VEIN BATCH 2027

النادي الطبي

Sub: Molecular المادة:

Lecture: 9 المحاضرة:

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Edited: تعديل:

Amino acids/ peptides/ proteins of biological importance- 1

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تفريغ : محمد العمري / تالا العمري

Protein

- **Definition:** Organic compounds with high molecular weight formed from amino acids
  - Composed of carbon, hydrogen, oxygen, nitrogen +/- sulphur
  - Nitrogen forms appx 16% of their weight (characteristic for proteins)

وهاي نقطة بتميزه عن الfats والcarbohydrates

المركّبات اللي بتعمل الprotein

- **Amino acids:** organic acids with one or more amino groups (NH2)

Importance of amino acids/ peptides/ proteins

- Amino acids participate in the biosynthesis of:
  - Porphyrins → hemoglobinالموجودة في ال
  - Purines
  - Pyrimidines → DNAالموجودة في ال
  - Urea → nitrogenous compoundsالمسؤولة عن اخراج ال من الجسم

- AA form **peptides** (2-50 amino acids) which have a roles as:
  - Hormones
  - Neurotransmitters

بنقدر نقول انه الdefinitionلل peptides :
a combination of 2-50 amino acid

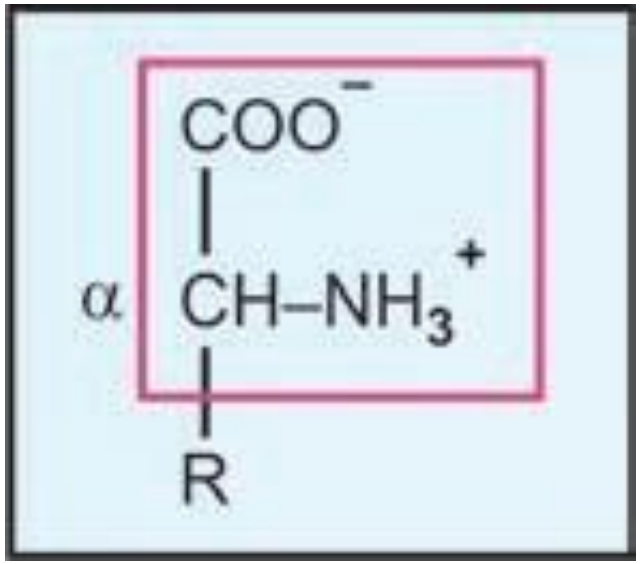
- AA form **proteins** (>50 amino acids) which have a roles as:
  - Plasma membrane
  - Hormones
  - Enzymes

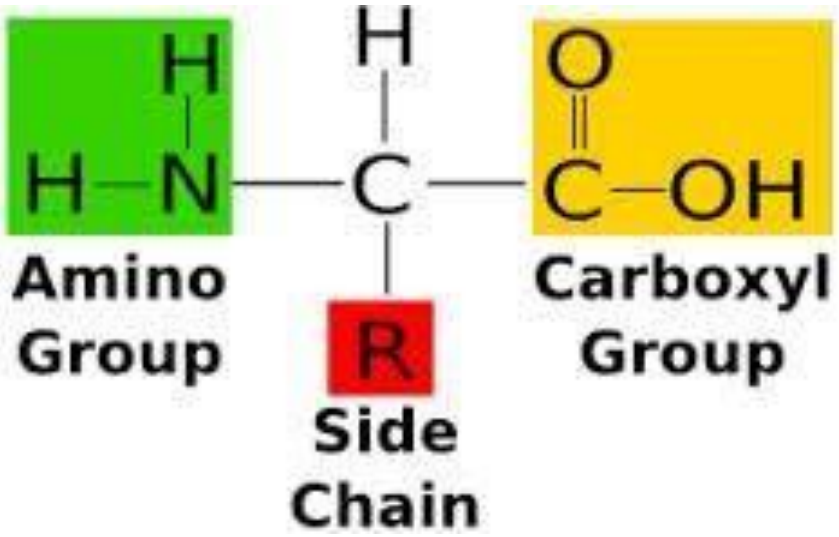
بكون بصيغة NH2 أو NH_3^+

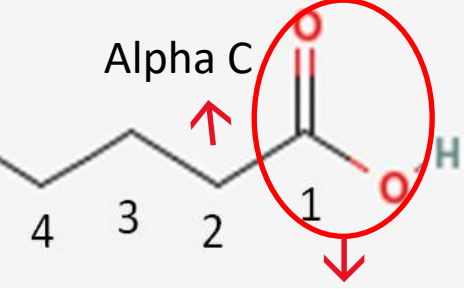
- Amino acids are carboxylic acids containing an amino group.

كلهم فيهم amino group باستثناء الproline فيه NH

- With the exception of the proline **which is an imino acids (NH)**, the building blocks of proteins are L-α- amino acids, having the general formula:







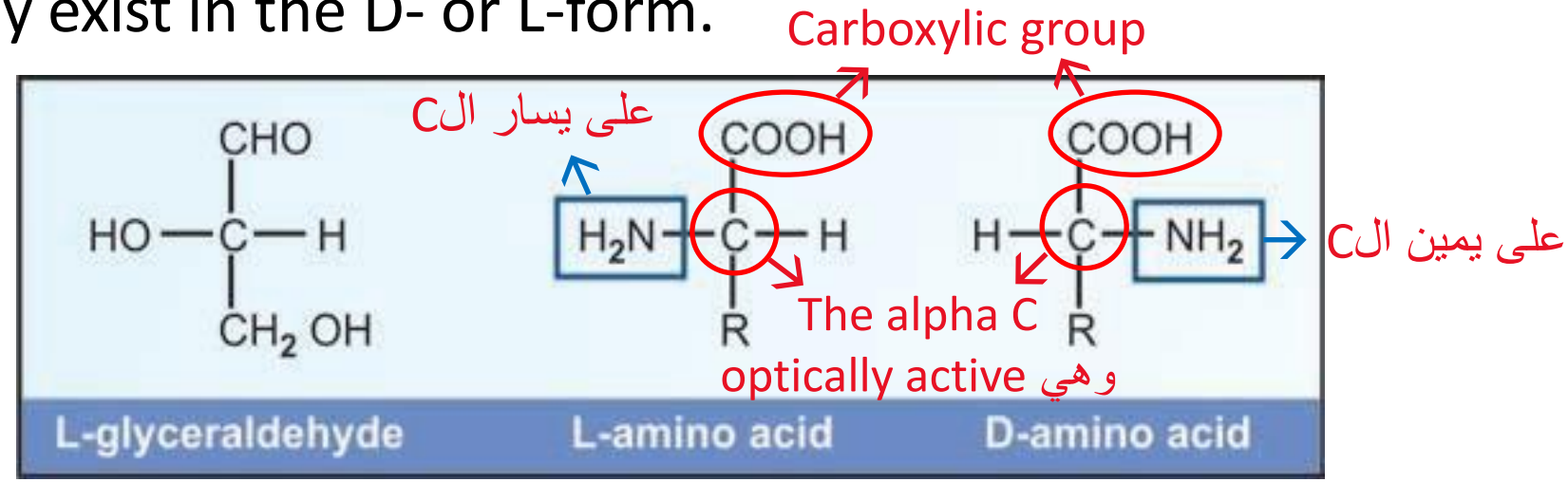
Carboxylic group

كل الamino acids اللي بكوّنوا الprotein بالجسم عبارة عن alpha AA..
ايش يعني alpha ؟ يعني انه الamino group دايما بترتبط بالalpha C
(اللي انذكرت بالFA وهي اللي بتكون مرتبطة بالcarboxyl group) , وكمان
الأغلبية العظمى من الAA بتكون بال L form (اذا كان موقع ال amino
group على يسار الalpha C بتكون L واذا على يمينها بتكون D)

Optical Activity

- **Except in glycine**, in which R is a hydrogen atom, the α-carbon is chiral, being connected to 4 different groups

- Therefore, amino acids are optically active, and each may exist in the D- or L-form.



