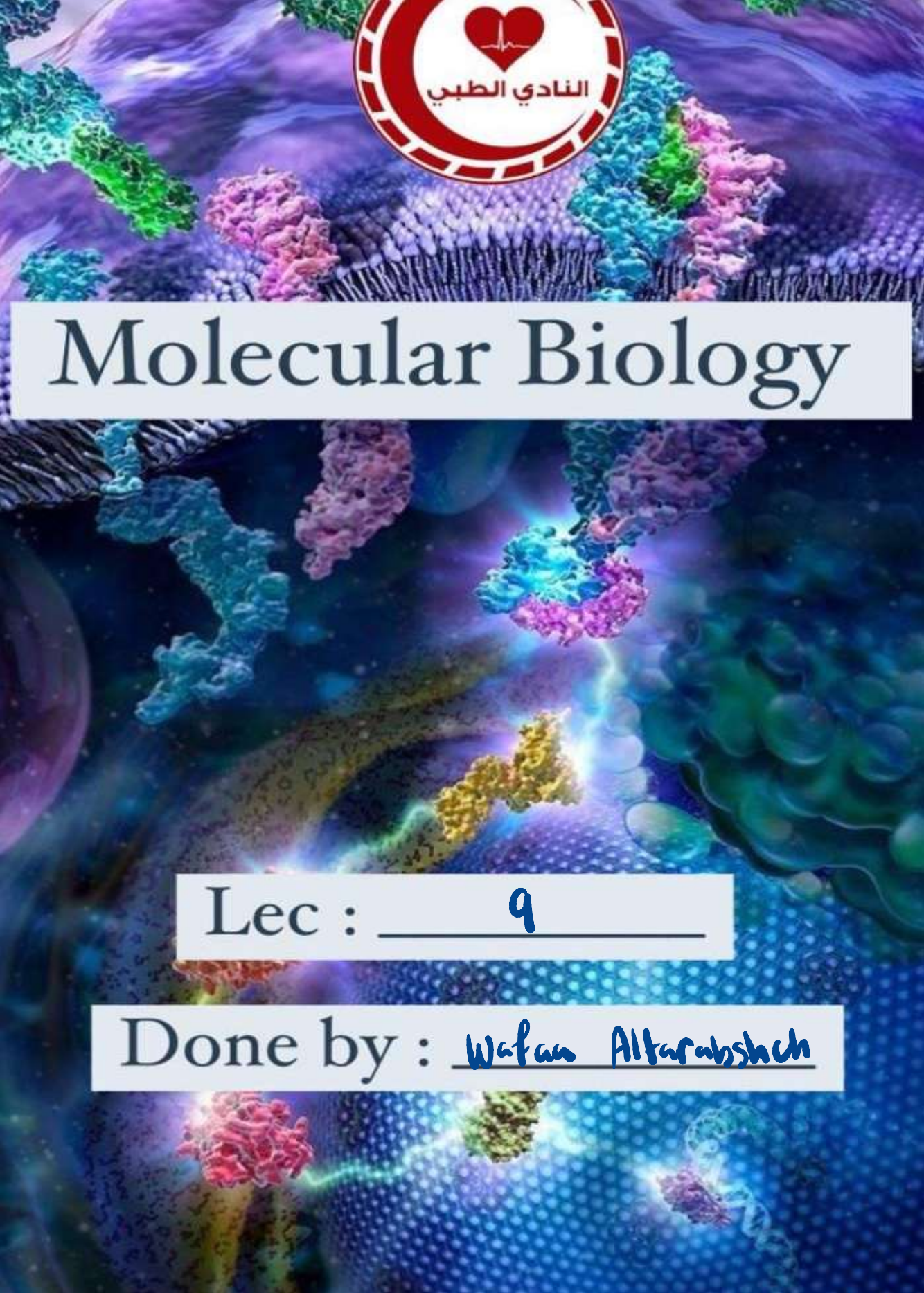


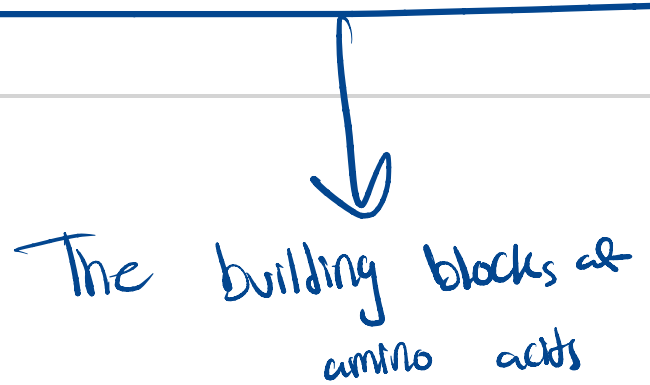
Molecular Biology

Lec : 9

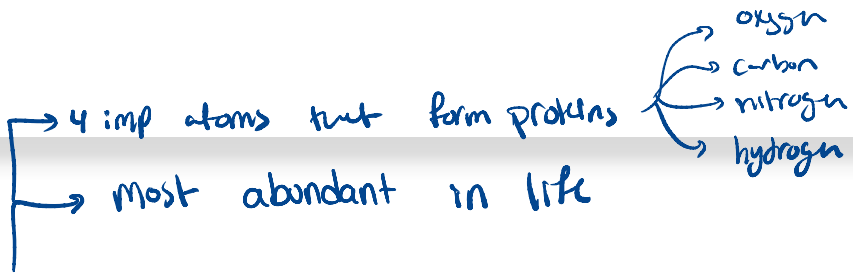
Done by : Wafaa Altarabshech

CLASSIFICATION OF AMINO ACIDS

Nebras Melhem



Introduction



Protein: 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)

Besides water, proteins are the most abundant molecules in all known forms of life. Proteins are the most diverse class of biological molecules, making up everything from enzymes and hormones to antibodies.

