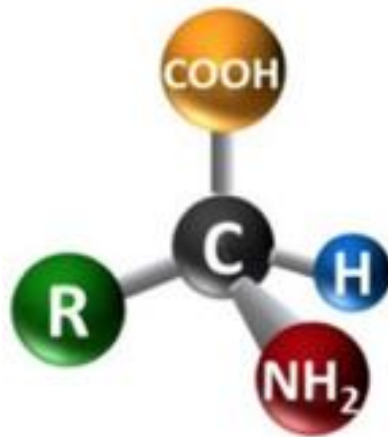




Amino Acids 2



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Nutritional Classification

- Standard amino acids are divided into three types according to the classification based on nutrition and body requirement:

صیغہ ایسا جاسیے

الاساسیہ
1. Essential amino acids

الطعام سے
2. Non-essential amino acids
ایسی بننے والی

3. Conditionally essential amino acids

نہ اس کا بننے سے بننے والی اور اس کے طور پر صیغہ بننے والی لیکن اس میں غیر ضروری
تغذیاتی اجزاء سے بننے والی اور اس کے طور پر صیغہ بننے والی اور اس کے
اور اس کے درمیان میں فتنی صیغہ بننے والی اور اس کے
essential کی جگہ پر بننے والی اور اس کے
non-essential (یعنی اس کے تحت شرط صیغہ)

Essential Amino Acids



- Cannot be produced by the body
- Must be supplied through diet
- 8 amino acids: valine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine and tryptophan

non-polar

هذه 8 من الأحماض الأمينية الأساسية

Non-essential Amino Acids



- Can be synthesized by the body
- 9 amino acids: Glycine, alanine, serine, cysteine, aspartic acid, glutamic acid, asparagine, glutamine and proline



Conditionally Essential Amino Acids

یا اصل سے *non essential* یعنی، بلکہ *مصنوع*

غیر کافی

میں طلبہ سے

- 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 and tyrosine. For example, arginine and histidine are growth promoting factors and during growth are not synthesized in sufficient amounts so essential in growing children, pregnancy and lactation.

مریضیا سے

تقریباً

کافی



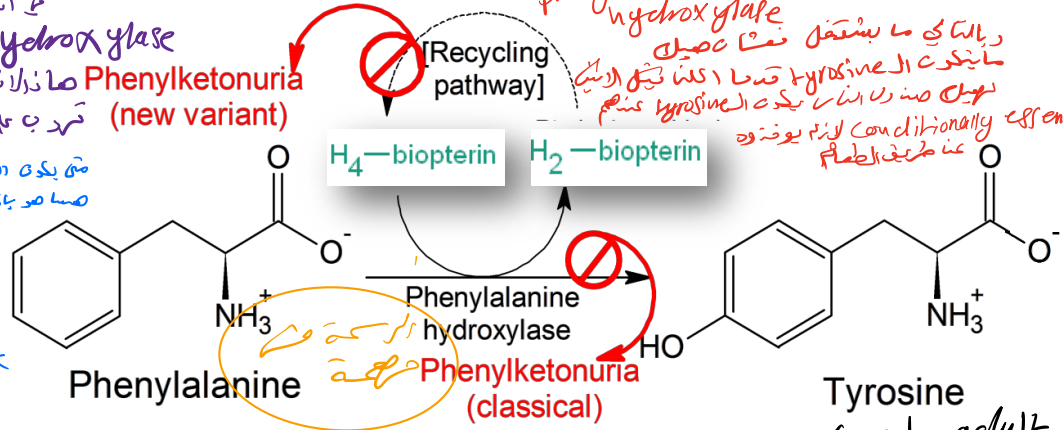
Conditionally Essential Amino Acids

- On the other hand, tyrosine is produced from phenylalanine (essential amino acid), so if the diet is deficient in phenylalanine or if an individual is congenitally deficient in an enzyme required to convert phenylalanine to tyrosine (the inherited/ inborn /congenital disease phenylketonuria PKU), tyrosine will be required as well.

