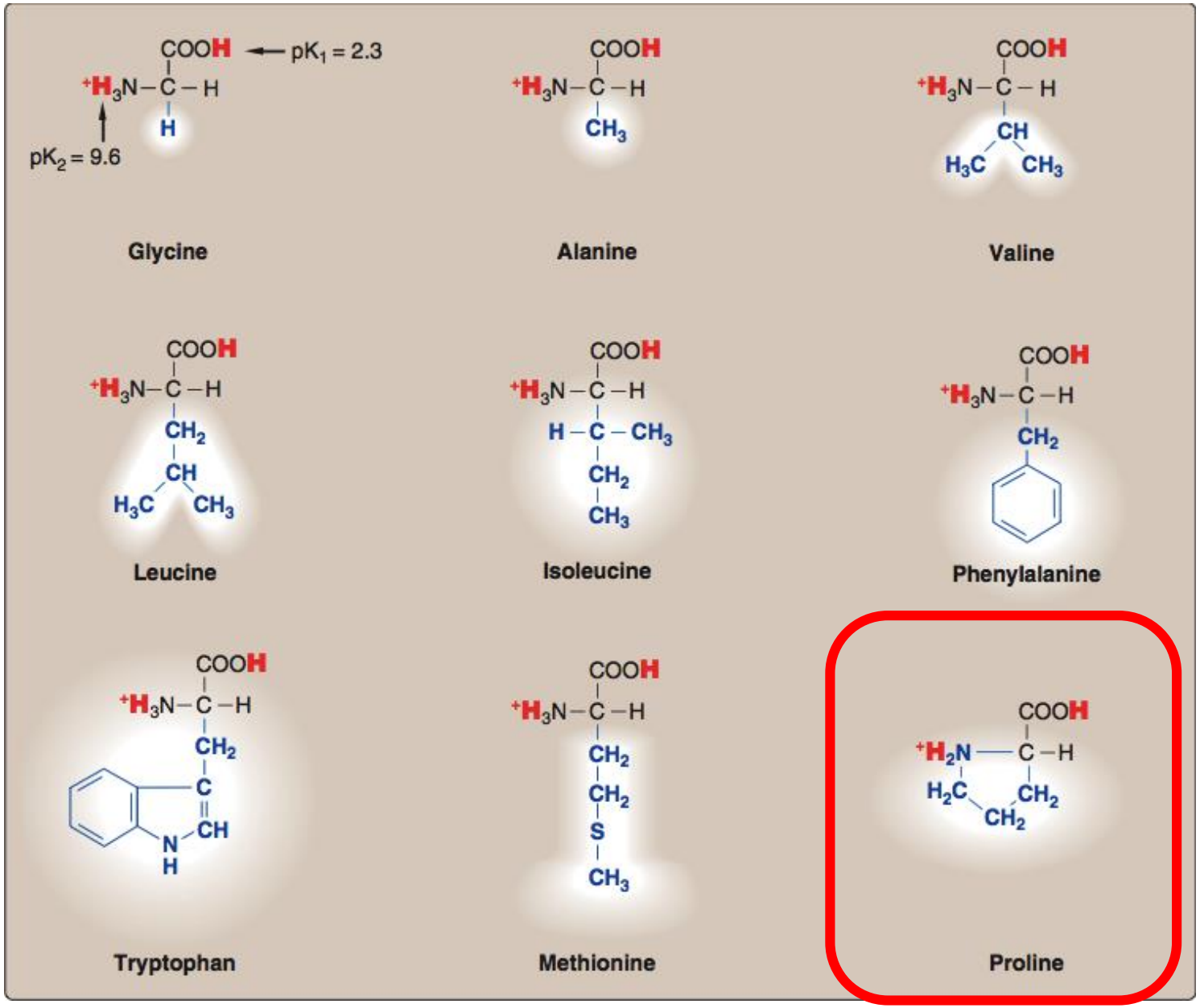
You don't need to memorize the structures

Non-polar Amino Acids:

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

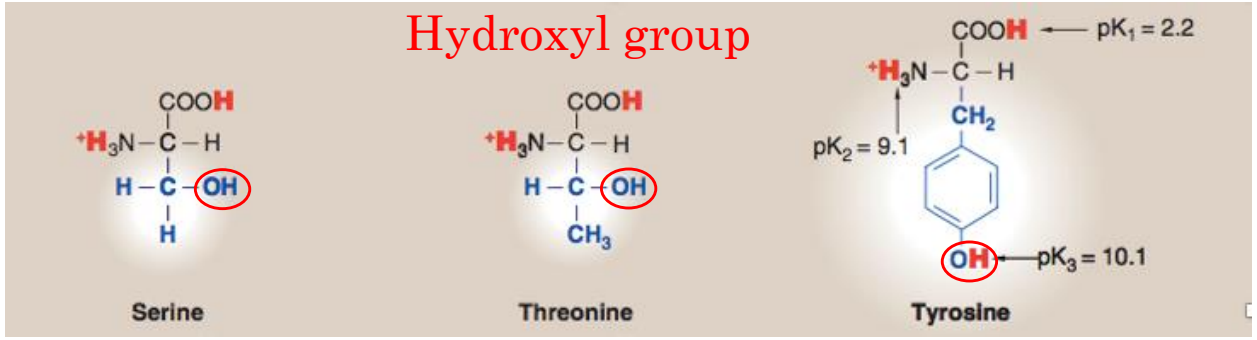
يختلف **البرولين** عن بقية الاحماض لان السلسلة الجانبية تكون حلقة مع مجموعة الأمين مما يجعل مجموعة الأمين "secondary"





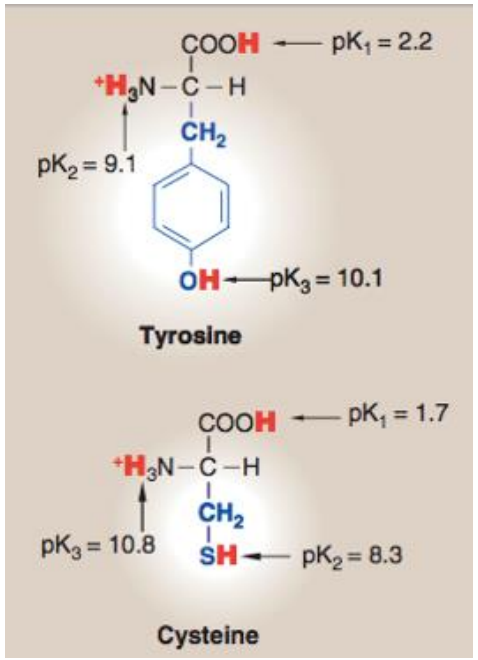
Uncharged amino acids: = zero net charge at neutral pH

HOWEVER:



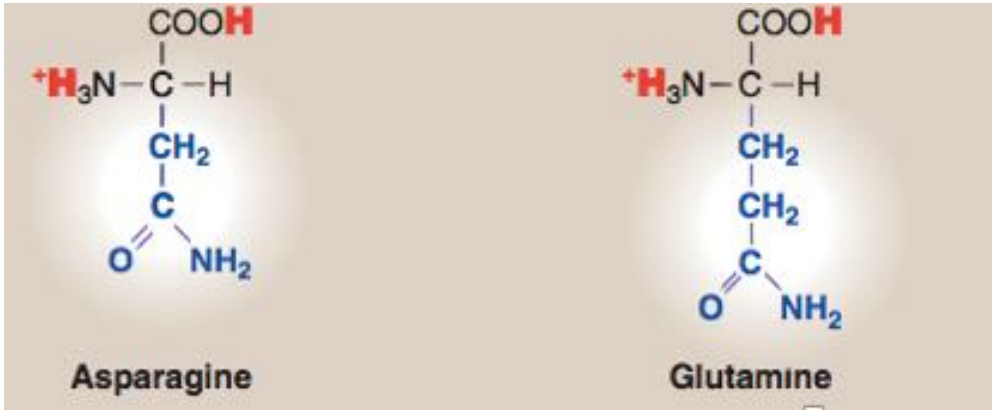
1- The side chains of **cysteine and tyrosine** can **lose** a proton **at an alkaline pH.** بي انش عالي >

البروتونات فيه قليلة فبالتالي هو يحاول يكسب بروتونات دايم



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

both can participate in hydrogen bonds.



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 amino acids

Amino acids with **acidic** side chains:

- Aspartic - glutamic acids

proton donors

At **neutral pH**, these amino acids are fully ionized **(negatively charged)**. So, they are called aspartate and glutamate.