- About 70% of your body weight is water, and about 17% is protein.

Introduction

→ Amino-acids nearly have a function in everything in our bodies.

Amino acids participate in the biosynthesis of: [amino acids Not proteins]

- Purines
- Pyrimidines
- Urea

* ممكن حتى يكون عنا amino acid يعمل كـ neurotransmitter زي Histidine و glutamate اللي منه

AA form peptides (2-50 amino acids) which have a roles as: [peptides Not proteins]

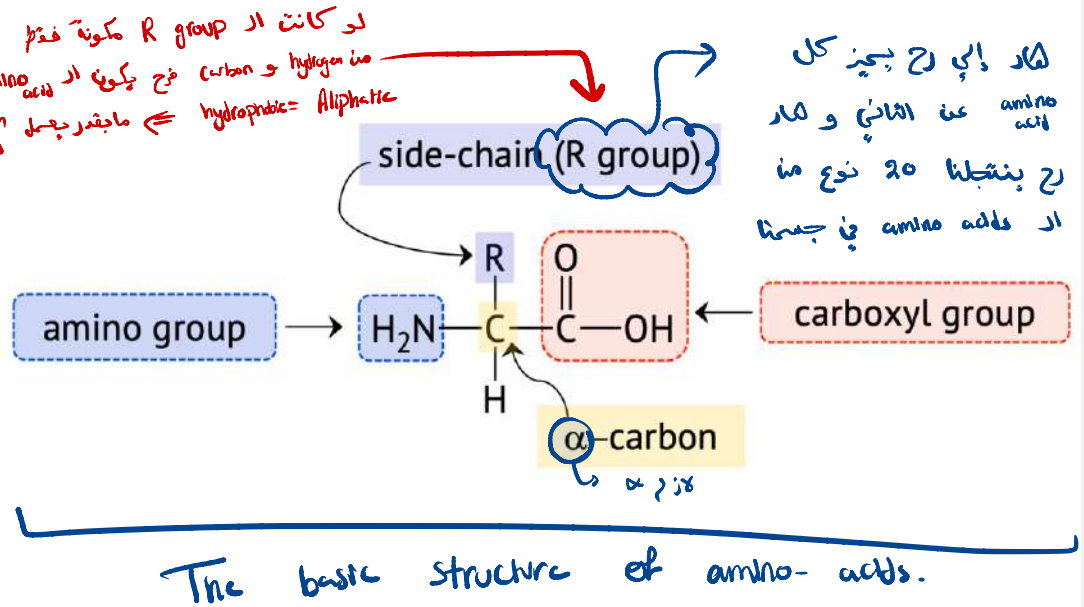
- Hormones
- Neurotransmitters

AA form proteins (>50 amino acids) which have a roles as:

- Plasma membrane
- Hormones
- Enzymes

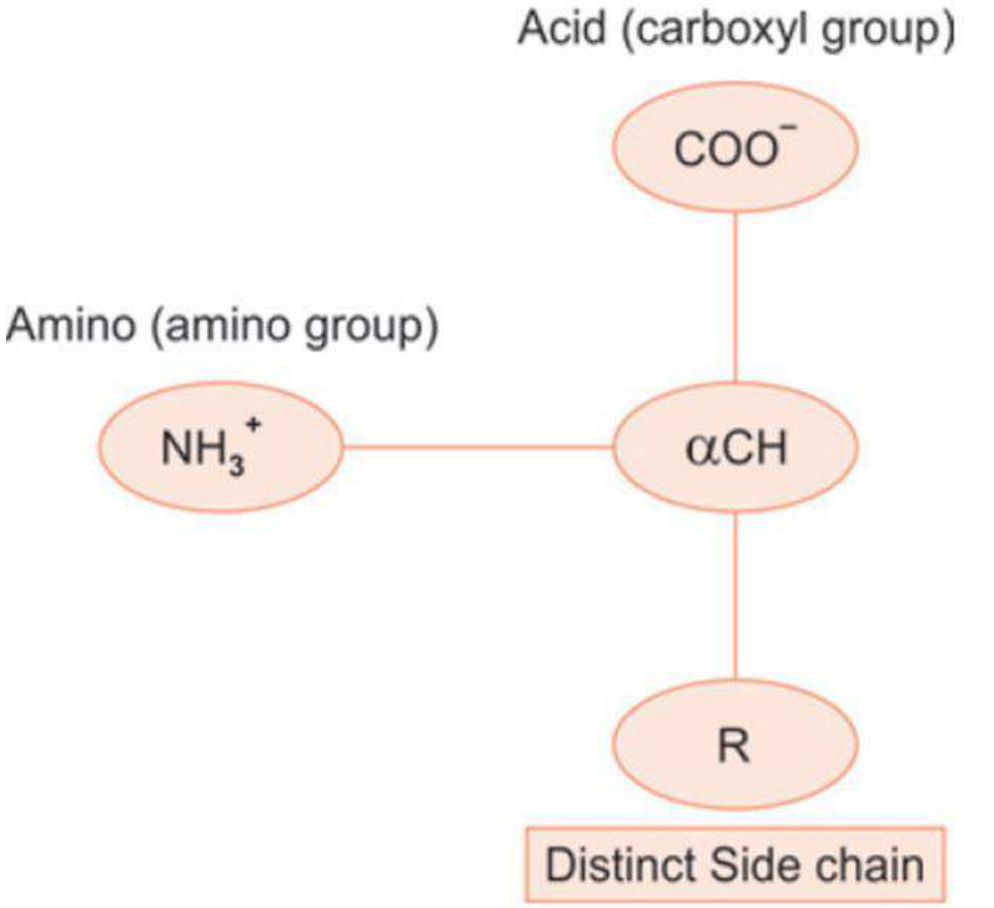
General Structure of Amino Acids

- All amino acids have a central carbon atom attached to a carboxyl group, an amino group, and a hydrogen atom.
- The amino acids differ from one another only in the chemical nature of the side chain (R).
- There are hundreds of amino acids in nature, but only 20 are used as building blocks of proteins in humans.



General Structure of Amino Acids

- The R group is the only part of an amino acid's structure that varies from one to the other; the other parts of the structure are common to all of them.
- R groups are aliphatic when they contain only carbons and hydrogens, which are so similar in electronegativity that they are **nonpolar**—meaning they are **hydrophobic** or can't make hydrogen bonds with water and therefore avoid it.
- Other R groups contain other atoms and can ionize or make hydrogen bonds, so these are **hydrophilic**—they like water.