على الاكل، لا غنى عن التي في حبيقتك الاكل
في التزام داخل الجسم
Phenylalanine hydroxylase
ما هذا التزام رضيعك المصدر ركيك
تدرب في الكلفة ربحولها ل Tyrosine

Essential Tyrosine
من يكون في Tyrosine
صحة هو بالذبح الطبيعي
non-essential
لا يكون essential في حالات
- لا يكون الطعام فيه
بالفعل الاكل (يعني متناولة)
في حالة كالتالي منه
- عند النساء التي عندهم مرض دراني
pku فيكون Tyrosine

سبب كل في التزام Phenylalanine hydroxylase
ربالتي ما يستعمل تحت عصيل
ما يكون Tyrosine قدام اكلنا في الازمنة
نويل منه اننا يكون Tyrosine عندهم
Conditionally essential
لازم يوفرو
عن طريق الطعام



inherited disease → وراثة ينتقل به الوراثة
inborn disease → وراثي في الولادة
congenital disease → مرضه يتولد معناه

in normal adult Tyrosine is non essential
لا يلزم رضيعه
ما يقدر رضيعه في حالة نقص يكون عن pku



Phenylketonuria

- The accumulated phenylalanine is toxic to brain and can lead to intellectual disability and mental disorders.

الحكومة
بجملہ نوجوانوں
کے لفظ لارڈا ما بولڈو
کے آر بیج امراض وراثیہ
میں سے PHU
کے لئے نیکو لہذا
وما سٹا خیر عیالہ

Newborn screening program



تحيه! - الاعداد بالا protein die gaba اديك في الدم protein die البر ايضا ما بطريقة خاصة
 بعد الترجمة في hydroxyproline
 post-translation modification



Amino Acid Derivatives

20-300

23-300

- The non-standard/ non-proteinogenic amino acids are either not found in proteins (e.g. carnitine and GABA) or are not produced directly by standard cellular machinery (e.g. hydroxyproline)

- Non-standard amino acids that are found in proteins are formed by post-translational modification. These modifications are often essential for the function or regulation of a protein:
 - عن يد البروتين functional
 - تعدله
 - بعد الاكتمال الى تغير post-translational modification يصير
 - non standard & non proteinogenic من الالام كان proteinogenic standard نتيجة ال post amino acid derivatives

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

مبارك
 يعني ضمنا Ca²⁺ مجموعة كربوكسيل
 متغير
 اندفاعي

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

بنفسه ال
 لسا لسا

Standard بس عمل modification بس وتغير

Amino Acid Derivatives



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
د وجود ال P ال دور كبير في مهمة الانزيم ادا البروتين
تعدل
4. Glycosylation (addition of sugar moieties) stabilizes protein conformation and direct selected proteins to various intracellular organelles (targeting process)
استقرار
تصغير molecule
تثبيت



Non-protein Functions

- 2) **Tyrosine** is a precursor of the **thyroxin** (thyroid hormone) and the catecholamine neurotransmitters like **dopamine, adrenaline** and **noradrenaline**
- 3) The local mediator **histamine** which is released during allergy is derived from the **decarboxylation** of **histidine**
تنتج من عملية كيميائية *Standard amino acid*
- 4) γ -aminobutyric acid (**GABA**) is the major inhibitory NT in brain. It is nonstandard amino acid derived from **glutamate**.
NT *neurotransmitter*

Non-proteinogenic Non-standard



تکثیره - انسانی سے ال سو کے امی 20 Standard کے ساتھ سے Non-standard سے سے
پروتینوجنیک → non proteinogenic → derivatives of Standard کے سے

- Nonproteinogenic nonstandard amino acids are derivatives of standard amino acids:

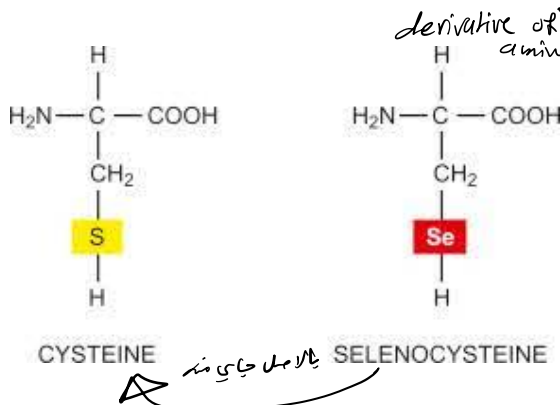
1. As intermediates during metabolism *ornithine, Citrulline*
2. Post translational modification process *proline / glutamate*
3. Other enzymatic reactions *dopamine, adrenaline*

- Nonproteinogenic nonstandard amino acids may have protein role or nonprotein role (they are active by themselves and have a function *like GABA*)

Proteinogenic Non-standard

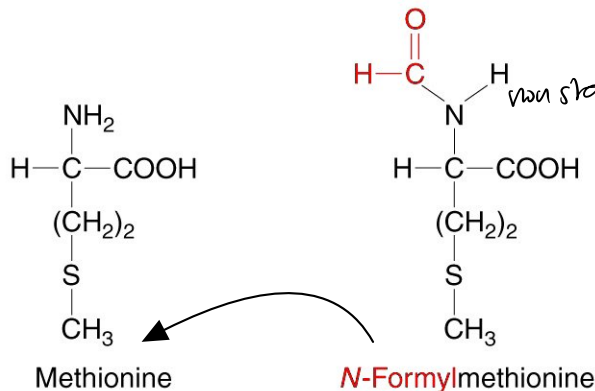
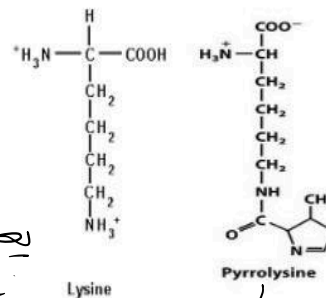


- Proteinogenic nonstandard amino acids are also derivatives of standard amino acids



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)**.



proteinogenic or non proteinogenic
 300 or more
 non proteinogenic
 protein role or non protein role



Amphoteric property of Amino Acids

Standard amino acid have two functional group
 صيغ بالازرق

- Amino acids are amphoteric molecules (ampholytes) having both acidic (-COOH) and basic (-NH₂) groups
- α-amino acids are ionized in aqueous solutions with the ionization state is dependent on the pH value

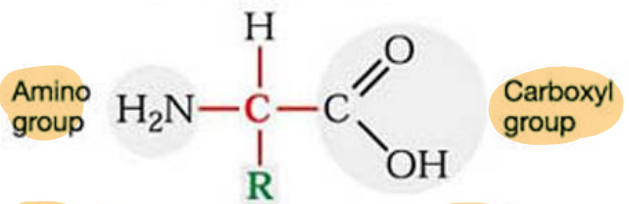
كلمة ليو...
 يعني مرتبة...
 يتصرفون...
 تحتها...
 كما كلمة

carboxylic acid group

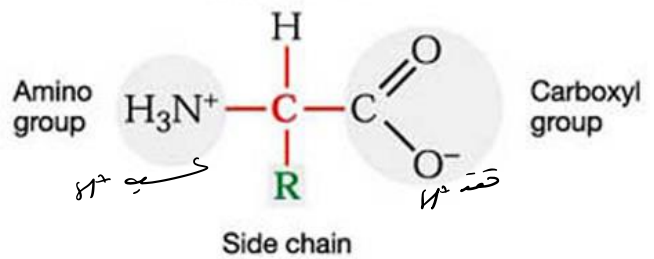
amino group

amphoteric molecules
 الحامض والامبيوتيك
 كونه ايزو ايسية في المحلول
 والاسم...
 هذه القدرة...
 حيث...
 pH

Non-ionized form



Ionized form



base
 proton acceptor
 عندما القدرة توضع
 وتضع محتوية بيوتيك

acid
 proton donor
 يعني عند...
 مع...
 carboxylate group
 وتضع محتوية بيوتيك

which group is ionized depends upon the pH

Ionization of Amino Acids



(الكلام المكتوب أحمر كالم)

