Editing File

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Amino acids

Color index :

Main text

IMPORTANT

Extra Info

Drs Notes

Foundation Block - Biochemistry Team

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MED439

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 the amino acids ?

Amino acids are :

- **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

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).

In the human body, there are **20** amino acids

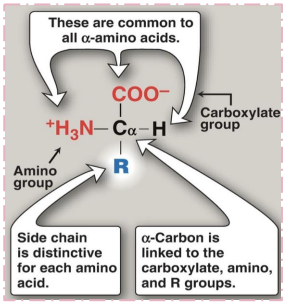
- Humans produce about half (11) of the amino acid.
- The rest (9) are supplied in food (human should obtain from diet).
- When proteins are digested or broken down, **amino acids** are left.

General structure of amino acids

Alpha carbon is attached to :

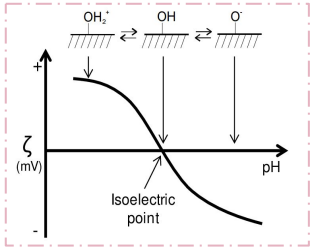
- Hydrogen atom (H)
- Side chain (R)
- Carboxylic acid (COOH)
- Primary Amino group (NH_2)

- R differs in each amino acid, which gives the amino acid its unique structure and set of characteristics.
- NH_2 : 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



A helpful video

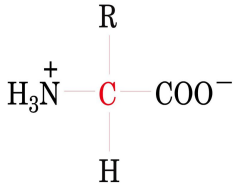
Isoelectric point (Pi)



Isoelectric point (PI) :

- The pH of the medium at which the molecule carries no net charge, and becomes a zwitterion.
- Each molecule has its own isoelectric point depending on the side chain (R).
- Isoelectric point is always in the zwitterion form

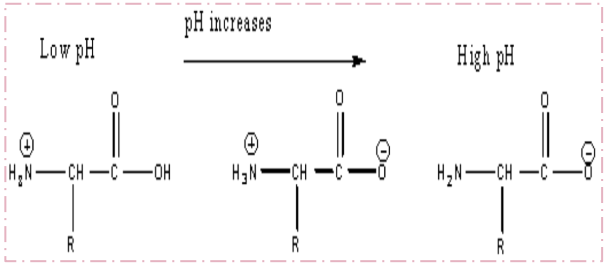
Zwitterion



Structure of zwitterion
Net charge is zero on the molecule

Zwitterion (neutral amino acid) :

- a molecule that has at least two functional groups: one having a **positive charge** (NH_3^+) and the other having a **negative charge** (COO^-), with an overall net charge of **zero**.
- Amino acids with ionized R can not be zwitterions.
- The (neutral) zwitterion is the usual form amino acids exist in solution. Depending on the pH, there are two other forms, an **anion** and a **cation**.



About the pic on the left

Zwitterion is used to describe the molecule. **Isoelectric** point is used to describe the pH level.

- In an acidic solution (low pH which means high conc. of H+): The carboxylic acid will gain a proton (Hydrogen atom) and lose its negative charge. The overall charge on the molecule is now positive. It becomes **cationic.** (+)

- In a basic solution (high pH which means low conc.of H+): The amino group will a give a proton and lose its positive charge. The overall charge on the molecule is now negative. It becomes **anionic** (-)

A helpful video

PK value

PK value: (acid dissociation constant) (pKa)

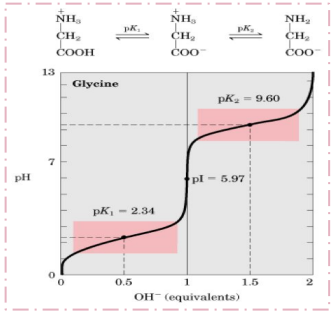
- The ability of an acid to donate a proton (**dissociate)**
- Amino acids with ionized R can not be zwitterions.
- pK and acidity have an **inverse relationship.** (high pK value = low acidity = low amount of protons)
- carboxylic group is a stronger acids (with low pk value) than the amino group, so it will give off its proton first (first pk value = 2.2) then the amino group (higher pk value) will donate afterward (second pk group = 9.4).

pK values

- a-carboxylic group is in the range of 2.2
- a-amino group is in the range of 9.4

★ Titration curve of glycine

- Titration: a technique where a solution of known concentration is used to determine the concentration of an unknown solution.
- Buffer: it is a solution that resists a change in pH when an acid or base is added to it.
  Ex: glycine (simplest amino acid).
  - Buffer action is max: high resistance to pH change
  - Buffer action is low: low resistance to pH change
- The **titration curve** on the right display what happens to **glycine** as you change the pH by adding OH (base).
- Pk = measurement of the acidity of the **GROUP** while pH= measurement of the acidity of the **SOLUTION**
- When pk= ph the group starts donating hydrogen instead of the medium
- The carboxyl group loses a proton first, then the amino group
- All free amino acids and charged amino acids in peptide chains can serve as buffers