Amino acid (AA) structure

- Contain carboxyl group (COOH) → **acid**
- Contain amino group (NH2) → **amino**

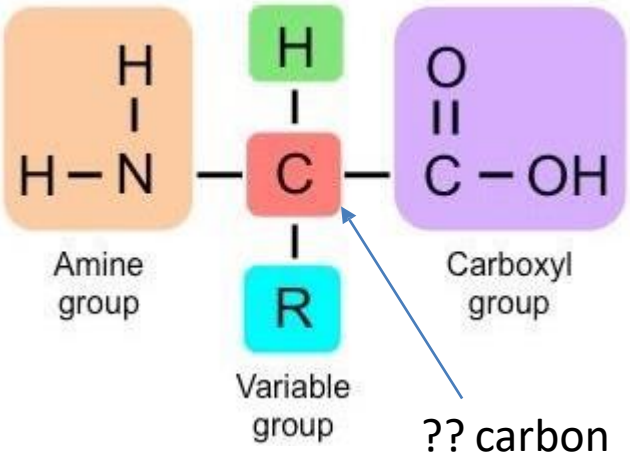
بس 20 موجودات بالDNA الجسم بقدر يصنعهم
لانهم coded (الهم كودونات زي ما اخذنا بالأحياء)
والهم اختصارات من 3 حروف

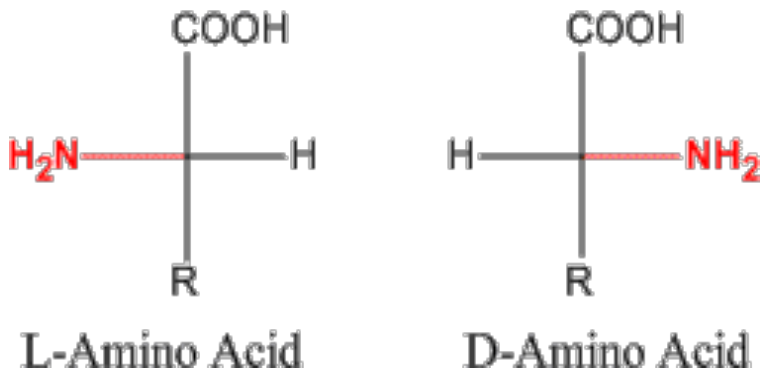
- 300 naturally occurring AA, but only 20 constitute monomer units of protein & coded by DNA
- Only L alpha amino acids occur in protein **in humans** (except D-serine and D-aspartate in brain tissue)
- Nineteen L-α- amino acids and 1 imino acid (proline) are required for the synthesis of all proteins

(Addition of selenium to cysteine)

- **Selenocysteine** is 21st L-alpha amino acid →

Not coded by DNA , but too important in the body





Classification of amino acids

وهو الأهم

- **Chemical classification:** according to their chemical structure

Water soluble بكون

- **Polar vs non-polar:** according to the polarity of the side chain; can be **charged or neutral**

Positive or negative

- **Acidic vs basic** (بغض النظر عن انه اسمهم acids بس برضه بعضهم basics)

- **Nutritional classification:** according to their nutritional importance (essential vs non-essential) بتم تصنيعهم non-essentialال

الجسم ما بقدر يصنعهم

داخل الجسم وللأسف مطلوب منا طريقة تركيبهم

- **Metabolic classification:** according to their metabolic fate

حسب نتائج تكسيرهم.. بتعطي glucose , ولا ketone bodies , أو ممكن الثنين مع بعض

مهمين جدا ومطلوب حفظهم كاملين وتمييز الstructure الهم, ولازم نحفظ الاسم الشخصي والاسم العلمي لكل واحد

Fatty acids

1- acetic acid: 2c (CH_3-COOH):

- **Glycine:** (alpha amino acetic acid).

2- Propionic: 3c (CH_3-CH_2-COOH):

- **Alanine:** (alpha amino Propionic acid)
- **Serine:** (alpha amino beta hydroxy Propionic acid)
- **cysteine:** (alpha amino beta thiol, Propionic acid)
- **Phenylalanine:** (alpha amino, beta Phenyl Propionic acid)
- **Tyrosine:** (alpha amino, beta parahydroxy phenyl Propionic acid)
- **Tryptophan:** (alpha amino beta indole Propionic acid)
- **Histidine:** (alpha amino beta imidazol Propionic acid)

نسبةً لموقعها على الring

Amino acids

الأبسط, والوحيد اللي ما فيه asymmetric C

Glycine

Alanine

Serine

Cysteine

Phenylalanine

Tyrosine

Tryptophan

Histidine

heterocyclic

(الاسم الشخصي)

بغض النظر عن موقع الNH3 بس كلهم L

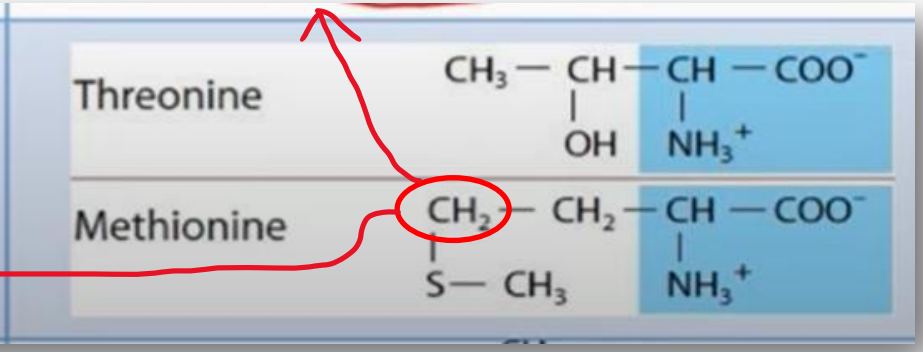
والاسم الطويل اللي بين قوسين هو الاسم العلمي (وهو سهل مش صعب.. عبارة عن اسم الacid بالإضافة ل اسم التفرع وموقعه)

A	B	Γ	Δ	E	Z
Alpha	Beta	Gamma	Delta	Epsilon	Zeta

لانه الC gamma عليها التفرعين بقدر اسميها gamma thiol methyl برضه كله واحد

3- butyric acid: 4c (CH_3-CH_2-CH_2-COOH)