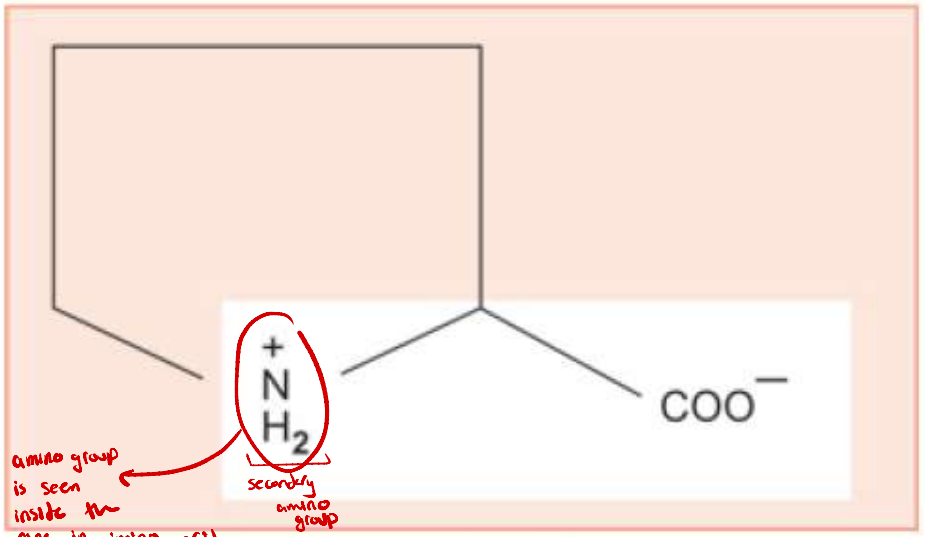
General structure of alpha amino acid

Imino Acid

↳ The only amino acid that has a different structure [in terms of the back bone structure] than the one above.

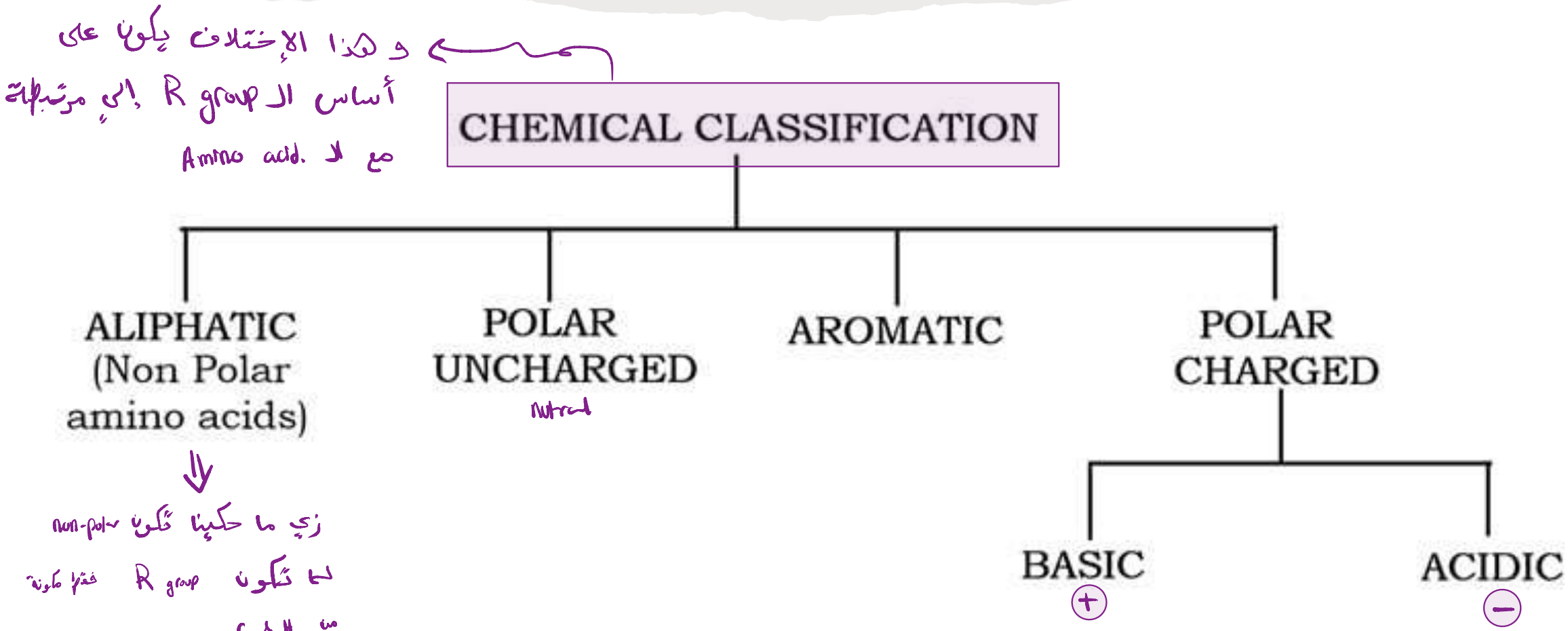
- Amino acid group not free
- The nitrogen of amino group is seen inside the ring
- **Proline** is an imino acid

↳ From proline, we can biosynthesize proteins.