- 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



ionized (المجموع صفر)
(متعادل)

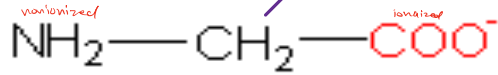
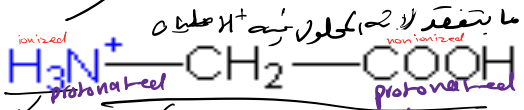
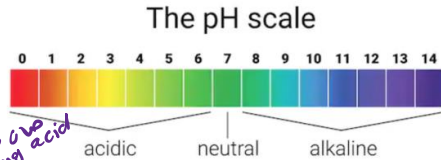
بمؤقتة H⁺ من المحلول لانه
صحة C يكون بار

بزيادة pH
تفتيح base strong

بزيادة pH

المعادني at high pH يكون موجود
Deprotonated form

تكون اذكريكون
ionized amino group;
non ionized



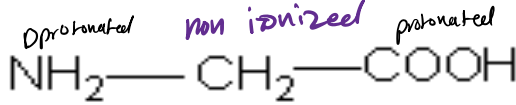
total charge (+1)

صحة صحت
strong acid
طبيعا. لاجل
pH

total charge = (-1)

عليه صحة سالبة

at low pH =
protonated form



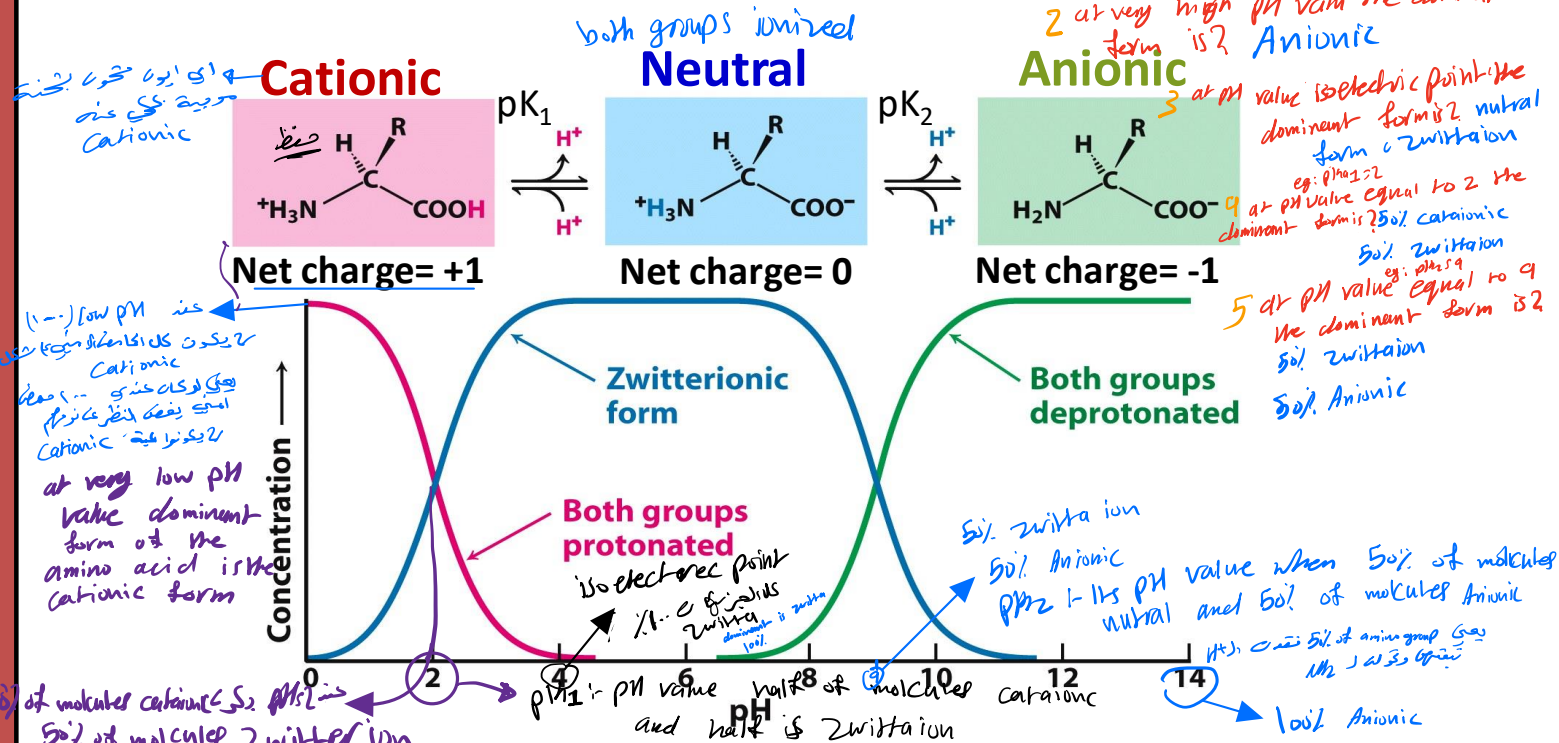
يعتبر في شكل اضعف
non ionized form
بفضل توازي ربحه يتحول