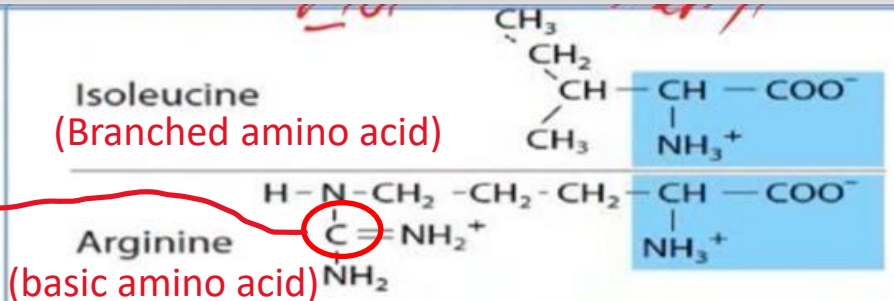
- Threonine:(alpha amino, beta hydroxy butyric acid)
- Methionine:(alpha amino, gamma methyl thiol butyric acid)



4- Valeric acid: 5c (CH_3-CH_2-CH_2-CH_2-COOH)

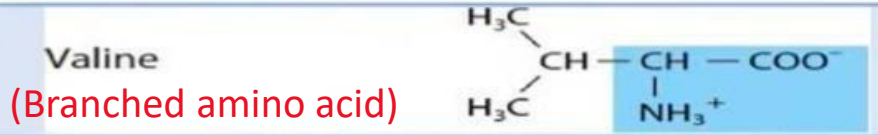
- Isoleucine: (alpha amino, beta methyl Valeric acid)
- Arginine: (alpha amino, delta guanido Valeric acid)

(كربونة عليها 3N)



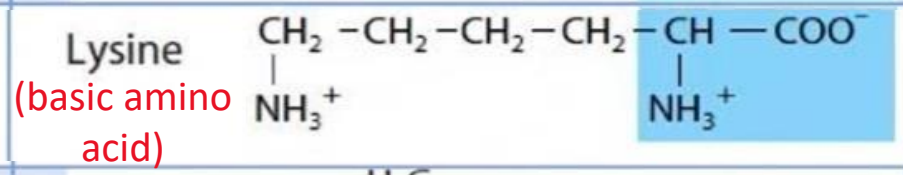
5- Isovaleric acid: 5c

- Valine: (alpha amino, Isovaleric acid)



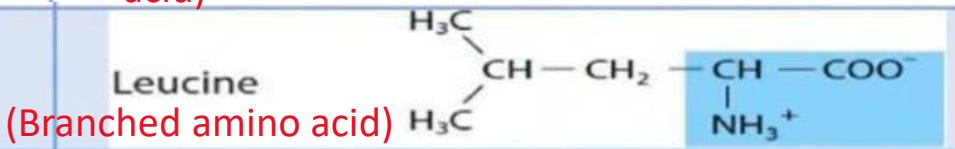
6- Caproic acid: 6c

- Lysine: (alpha amino, epsilon amino caproic acid)



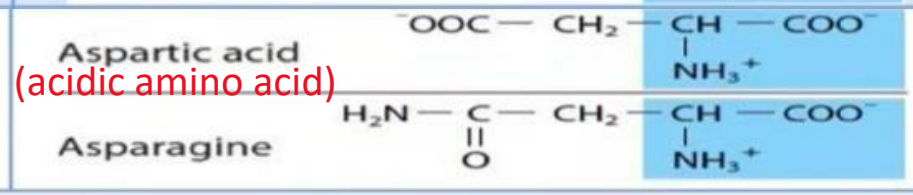
7- Isocaproic acid: 6c

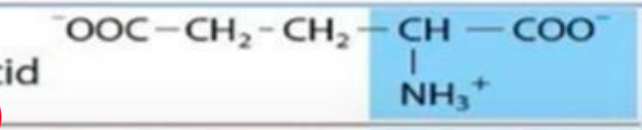
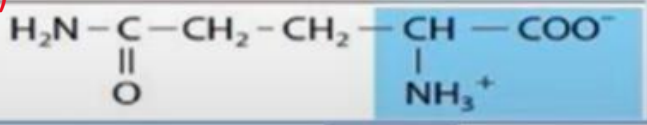
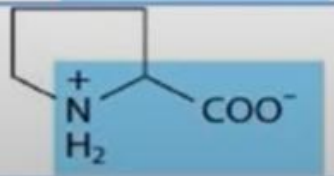
- Leucine: (alpha amino isocaproic acid)



8- Succinic acid: 4c dicarboxylic acid

- Aspartate: (alpha amino succinic acid)
- Asparagine:(alpha amino succinic



9- Glutaric acid: 5c dicarboxylic acid - Glutamate: (alpha amino glutaric acid) - Glutamine: (alpha amino glutaric acid amide)	Glutamic acid (acidic amino acid)  Glutamine 
10- pyrrolidine ring: 4c - Proline:	Proline heterocyclic 

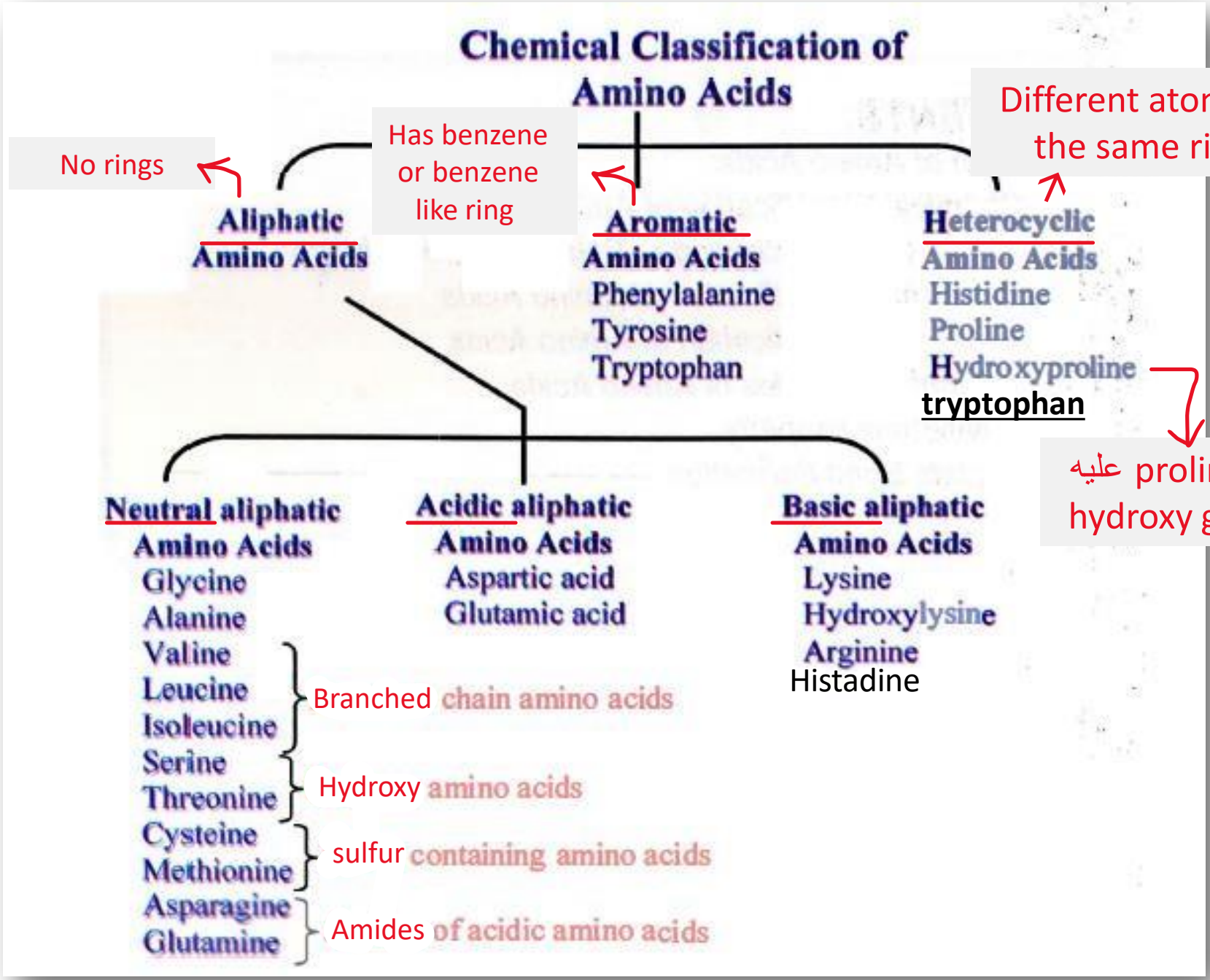
*المواضيع اللي بدها حكي تركتها للاخر لانه ما في وسع فوق.. ف الله بعينكوا كل نقطة ارجعوا دوروا على الacid تاعها ☺