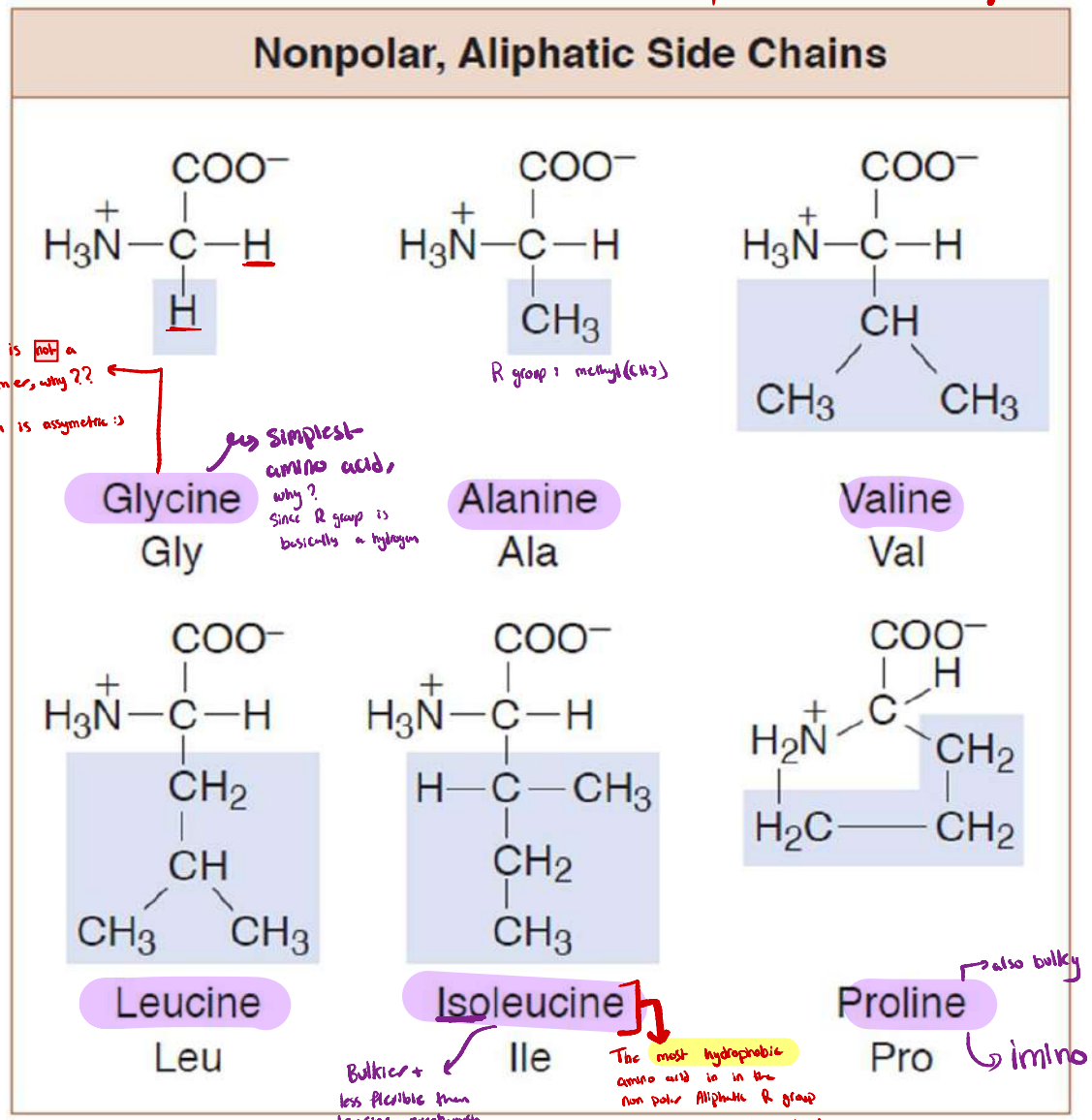
Structure of imino acid

BASED ON CHEMICAL CLASSIFICATION



Non-Polar Aliphatic Side Chain

- **Hydrophobic amino acids**, which have R groups that mostly contain carbons and hydrogens, include glycine, alanine, valine, leucine, isoleucine & proline.
- The degree of **hydrophobicity increases steadily from glycine to isoleucine** as the R groups increase in size and complexity.