non ionized NH₂ & non ionized COOH

Amino Acids as Zwitterions



- Zwitterions (dipolar molecules) have charged —NH_3^+ and COO^- groups (both groups are ionized). Zwitterion is neutral as it carries + and - charges



Isoelectric Point (pI)

pH value when the dominant form is zwitterion. (neutral) net charge = zero

∴ pI value is the pH value when the net charge is zero. (neutral)



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

Isoelectric Point (pI)

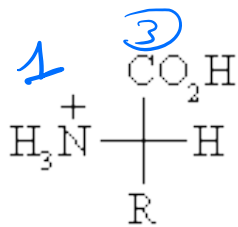


- For example, the simplest amino acid glycine has $pK_1 = 2.34$ and $pK_2 = 9.6$

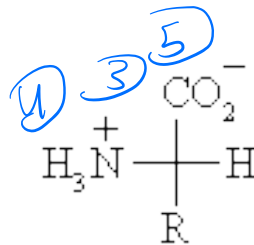
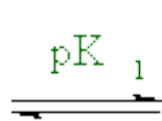
$$\begin{aligned}
 pI &= \frac{1}{2} (pK_1 + pK_2) \\
 &= \frac{1}{2} (2.34 + 9.6) \\
 &= 5.97
 \end{aligned}$$

what is the dominant form?

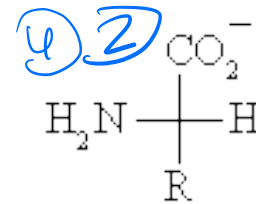
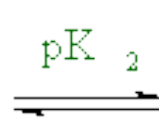
- at pH value = 1 → Cationic
- pH value 13.5 ⇒ Anionic
- pH value 2.34 → 50% Cationic, 50% zwitterion
- pH value 9.6 → 50% zwitterion, 50% Anionic
- pH value 6 → zwitterion