**هسا لما بدكو تدرسوهم.. بدكو تركزوا على كل واحد ايش بميزه, ايش اللي فيهم hydroxyl ايش اللي branched ايش الbasic وهيك.. لانه السؤال رح يقلك ايش بين هضول بحتوي على كذا

- الheterocyclic ring هي الحلقة اللي بكون فيها أكثر من ذرّة مختلفة.. زي اللي بالtryptophan ال ring فيها كل من الC والN (مش حلقة كاملة من الC atoms)

- الbranched amino acids بنشوفهم مع الناس اللي بتروح عالgym.. لانهم بساعدوا بال muscle recovery وبقللوا الfatigue للmuscles بعد التمارين وبقووا العضلات

- الamino acid فيه 2 functional groups.. عندك الcarboxyl group والamino group, وحدة منهم acidic (الcarboxyl) و وحدة basic (الamino) ومعظمهم بكون فيه وحدة مقابل وحدة ما فيهم لا acid ولا basic (neutral).. بس لما تيجي تحكي عن الarginine اللي بحتوي على 4 amino groups فهو أكيد رح يكون basic , بينما بمركبات أخرى زي الaspartate والglutamate فهضول فيهم 2 carboxyl groups فهمه acidic (لإنه في اشي رح يطغى على الثاني)


Chemical Classification of Amino Acids
No rings
Has benzene or benzene like ring
Different atoms in the same ring
Aliphatic Amino Acids
Aromatic Amino Acids
Phenylalanine
Tyrosine
Tryptophan
Heterocyclic Amino Acids
Histidine
Proline
Hydroxyproline
tryptophan
هو proline عليه hydroxy group
Neutral aliphatic Amino Acids
Glycine
Alanine
Valine
Leucine
Isoleucine
Serine
Threonine
Cysteine
Methionine
Asparagine
Glutamine
Branched chain amino acids
Hydroxy amino acids
sulfur containing amino acids
Amides of acidic amino acids
Acidic aliphatic Amino Acids
Aspartic acid
Glutamic acid
Basic aliphatic Amino Acids
Lysine
Hydroxylysine
Arginine
Histadine

Neutral aliphatic amino acids

- These are amino acids that **contain no ring structure.**
- According to their side-chain, these are classified into 3 groups:

(1) Amino acids with a hydrocarbon side chain

   (1) Branched amino acids
   (2) Unbranched amino acids

(2) Hydroxyl-containing amino acids

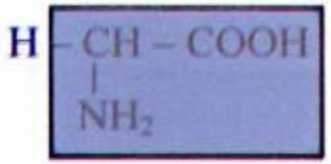
(3) Sulfur-containing amino acids

Amino acids with aliphatic side chain

ال3 أحرف هاي هي الcodons

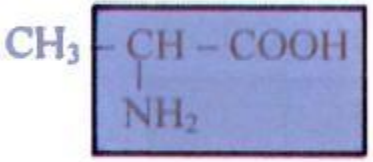
1- Glycine *(Gly or G)*

α-aminoacetic acid



2- Alanine *(Ala or A)*

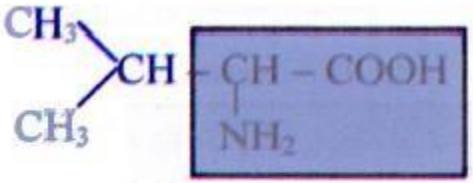
α-aminopropionic acid



3- Branched Chain Amino Acids

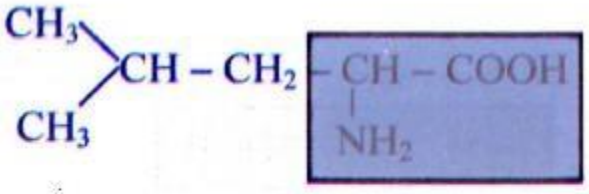
A- Valine *(Val or V)*

α-aminoisovaleric acid



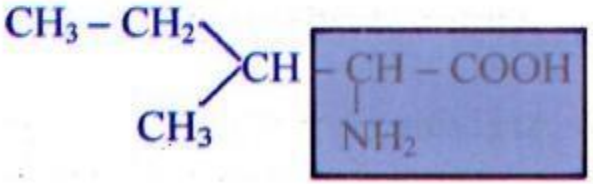
B- Leucine *(Leu or L)*

α-aminoisocaproic acid



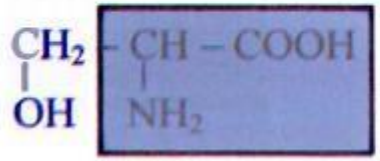
C- Isoleucine *(Ile or I)*

α-amino, β-methyl, β-ethylpropionic acid

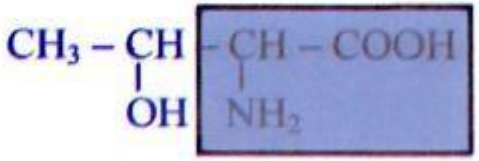


Amino acids with aliphatic side chain containing a hydroxyl group

1- Serine ***(Ser or S)***
α-amino, β-hydroxypropionic acid

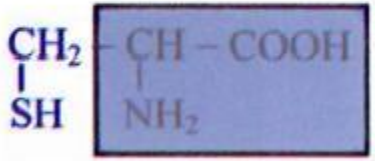


2- Threonine ***(Thr or T)***
α-amino, β-hydroxybutyric acid

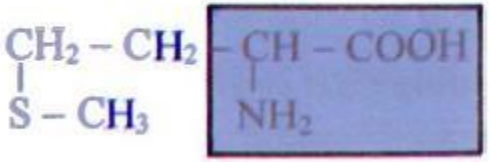


Amino acids with aliphatic side chain containing sulphur atoms

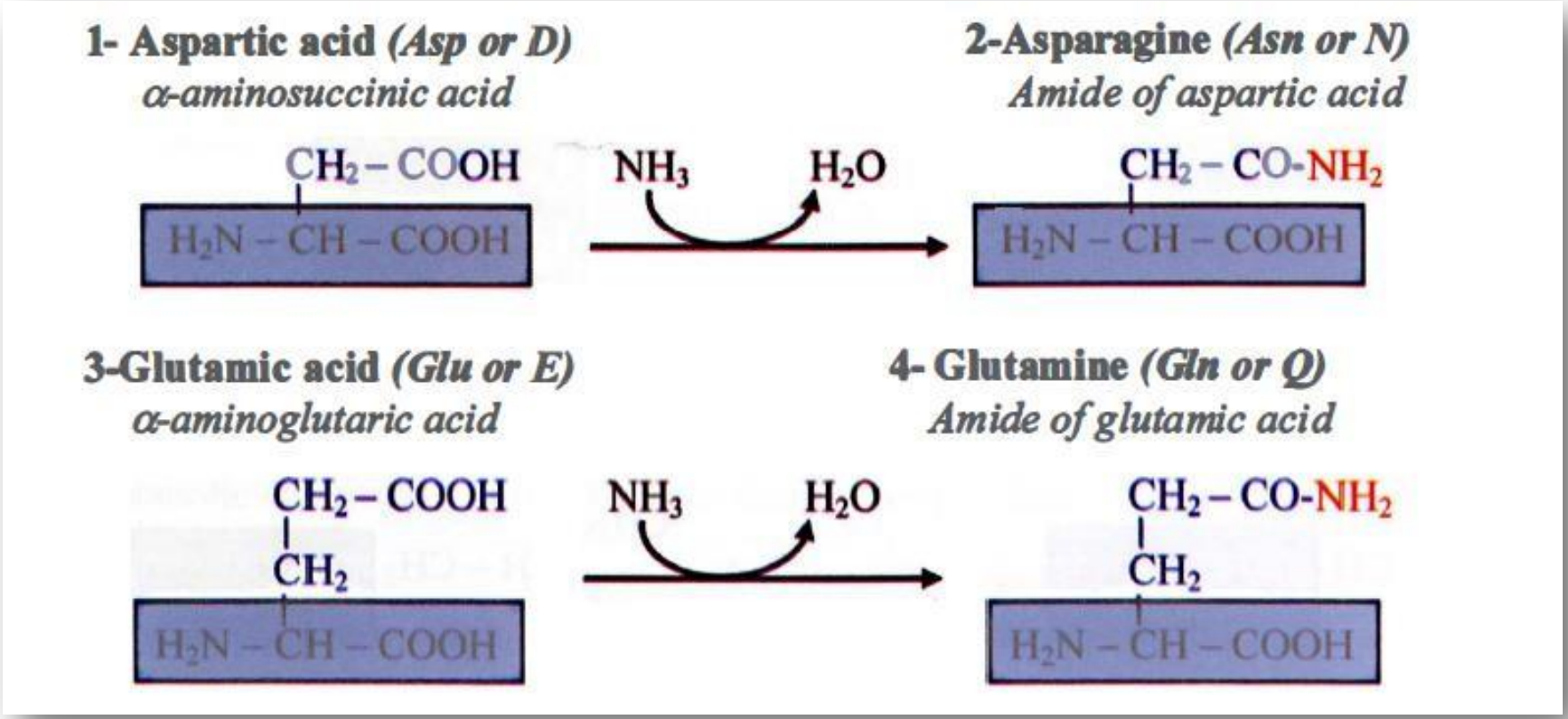
1- Cysteine ***(Cys or C)***
α-amino, β-thiolpropionic acid



2- Methionine (Met or M)
α-amino, γ-methylthiolbutyric acid



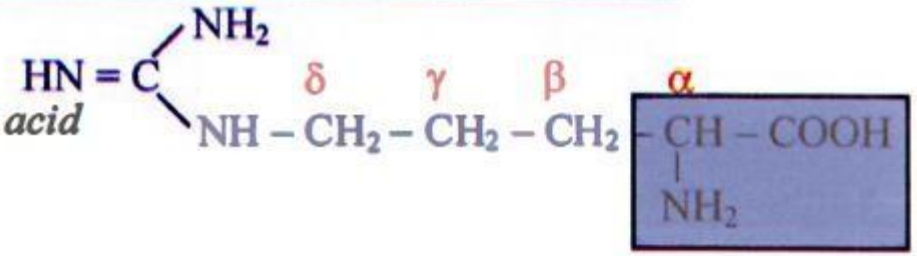
Amino acids containing acidic groups or their amides



