

[Amino Acids 2]

~ Nutritional classification ~

(the classification based on nutrition and body requirement).

- 1- Essential amino acids. Essential → - يجب أن يحصلوا على كل من الغذاء اليومي
- 2- Non-essential amino acids
- 3- Conditionally essential amino acids.

1- Essential amino acids

♥ Cannot be produced by the body.

♥ Must be supplied through diet.

♥ 8 amino acids : Valine isoleucine leucine lysine

methionine phenylalanine threonine tryptophan.

2- Non-essential amino acids

♥ Can be synthesized by the body.

♥ 9 amino acids : Glycine alanine serine cysteine

aspartic acid glutamic acid asparagine glutamine proline.

3- Conditionally essential amino acids

■ Synthesized in the body in insufficient amounts so should be supplied in diet [requirements are higher than production rate].

■ Essential only in certain cases: children, pregnant, and lactating women.

[3 amino acids]

- Histidine
- arginine
- tyrosine

for example, [arginine and histidine] → growth promoting factors
 → during growth are not synthesized in sufficient amounts →
 So essential in growing children, pregnancy and lactation.

* histidine is essential amino acid in normal adult
 no, histidine is non-essential amino acid in normal adult
 * histidine is essential amino acid in pregnant
 yes

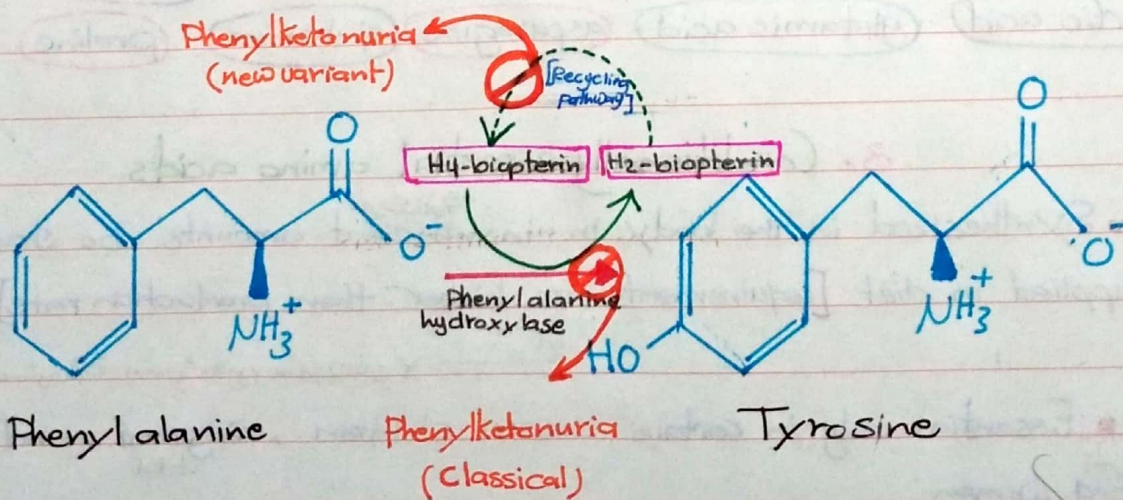
tyrosine is produced from phenylalanine (essential amino acid)

- If the diet is deficient in phenylalanine

- If an individual is deficient in an enzyme required to convert Phenylalanine to tyrosine.

[Phenylketonuria PKU: the inherited disease / inborn error of metabolism]

- tyrosine will be required as well.



مش مطلوب ولكن للتوضيح

- **Phenylketonuria [PKU]**: is toxic to brain and can lead to intellectual disability and mental disorders.

- [PKU] is an autosomal recessive disease

- The non-standard / non-proteinogenic amino acids

- not found in proteins

[e.g. carnitine and GABA].

lipid's transporter

- not produced directly by

standard cellular machinery

[e.g. hydroxyproline].

- Non-standard amino acids that are found in proteins are formed by post-translation modification. These modifications are often essential for the function or regulation of a protein

1. The **carboxylation** of **glutamate** occurring in proteins involved in blood-clotting cascade allows for better binding of calcium cations.

COOH / group

2. The **hydroxylation** of **proline** in collagen protein is critical for maintaining connective tissues.

3. The **phosphorylation** of an OH group on **serine**, **threonine** or **tyrosine** introduces a large group with a negative charge that can alter the activity of a protein or enzyme.