acidic media
low pH



neutral
form



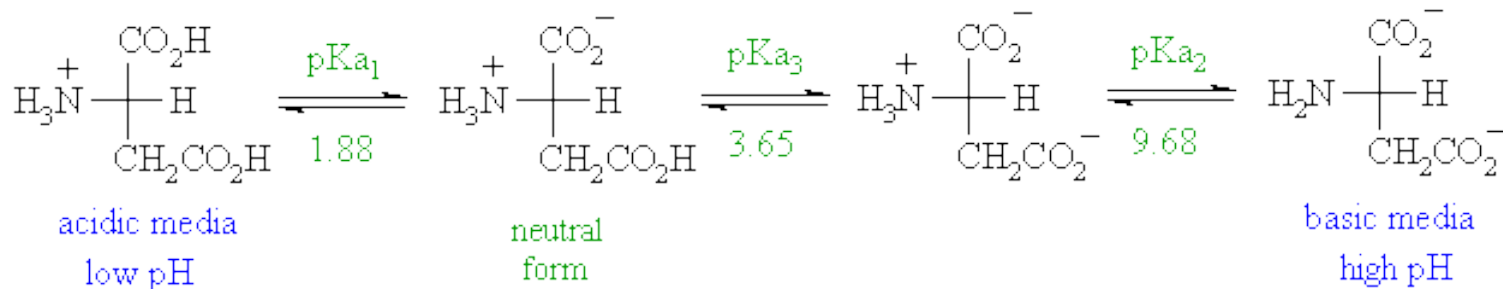
basic media
high pH

pI of Acidic and Basic Amino Acids



- For the acidic and basic amino acids which contain an ionizable "R" group in their side chains, pI calculation is different from those with neutral side chains
- Acidic side chain: zwitterion exists at more acidic conditions when the extra -ve has been neutralized

$$pI = \frac{1}{2} (pK_1 + pK_3)$$



pI of Acidic and Basic Amino Acids



- For example, the aspartic acid which has $pK_1 = 1.88$, $pK_3 = 3.65$ and $pK_2 = 9.68$

$$\begin{aligned} pI &= \frac{1}{2} (pK_1 + pK_3) \\ &= \frac{1}{2} (1.88 + 3.65) \\ &= 2.77 \end{aligned}$$

سؤال 20

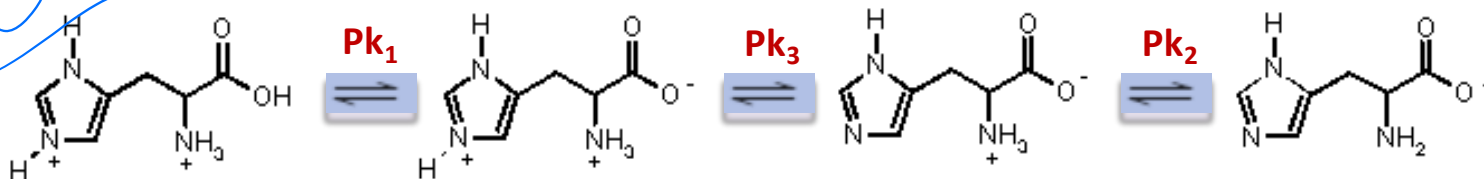
pl of Acidic and Basic Amino Acids



2. Basic side chain: zwitterion exists at more basic conditions when the extra +ve has been neutralized

504422

$$pI = \frac{1}{2} (pK_2 + pK_3)$$



For example, histidine which has $pK_2 = 6.00$, $pK_3 = 9.17$

$$\begin{aligned} pI &= \frac{1}{2} (pK_2 + pK_3) \\ &= \frac{1}{2} (6.00 + 9.17) \\ &= 7.59 \end{aligned}$$

pKa values of Amino Acids



The pK values for the α -carboxyl, α -amino groups and side chains

Amino acid	pK ₁	pK ₂	pK _R
Alanine	2.4	9.9	-
Arginine	1.8	9.0	12.5
Asparagine	2.1	8.7	-
Aspartate	2.0	9.9	3.9
Cysteine	1.9	10.7	8.4
Glutamate	2.1	9.5	4.1
Glutamine	2.2	9.1	-
Glycine	2.4	9.8	-
Histidine	1.8	9.3	6.0
Isoleucine	2.3	9.8	-

Amino acid	pK ₁	pK ₂	pK _R
Leucine	2.3	9.7	-
Lysine	2.2	9.1	10.5
Methionine	2.1	9.3	-
Phenylalanine	2.2	9.3	-
Proline	2.0	10.6	-
Serine	2.2	9.2	-
Threonine	2.1	9.1	-
Tyrosine	2.2	9.2	10.5
Tryptophan	2.5	9.4	-
Valine	2.3	9.7	-