Amino acids with basic groups

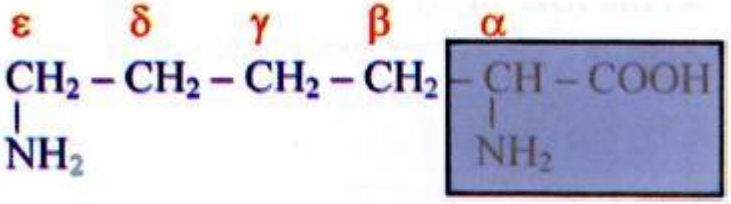
1- Arginine *(Arg or R)*

α amino, δ-guanidovaleric acid



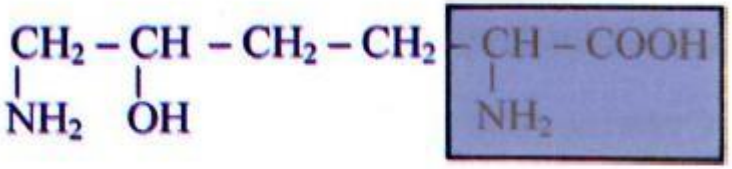
2- Lysine *(Lys or K)*

α,ε-diaminocaproic acid



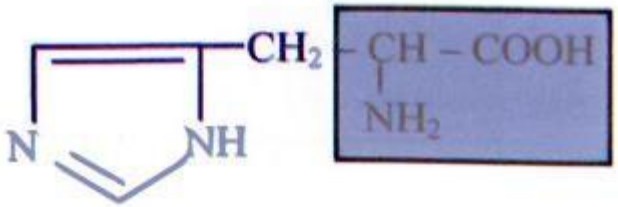
metabolism مهم بال

3- Hydroxylysine



4- Histidine *(His or H)*

α-amino, β-imidazole propionic acid

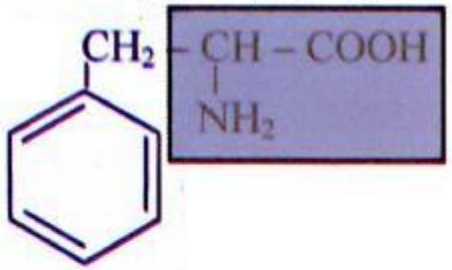


Amino acids containing aromatic rings

These are amino acids that contain an aromatic ring

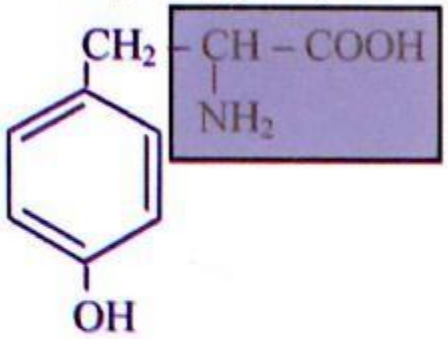
1- Phenylalanine ***(Phe or F)***

α-amino, β-phenylpropionic acid



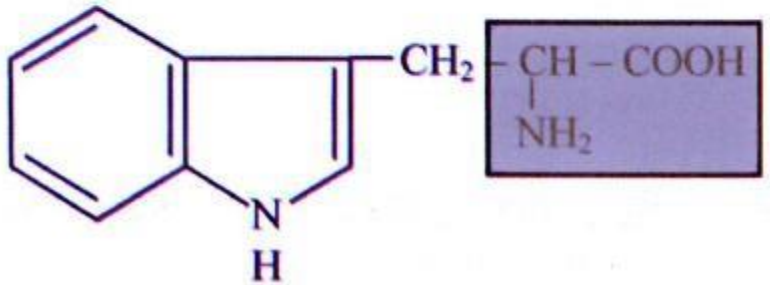
2- Tyrosine ***(Tyr or Y)***

P-hydroxyphenylalanine



3- Tryptophan ***(Trp or W)***

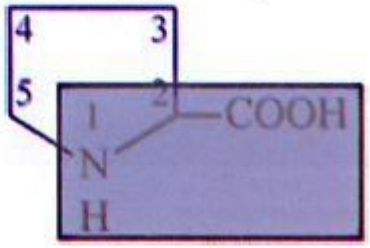
α-amino, β-indole propionic acid



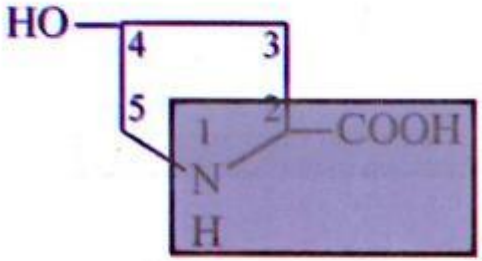
Imino acids: contain imino group

1- Proline *(Pro or P)*

(2-Pyrrolidine, carboxylic acid)



2- Hydroxyproline



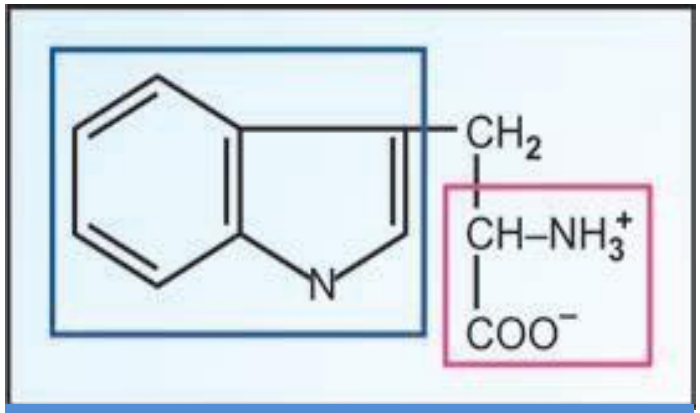
N.B. **Heterocyclic amino acids** are those containing rings other than phenyl ring and they include tryptophan, histidine, proline and hydroxyproline.

Neutral Heterocyclic amino acids

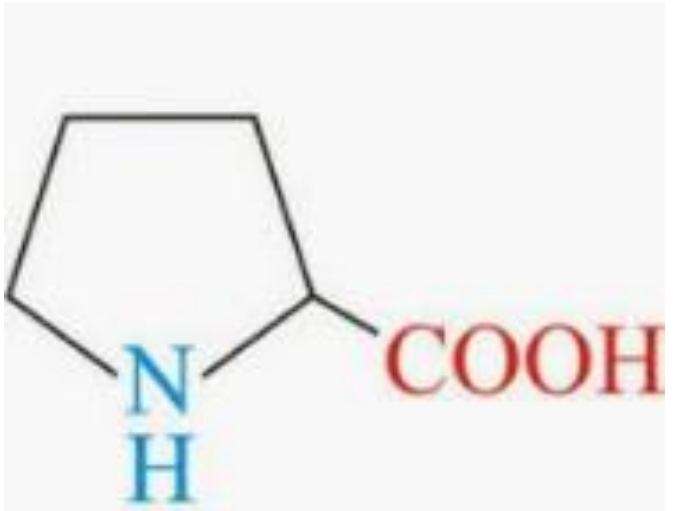
- These are amino acids that contain a heterocyclic ring
- **Heterocyclic ring:** A ring containing at least one atom other than carbon
- **They include tryptophan , histidine, proline, hydroxyproline**
    - Proline is an imino acid (contain imino group (NH) rather than amino group)

❖ Note: **Histidine** is also a basic amino acid

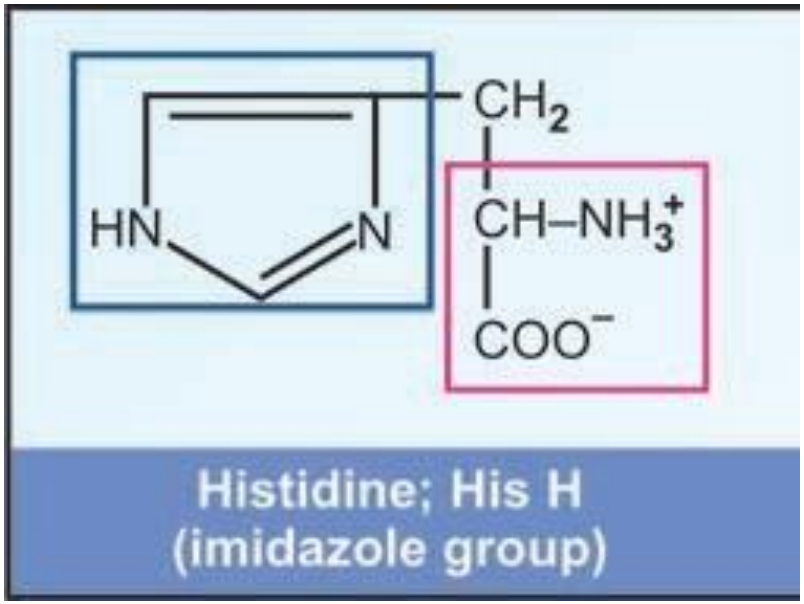
بنلاحظ انه ممكن acid واحد يكون فيه
أكثر من خاصية زي الhistidine