[Phosphate group] [phosphorylation] [Extra OH group] [negative charge] [Phosphate group] [Enzymes]

4. **Glycosylation** [addition of ^{sugar} sugar moieties] stabilizes protein conformation and direct selected proteins to various intracellular organelles [targeting process].

~ Non-protein functions ~

✓ are not found in protein. Ex include the neurotransmitter [gamma-aminobutyric acid] (GABA). ^{معدّل}

✓ occur as intermediates in the metabolic pathways for standard amino acids [e.g. ornithine and citrulline occur in the urea cycle which is part of amino acid catabolism].

* ornithine and citrulline are non-standard, non-proteinogenic with non-protein role.

✓ Many amino acids are used to synthesise other molecules called [amino acid derivatives], example

1. **Tryptophan** is a precursor of the neurotransmitter **serotonin**. ^{معدّل المادة}

2. **Tyrosine** is a precursor of the **thyroxine** [thyroid hormone] and the catecholamine neurotransmitters like dopamine, adrenaline and noradrenaline. ^{معدّل الغدة الدرقية}

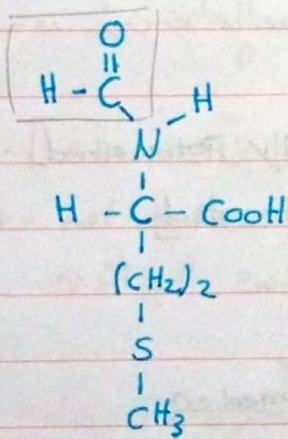
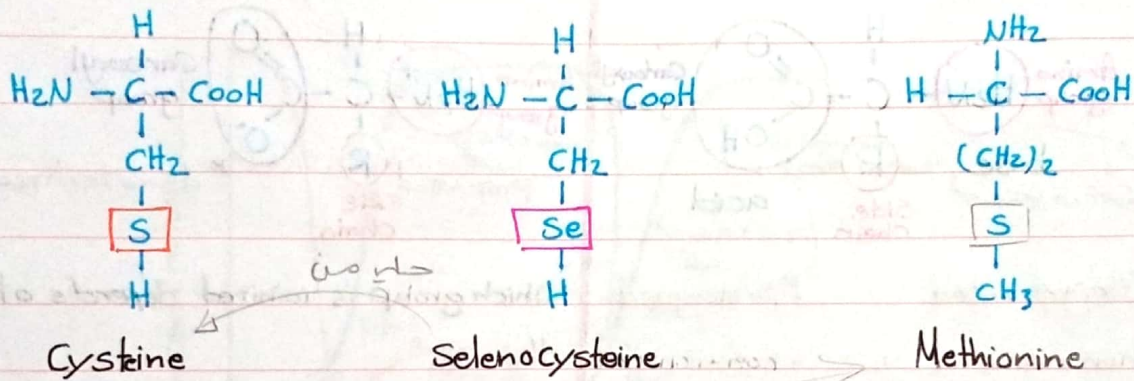
3. The local mediator **histamine** which is released during allergy is derived from the decarboxylation of **histidine**. ^{معدّل}

4. **γ -aminobutyric acid [GABA]** is the major inhibitory NT in brain. It is nonstandard amino acid derived from **glutamate**. ^{standard amino acid}

* Nonproteinogenic nonstandard amino acids are derivatives of standard amino acids How ?!

1. As intermediates during metabolism.
2. Post translational modification process.
3. Other enzymatic reactions.

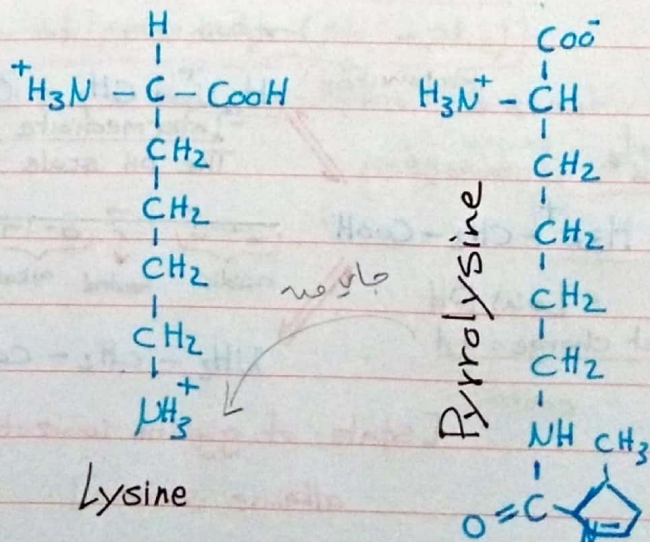
* Proteinogenic nonstandard amino acids are also derivatives of standard amino acids.