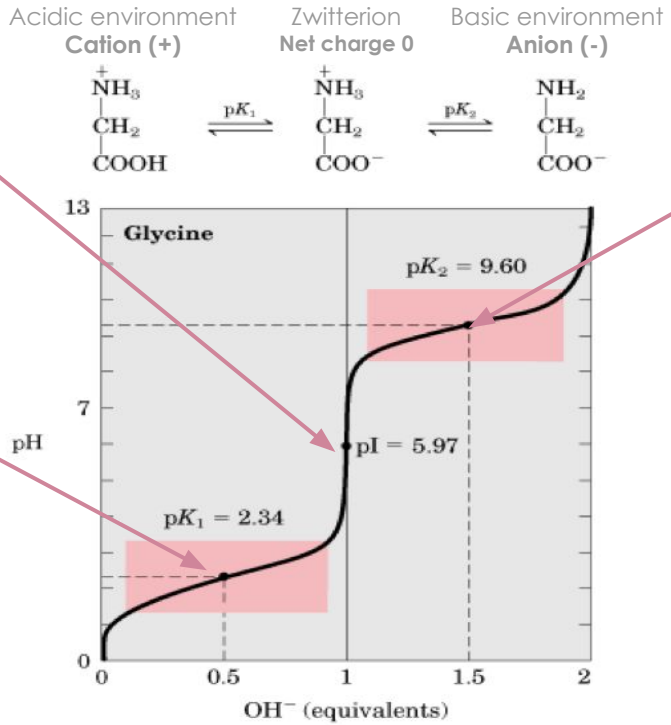
A helpful video

★ Important slide

Titration curve of glycine, contd..

Buffer capacity is low:
All COOH donate their H (protons) and become COO-. All of molecules are in **zwitterion form**.
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.**

PK_1 : Buffer capacity is max:
50% of molecules are in **cation (+) form** and 50% are in zwitterion form.



PK_2 :Buffer capacity is max:
50% of molecules are in **anion (-) form** and 50% are in zwitterion form.
The ammonia group starts donating protons, and becomes $NH_3 \rightarrow NH_2$. Zwitterions will lose a positive charge, & anions (-) are formed.

Buffering action of proteins is maximum around pK values and minimum at isoelectric point.

★ Important slide

Classification of amino acids

Properties of side chain

Polar "uncharged"

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

Polar " charged "

Basic side chain:
-Histidine -Lysine
-Arginine

Acidic side chain:
-Glutamic acid
-Aspartic acid

Non-polar

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

mnemonics about this part in the next slide

Body requirements

Essential Amino acids

Our bodies cannot make it therefore we obtain it in diets
-Phenyl Alanine
-Valine
-Threonine
-Tryptophan
-Isoleucine
-Methionine
-Histidine
-Leucine
-Lysine

PVT TIM HLL

بقّت تيم هال ، يقال انه اسم جندي

Non -essential Amino acids

Our bodies can produce it
-Glutamic acid
-Alanine
-Aspartic acid
-Asparagine

Glu Ala AsAs

قله على اساس

Conditional Amino acids

Our bodies can make it except in times of illness or stress
-Proline
-Glycine
-Glutamine
-Cysteine
-Arginine
-Tyrosine
-Serine

PGG CATS

Sounds like (Big cat)

★ Extra slide

Mnemonics

Non - polar	Polar "uncharged"	Polar "charged"
ProGAV PIL TM تخيلوها اسم جندي ثاني عاد Proline, Glycine, Alanine, Valine, Phenylalanine, Isoleucine, Leucine , Tryptophan, Methionine	SomeTimes Cats Try A Growl Serine, Threonine, Cysteine, Tryrosine , Asparagine, Glutamine	A Good Lawyer Aims High Aspartate, Glutamate, Lysine, Arginine, Histidine

Med435
The side chain of the nonpolar amino .acids tend to cluster together
*تشبيه لتسهيل التذكر:
زي لما نحط الزيت مع الماء مايختلطون مع بعض, لما نخلطهم راح ينزل شوي من الزيت تحت على شكل كتل .بعدين ترجع تتجمع مع بعض مثل اول

Non polar amino acids

Location of the nonpolar amino acids in proteins

In protein found in aqueous solution " hydrophilic " (**polar environment**)