Trytophan



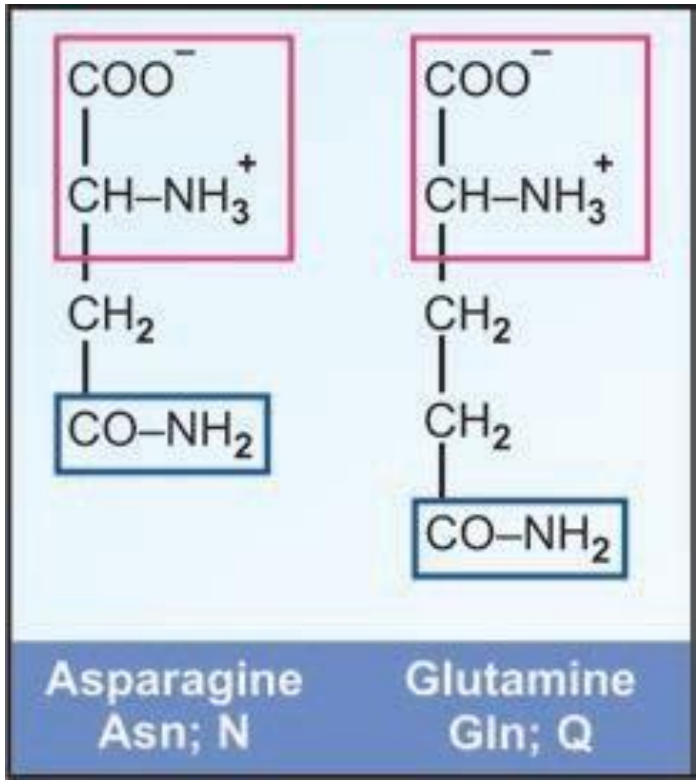
Proline

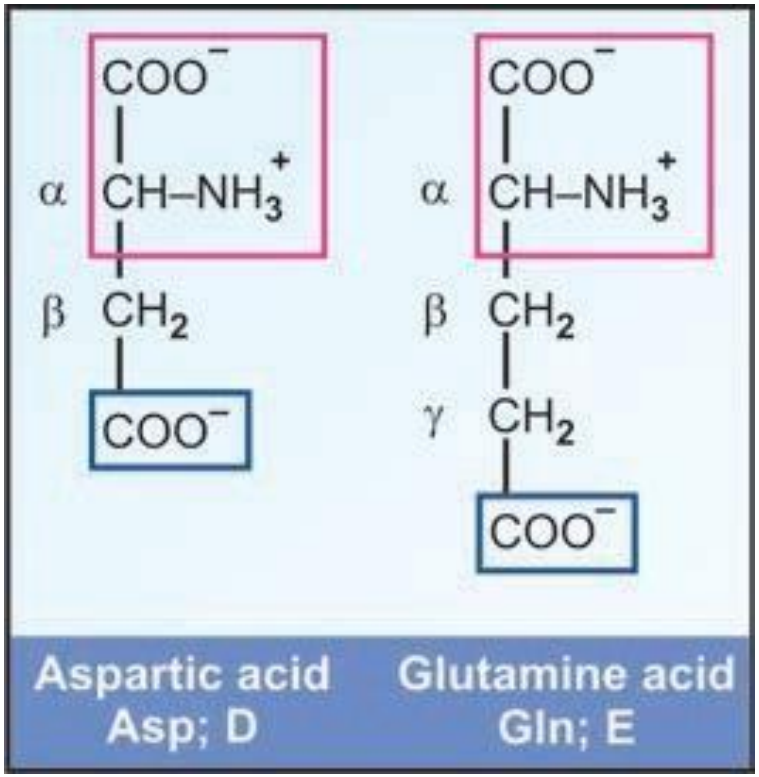


Histidine; His H
(imidazole group)

❖ Acidic amino acids and their amides:

- The acidic amino acids are **monoamino-dicarboxylic acids**
- They include **Aspartic acid**, **Glutamic acid**
- Asparagine and glutamine, the amides of aspartic and glutamic acids, respectively, **are neutral**

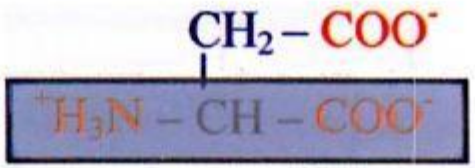




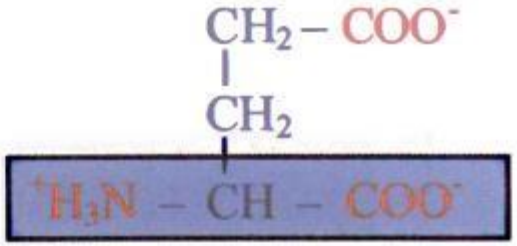
B- Acidic Amino Acids (monoamino-dicarboxylic acids)

They include the following:

1- Aspartic acid



2- Glutamic acid

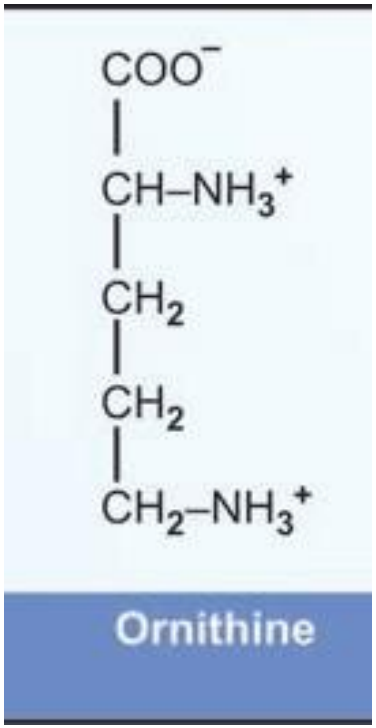


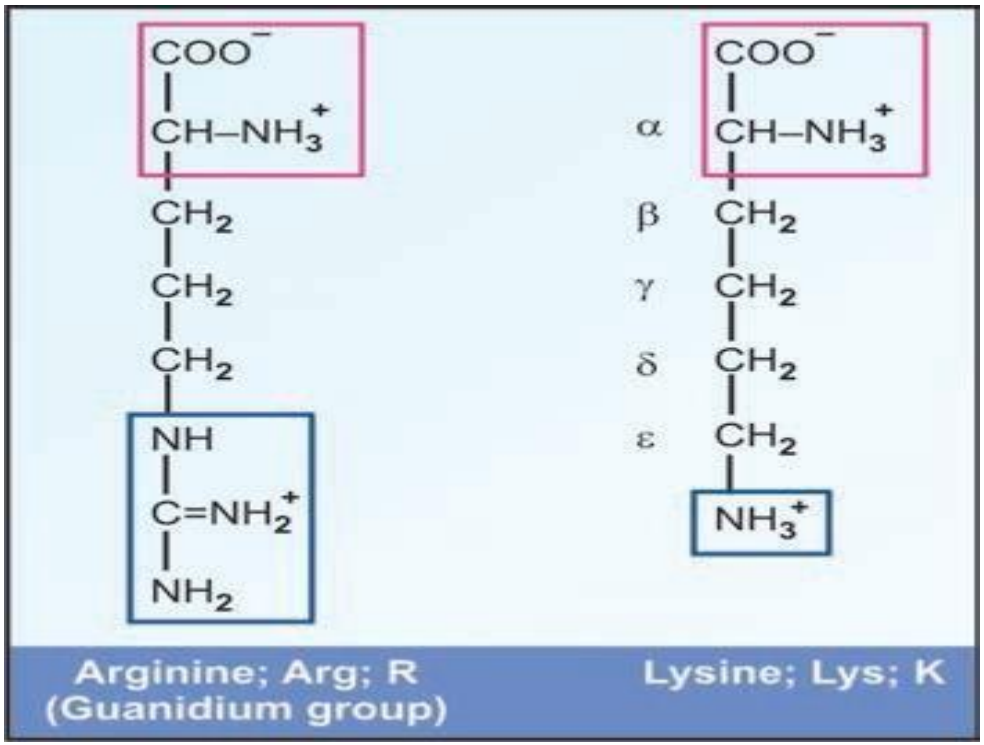
❖Basic amino acids

- **Histidine**, **Arginine** and **Lysine** are the only members of this group required for protein synthesis

لا يدخل في تصنيع الproteinال

- Ornithine is not found in proteins (non-proteinogenic) but is important in metabolism