Valine, Leucine, isoleucine are considered branched Chain amino acids...

* شو معنى Branched chain amino acids ؟؟

يعني اذا 3 إلي فوق essential amino acids الجسم غير قادر على تصنيعهم.

← في الحياة، بنشوف الي بروحوا الجيم بشربوا أشياء فيها branched amino acids عشان إله فائدتين: alleviate muscle soreness, restore muscle strength

* تذكير:

لما نعرف اذا Structures ال amino acids

Polar Uncharged R groups

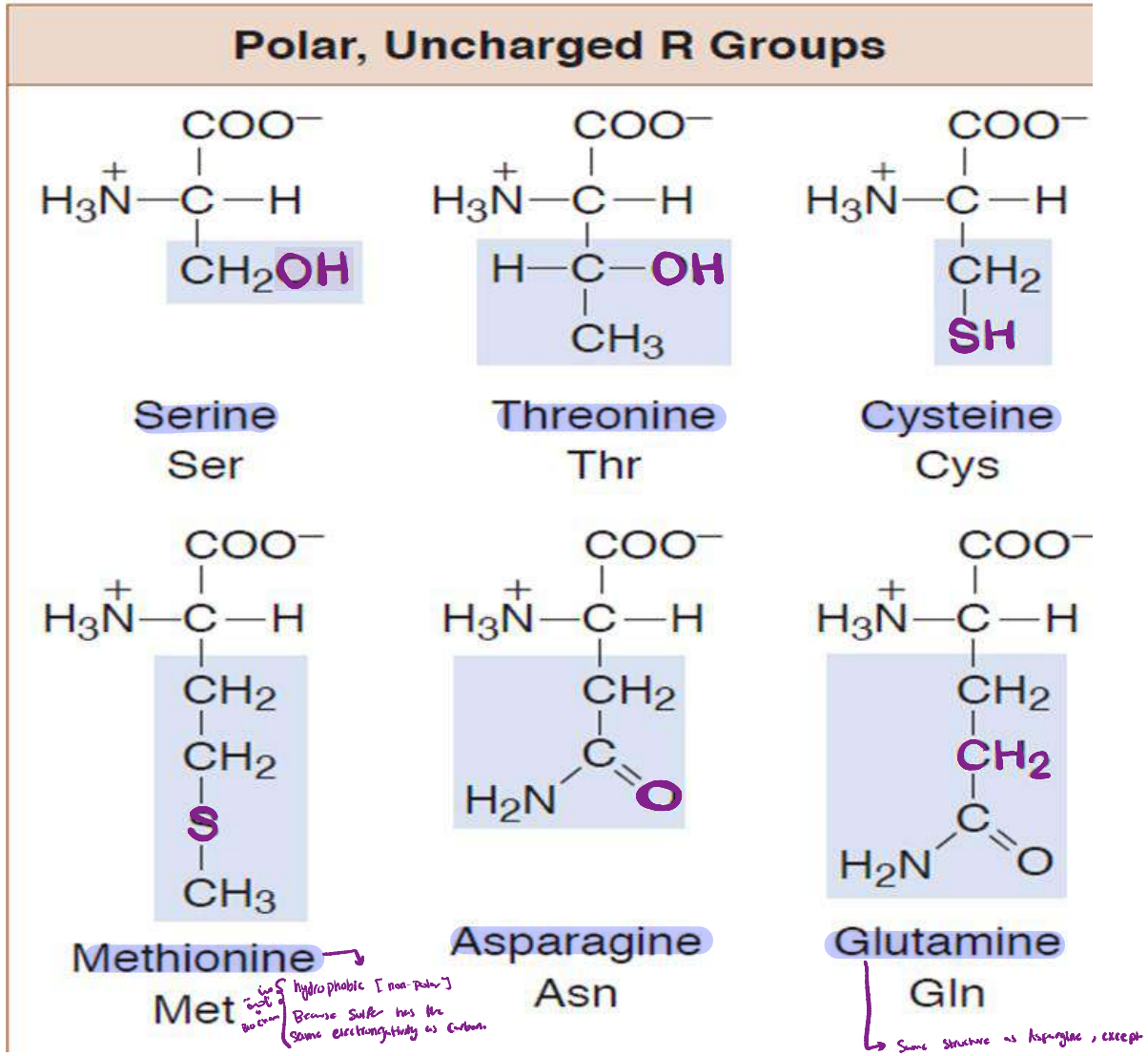
More soluble in water than the non-polar aliphatic group.