- Interior of the protein
- The nonpolar R-group fill up the interior of the folded protein and help give it its 3D shape

Med435:
*تشبيه لتسهيل التذكر:
لما تكون ال non polar amino acids في الـ proteins اللي تتواجد بوسط ماني راح تكون خايفه من الماء لانها هي الوحيده الnon polar في هذاك المكان .. فتتجمع مع اخواتها non polar amino acids الباقيين ويتخبون ببيتهم الـ protein .. فيعطون البيت هيبته وشكله الثالثي الابعاد 3D.. .فهو بالنسبه للماء بيت اشباح

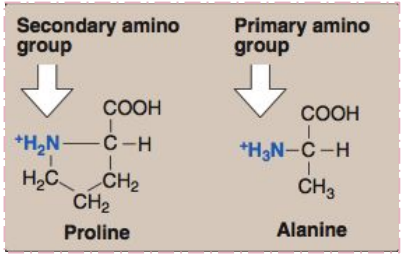
In protein located in hydrophobic region such as membrane (**non polar environment**)

- Outside surface of the Protein
- interacting with lipid environment to Stabilize protein structure

Med435:
*تشبيه لتسهيل التذكر
اذا كانت في وسط hydrophobic يعني كاره للماء رح تحس بالامان لان كل الاشياء اللي حولها مثلها كلهم non polar .. بتطلع للسطح وللعالم الخارجي ورح تشارك في تثبيت تركيب الـ protein .. لانها ماتبي ترجع للعالم المائي .

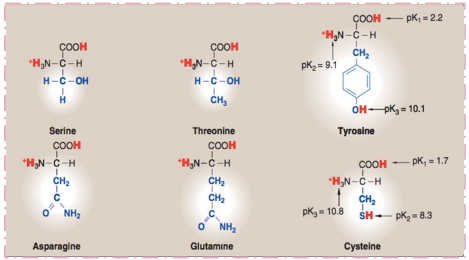
- The structure of the proline amino acid differs from other **nonpolar amino acids** that the side chain of proline and its α-amino group form a ring structure (an imino group).

*Keep in mind each amino acid has an **α**-carboxyl and a primary **α**-amino group (except for proline which is an imino acid)*



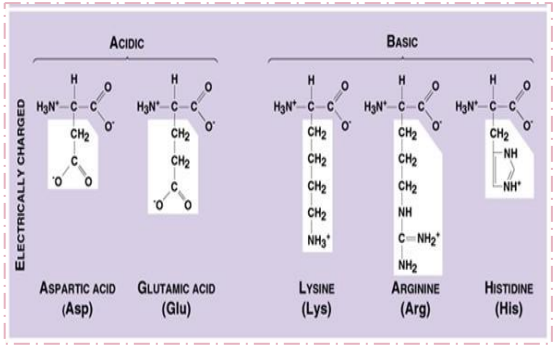
Uncharged amino acids

- These amino acids have zero net charge at **neutral pH.**
- At an alkaline PH chains of **cysteine** and **tyrosine** can lose a proton .
- Serine, Threonine and Tyrosine each contain a polar hydroxyl group that can participate in hydrogen bonds.
- The side chains of asparagine and glutamine each contain a carbonyl group and an amide group. both can participate as well.



Polar (charged)amino acids

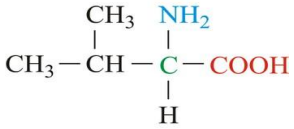
Amino acids with acidic side chains: they are ionic(charged).	Amino acids with basic side chains.
Aspartic and glutamic acids are proton donors. At neutral pH, these amino acids are fully ionized (negatively charged). So, they are called aspartate and glutamate.	Histidine, lysine and arginine are proton acceptors At neutral Ph, Lysine and Arginine are fully ionized (positively charged). Histidine (Pk around 6) is a weak base and therefore when fully ionized it carries a neutral charge, (Zwitterion form).



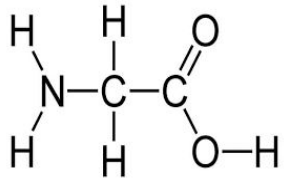
Optical properties

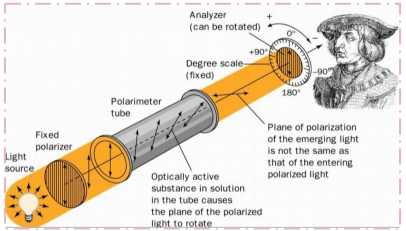
	Asymmetric	Symmetric
Definition	Asymmetric molecules rotate the plane of polarized light in a polarimeter	-
Attachment to α - carbon	The α-carbon of most of the amino acids is attached to four different chemical groups	They **Glycine** is an example of symmetric amino acids "α-carbon is not attached to 4 different groups"
The activity	- Asymmetric molecules are **active** - All mammalian amino acids are optically active**"except glycine"**	symmetric molecules are optically **inactive**