N-Formylmethionine
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Lysine V/s Pyrrolysine

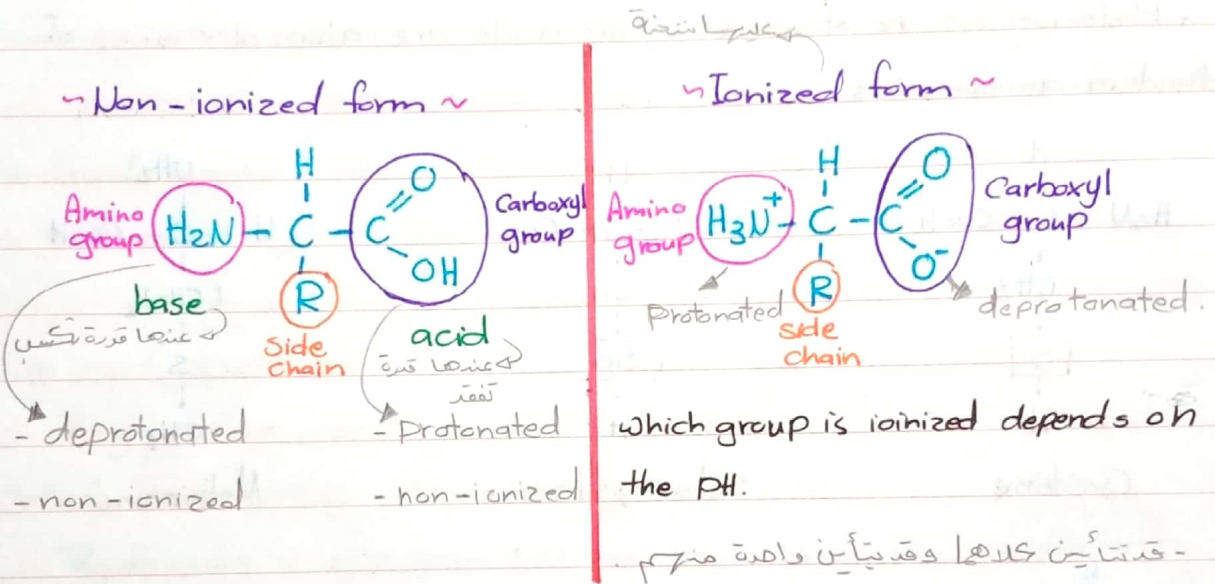
• Pyl is similar to Lys, but with an added Pyrroline ring linked the end of Lys side chain [stretching from NH₂ to NH].



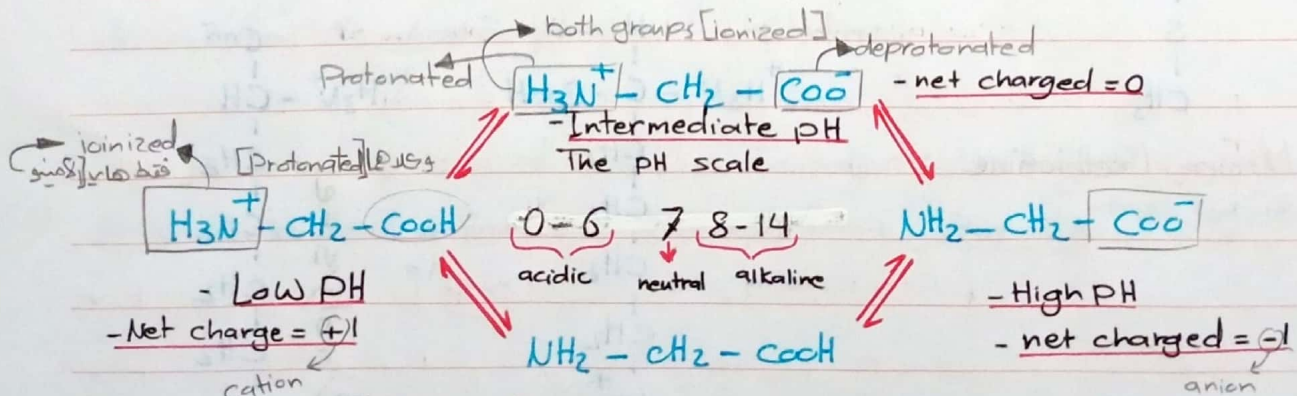
✓ Amino acids are amphoteric molecules [ampholytes] → duality
 having both → acidic $-COOH$ group
 ↳ basic $-NH_2$ group