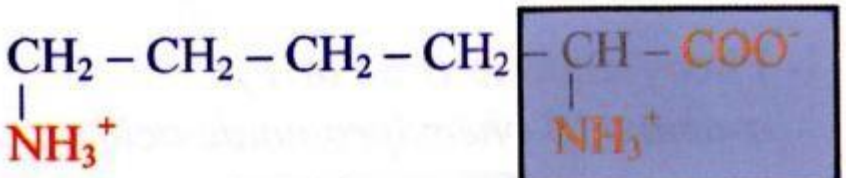




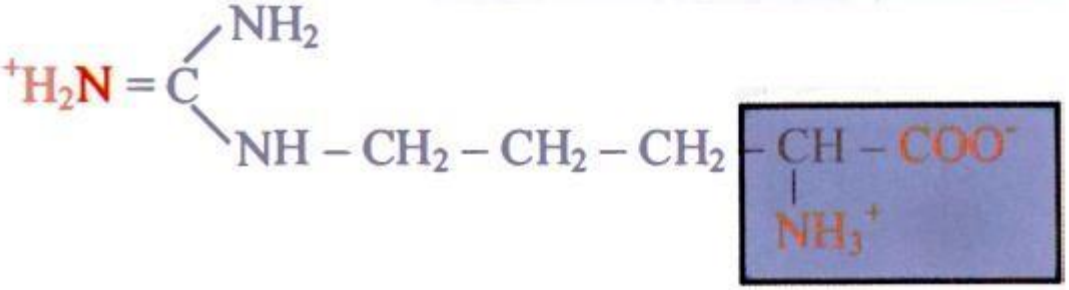
A- Basic Amino Acids (diamino-monocarboxylic acids)

They include the following:

1- Lysine and hydroxylysine



2- Arginine



3- Histidine

Nutritional Classification of Amino acids

- **20** amino acids are needed for protein synthesis

- 9 of these amino acids **can not** be synthesized in the body:
  - Phenylalanine
  - Valine
  - Threonine
  - Tryptophan
  - Methionine
  - leucine, isoleucine
  - Lysine
  - Histidine

ال arginine بكون essential بس عند
الأطفال, فال infantes عندهم 10
essential بينما ال adults عندهم 9

- They should be supplied in the diet, and hence the name ESSENTIAL (Indispensable) AMINO ACIDS.

- Arginine is only essential for growing infants, but not for adults hence the name semiessential (10 essential amino acids for infants)

- Proteins that are rich in essential amino acids are known as proteins of high biological value

Essential Amino Acid Mnemonic

Private Tim Hall => PVT TIM HALL

P.V.T.

- P = Phenylalanine
- V - Valine
- T - Threonine

T.I.M.

- T - Tryptophan
- I - Isoleucine
- M - Methionine

H.A.L.L.

- H - Histidine
- A - Arginine*
- L - Leucine
- L - Lysine

* Only essential during (+)Nitrogen Balance

10 ESSENTIAL AMINO ACIDS

Tryptophan
Threonine
Histidine
Valine
Isoleucine
Phenylalanine
Methionine
Arginine
Lysine
Leucine

TRY THIS VIP MALL

- **NONESSENTIAL (Dispensable)AMINO ACIDS:**
- Nonessential means that our bodies produce an amino acid, even if we do not get it from the food we eat

- Nonessential amino acids include: alanine, asparagine, aspartic acid, cysteine, glutamic acid, glutamine, glycine, proline, serine, and tyrosine

- Proteins that are deficient in one or more of the essential amino acids are of low biological value, e.g. zein of maize (deficient in tryptophan).

Metabolic classification

- According to their metabolic fate, amino acids can be classified into 3 main groups:
  - **Pure glucogenic:** give glucose inside the body
    - include all amino acids except the members of the other two groups (14 acids)
  - **Pure ketogenic:** give ketone bodies inside the body
    - Include leucine and lysine
  - **Mixed glucogenic and ketogenic:** give both glucose and ketone bodies inside the body
    - include phenylalanine, tyrosine, tryptophan and isoleucine

Polarity and charge classification

- **AA with non-polar R groups:**
  - 1 -Glycine & 2-Alanine
  - 3-Valine
  - 4-Lucine and 5-Isoleucine
  - 6-Methionine and 7- Phenylalanine
  - 8-Tryptophan and 9-Proline

- **AA with uncharged polar groups:** These are more soluble in water than the first group
  - Their (R) groups contain neutral polar functional groups, which form hydrogen bonds with water, they include:
    - 1- Serine, threonine, tyrosine and hydroxyproline (contain hydroxyl group)
    - 2- Cysteine (contains SH group)
    - 3- Asparagine and glutamine (contain amide group)

اي مركب فيه extra functional group هو
(C atomsاي مركب فيه اشي زيادة عال) polar

➢ Amino acids having charged or ionic polar side chains:

وبدي انتبه للزيادة هاي هل هي acidic (عليها negative charge) ولا basic (عليها positive)
والcharge هاي بفقدوها لما يعملوا peptides , (charge)

- These are amino acids in which the R group carries a full charge due to:
  - **Ionization** of the acidic groups (aspartic and glutamic acids) → giving amino acids negative charges
  - **Protonation** of basic groups (arginine, lysine and histidine) giving amino acids positive charge

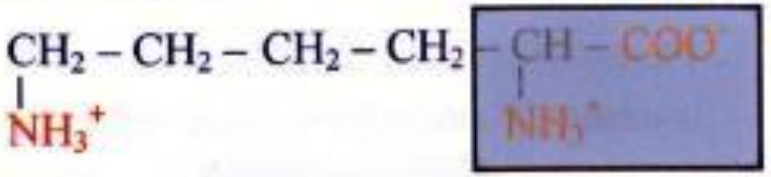
When amino acids are connected together to form peptides and proteins their carboxyl and amino groups lose their charges

III- Amino Acids with Charged (R) Groups:

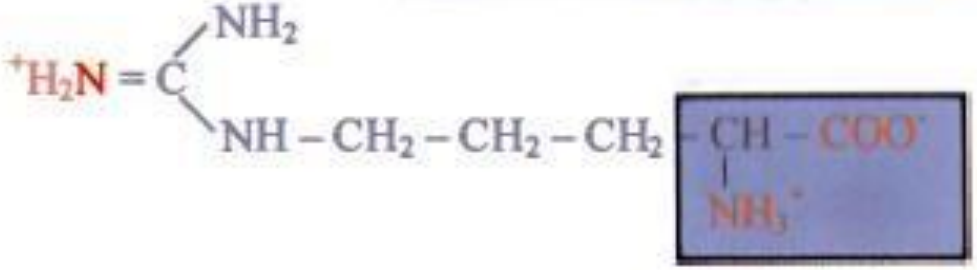
A- Basic Amino Acids (diamino-monocarboxylic acids)

They include the following:

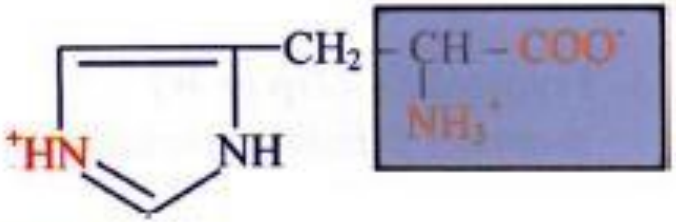
1- Lysine and hydroxylysine



2- Arginine



3- Histidine



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They include the following:

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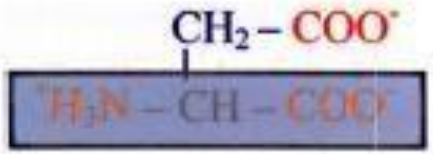

2- Glutamic acid