Valine (Asymmetric)



Glycine (symmetric)

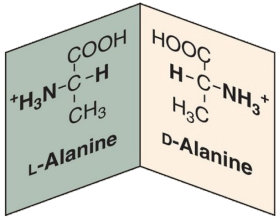




so All mammalian amino acids are optically active except glycine , and all mammalian amino acids are found in L-configuration

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-Configuration amino acids are found in antibiotics, plants and in the cell wall of microorganisms

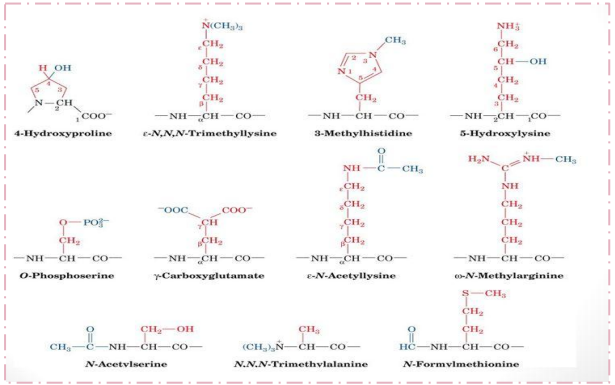


*Both L and D Amino Acids are chemically the same

Non standard amino acids

- 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.

Dr ; It is not necessary to memorize the names and the structures



Amino acids derivatives

	Gamma Aminobutyric Acid (GABA)	Dopamine	Thyroxine	Histamine
Derived from :	glutamic acid	Tyrosine		Histidine
Role	neurotransmitter		An important thyroid hormone	The mediator of allergic reactions

Review

		Essential	Non essential	Conditional
Non polar side chain		Isoleucine, Leucine, methionine, phenylalanine, tryptophan and valine.	alanine	Glycine, proline
Uncharged polar side chain		threonine	asparagine	Cysteine, glutamine, tyrosine and serine
Polar side chains	Acidic	——-	Aspartic acid, glutamic acid	——-
	Basic	Histidine, lysine	——-	arginine

Take home messages

- 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 : The Maximum buffering action is at:			
A) Pk_1	B) Pk_2	C) Isoelectric point	D) A and B
Q2 : Tyrosine is considered :			
A) Essential Amino Acid	B) Non-essential Amino Acid	C) Conditional Amino Acid	D) A hormone
Q3 : Which charge does Aspartic Acid carry when fully ionized ?			
A) Positive charge	B) Negative Charge	C) Neutral charge	D) A and D
Q4 : Arginine and Lysine are positively charged when fully ionized, what about histidine ?			
A) -ve charge	B) carries a neutral charge	C) +ve charge	D) none
Q5 : Proline has a ..... amino group ?			
A) Primary	B) secondary	C) tertiary	D) quaternary
Q6 : dopamine is a derivative from :			
A) Tyrosine	B) glutamic acid	C) thyroxine	D) arginine

SAQs :

Q1: The Structure of Proline differs from other non polar amino acids, explain how.

Q2: Enumerate the essential amino acids

★ **MCQs Answer key:**

1) D 2) C 3) B 4) B 5) B 6)A

★ **SAQs Answer key:**

1) The side chain and the alpha carbon of Proline form a ring structure with the amino group (the amino group is attached to two groups) hence it has a secondary amino group which makes Proline unique

2) Remember " PVT TIM HLL"
(PhenylAlanine , Valine , Threonine… etc)

Girls team:

Alia Zawawi
Nada Babilli
Rania Aqil
Reem alamri
Reema Alomar
Reem Alqahtani
Renad Alhumaidi
Shaden Alobaid
Noura Alsalem
Lama Alahmadi
Sadem Alhazmi
Somow Abdulrahman
Budoor Almubarak
Samar Almohammedi
Nuha Alkudsi
Norah Alsheikh
Muneerah Alssdhan
Mayasem Alhazmi
Noura alshathri
Duaa Alhumoudi

Boys team:

Mansour albawardi
Hassan alshuraf
Abdulrahman almbki
Mohammed alsayari
Abdullaziz alomar
Abdulaziz alrabiah
Saud alrasheed
Abdullah almazro
Hamad almousa
Ahmad alkhayat

The flower doesn't
dream of the bee , it
blossoms and
the bee comes.

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