Amino acids with **basic** side chains:

-Histidine -Lysine -Arginine

proton acceptors

At **neutral pH**, lysine and arginine are fully ionized **(positively charged).**

EXRA revision of amino acids and their classifications

ESSENTIAL

- phenylalanine
- Valine
- Threonine
- Tryptophan
- Isoleucine
- Methionine
- Histidine +
- Leucine
- lysine +

PVT TIM HLL

NON ESSENTIAL

- Glutamic acid.
- Alanine
- Asparagine
- Aspartic acid

GLU ALA ASAS

Negative (ate)

CONDITIOMAL

- Proline
- Glysien
- Glutamine
- Cysteine
- Arginine+
- Tyrosine
- Serine

PGG CATS

\+

Contain C=O and NH2- < make H bonds

Negative at an alkaline ph

Contain polar hydroxyl group = make hydrogen bonds

Non polar
Uncharged "zero net charge at neutral ph.
Polar

Optical properties

Optically Active amino acids

They rotate the plane of polarized light in a polarimeter

= asymmetric

= α-carbon attached to 4 different chemical groups

ثديات

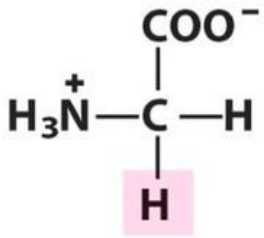
All mammalian amino acids **except Glycine**

Optically Inactive amino acids

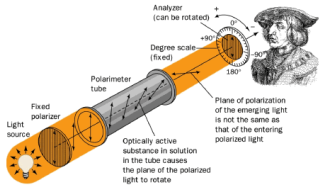
= symmetric

groups = α-carbon attached to less than 4

Only Glycine



* الكربون هنا متصل ب٣ مجموعات
3 < 4
فقط بالتالي هو symmetric



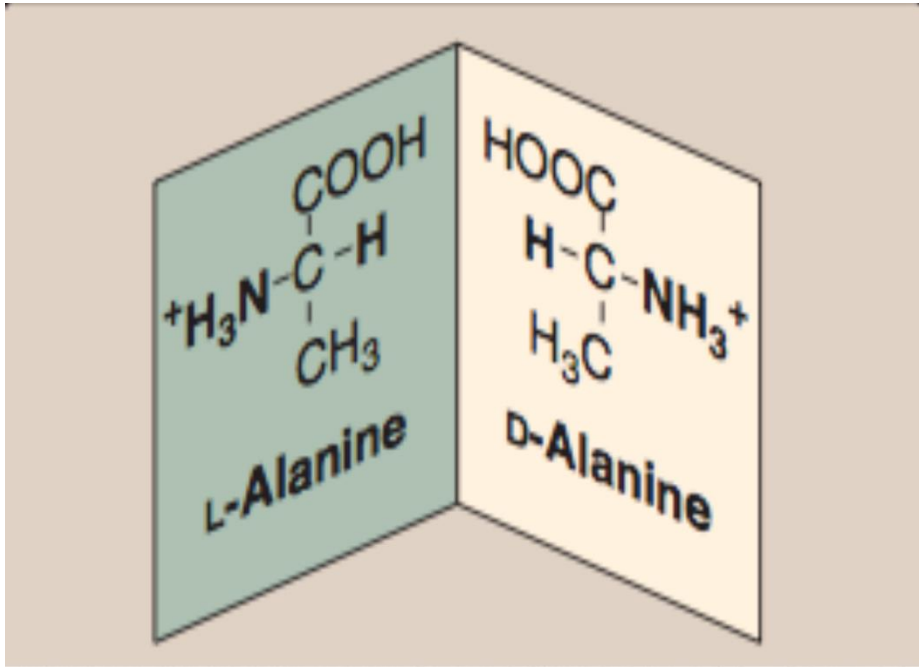
Schematic diagram of a polarimeter

مقياس الاستقطاب هو أداة علمية تستخدم لقياس مقدار دوران مستوى الضوء المستقطب عند مروره خلال عينة من المركب الذي به نشاط ضوئي.