↳ greek word [ἀμφότερος] → amphoteros

✓ α-amino acids are ionized in aqueous solutions with the ionization state is dependent on the pH value.

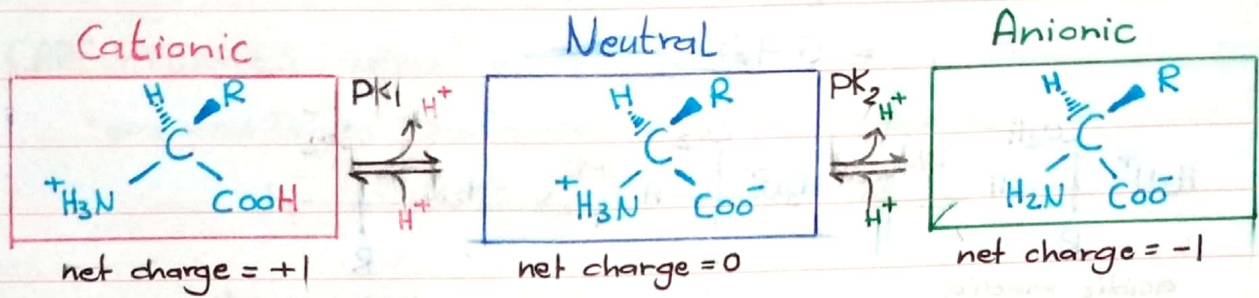


* At very [low pH] values, these groups are fully [Protonated] and at very [high pH] values, these groups are [deprotonated].
 At [intermediate pH], both are [ionized].



[State of glycine ionization of acidic and alkaline solution].

• Zwitterions [dipolar molecules] have charged $-NH_3^+$ and COO^- groups [both groups are ionized]. Zwitterion is neutral as it carries \oplus and \ominus charges.



① Isoelectric point is the pH at which a particular molecule carries no net electrical charge (overall charge = zero).

② At pI , zwitterion is the dominant form of the amino acids

$$pI = \text{average of } pK\text{'s} = \frac{1}{2} (pK_1 + pK_2)$$

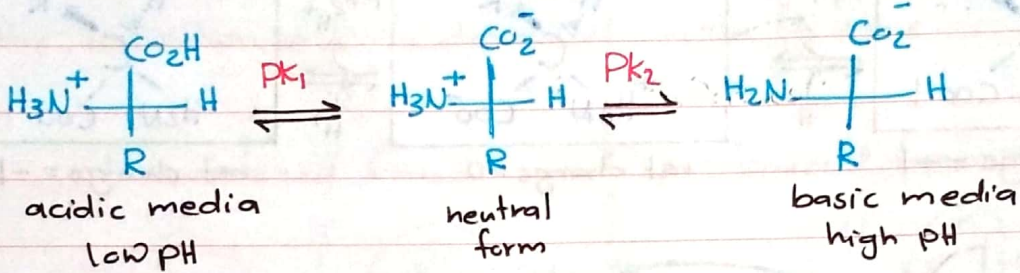
note: $pK = -\log [k]$ where k is the dissociation constant of a weak acid or base.

Ex. the simplest amino acid glycine has $pK_1 = 2.34$ and $pK_2 = 9.6$

$$pI = \frac{1}{2} (pK_1 + pK_2)$$

$$pI = \frac{1}{2} (2.34 + 9.6)$$

$$= 5.97$$



* باقي السليبات للذئب