Their (R) groups contain **neutral polar functional groups**, which form hydrogen bonds with water.

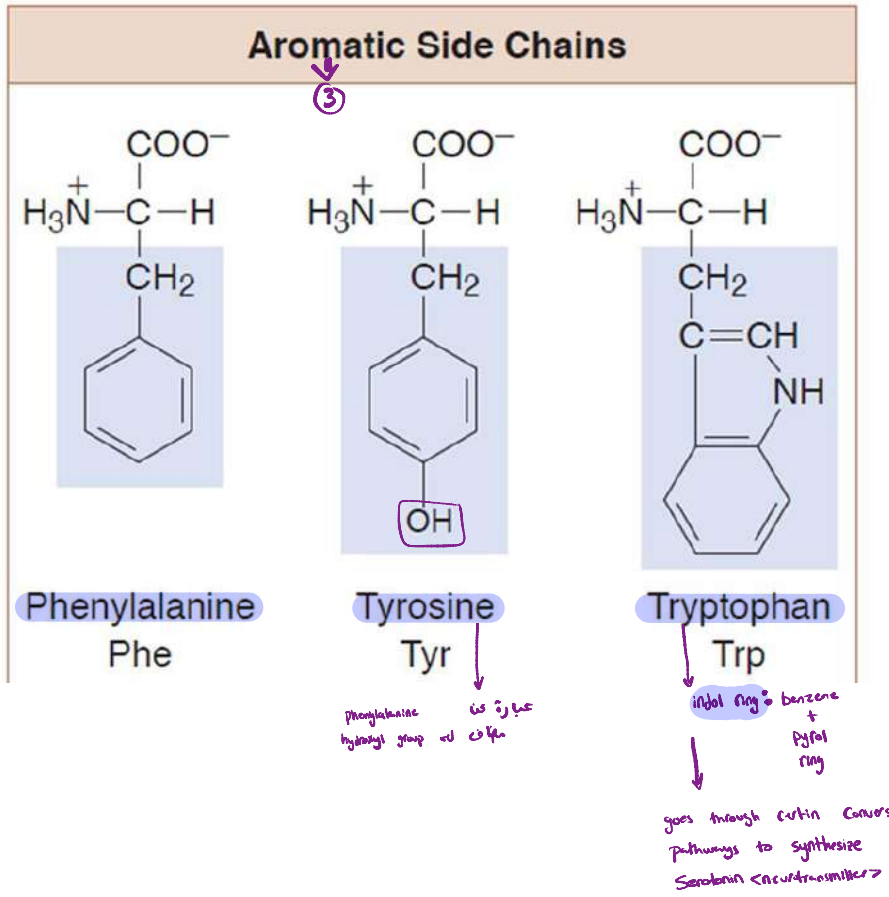
1- Serine, threonine (contain hydroxyl group)

2- Cysteine (contains thiol group)

3- Asparagine and glutamine (contain amide group)



Aromatic Side Chains



- A subgroup of the hydrophobic amino acids is the aromatic amino acids, named for the large and quite stable aromatic ring structures in their side chains.