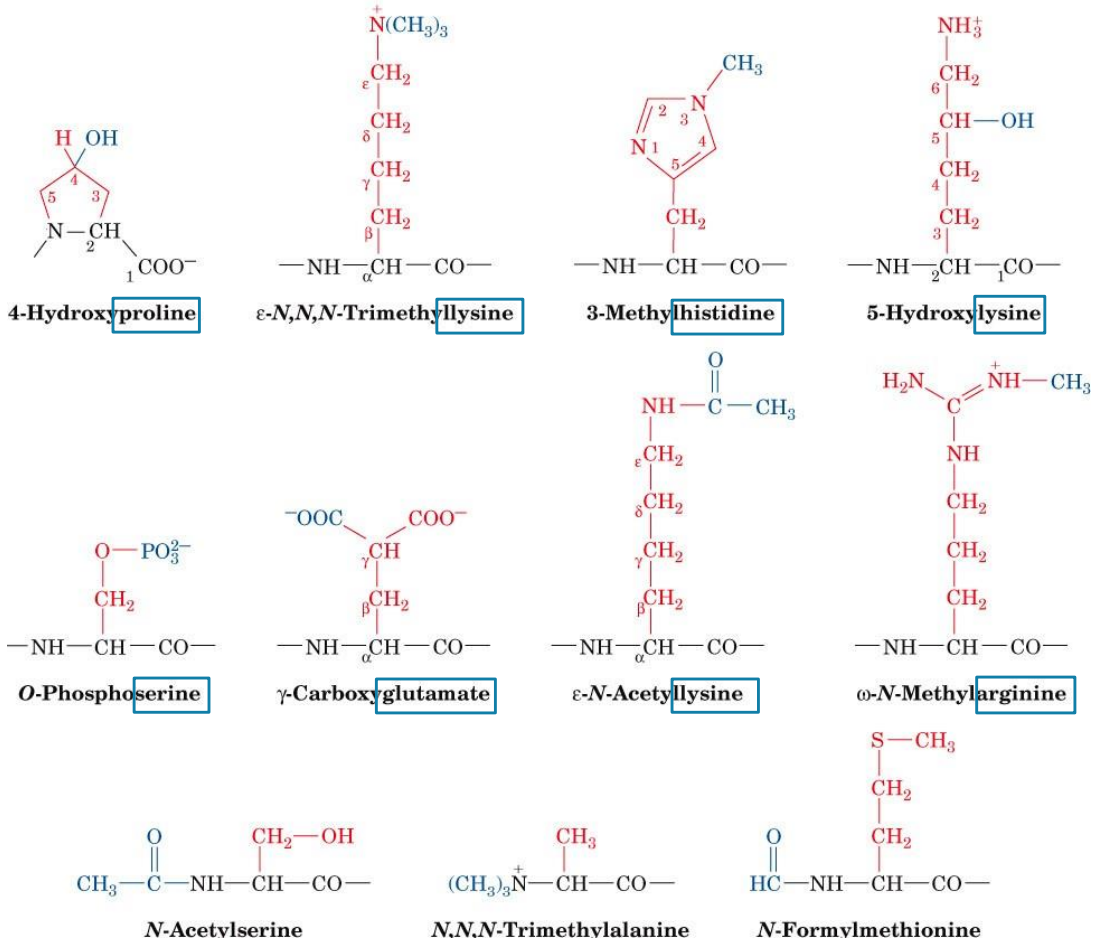
Optically active: they rotate the plane of polarized light in a (polarimeter).

Amino acid 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 the cell wall of microorganisms.



Non Standard Amino Acids:



*اسمائها غير مطلوبة، فقط اعرفي انها non standard

Aside from the twenty - standard amino acids, there are a vast number of "non-standard" .amino acids

زيادة على الاحماض العشرين الاساسية
فيه زيادة احماض غير اساسية

These nonstandard amino acids - are usually formed through modifications to standard amino acids.

تتكون هذي الاحماض من خلال تعديلات
على الاحماض الاساسية

مشتقات

Amino acids derivatives

Derivavtive of	name	Role
tyrosine	**dopamine**	neurotransmitters
	Thyroxine	an important thyroid hormone.
Histidine	histamine	The mediator وسيط of allergic reactions
Glutamic acid	Gamma amino butyric acid (GABA)	neurotransmitters

Mnemonics

- **Non-polar**
- ProGAV PIL TM

-proline, glycine, alanine, valine, phenylalanine, isoleucine, leucine, tryptophan, methionine

CHARGED
"**S**omeTimes Cats Try A Growl"
-serine, threonine, cysteine, ,tryrosine asparagine, glutamine

POLAR
"A Good Lawyer Aims High"
-Aspartate, Glutamate, Lysine, Arginine, Histidine

MCQs «اجتهاد شخصي و أرجو عدم الاعتماد عليها»

Amino acids are
a) building blocks of carbohydrates
b) building blocks of nucleic acids
c) building blocks of lipids
d) building blocks of proteins

2. Acidic amino acids include
a) Arginine and glutamate
b) Aspartate and asparagine
c) Aspartate and lysine
d) Aspartate and glutamate

3. Amino acids with hydroxyl groups are
a) serine and alanine
b) Alanine and valine
c) serine and threonine
d) Valine and isoleucine

.4Positively charged basic amino acids are
a) Lysine and arginine
b) Lysine and asparagine
c) Glutamine and arginine
d) Lysine and glutamine

GIRLS TEAM:

- الهنوف الجلعود
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- شهد الجبرين
- لينا الرحمة
- سارة البليهد
- ليلى الصباغ

BOYS TEAM:

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2- turkey al-bnhar

3- saeed alsarar

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Team leaders:
1- Mohammed hassa hakeem
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