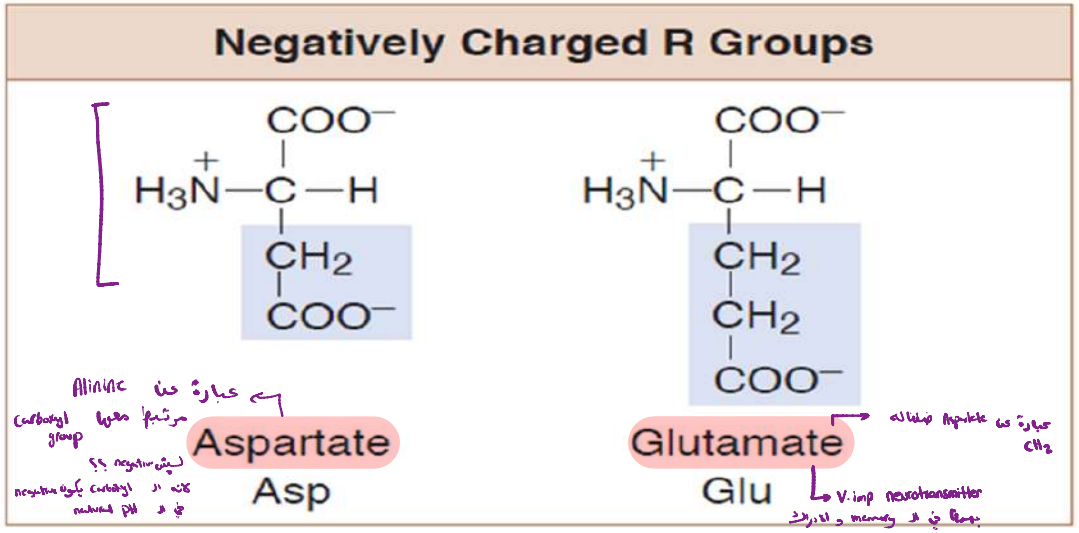
- **Phenylalanine**, is a phenyl ring of 6 carbons attached to an alanine. The R group is hydrophobic. It exhibits some properties of hydrophilic amino acids, but the ring makes it also hydrophobic.

- The largest hydrophobic amino acid is **tryptophan**, which has an R group of 9 carbons and 1 nitrogen in a structure known as an **indole ring**. *Tryptophan is also a component of the neurotransmitter serotonin.*

Negatively Charged R Groups

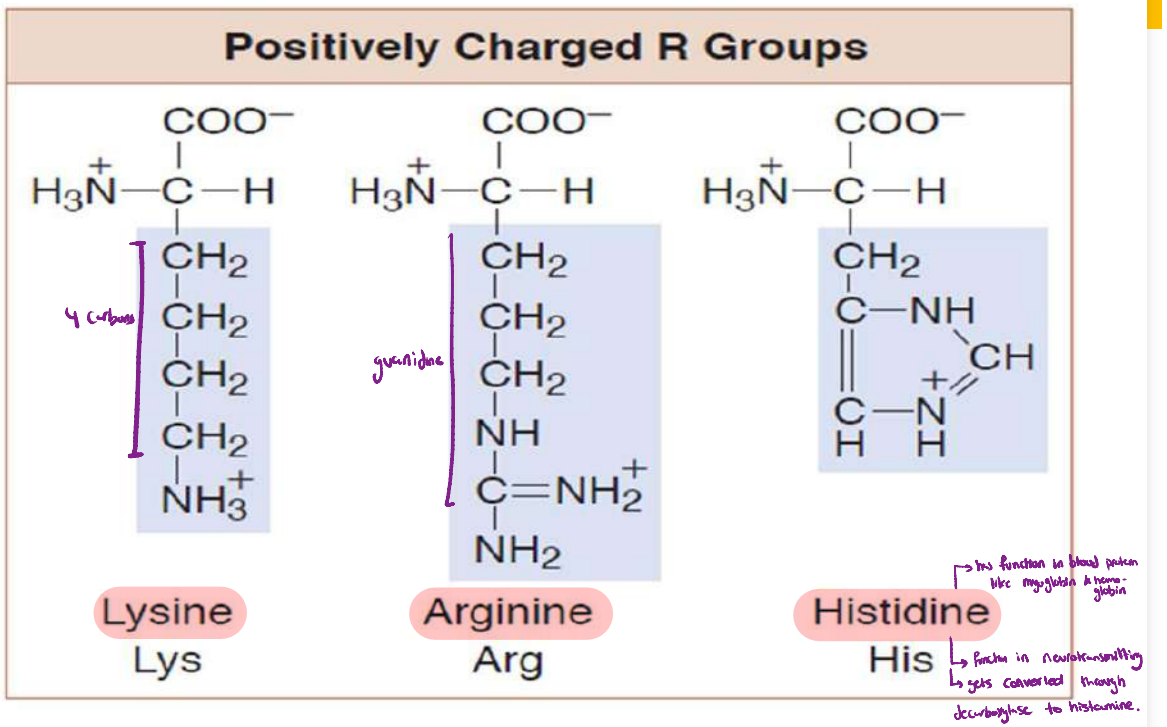
- The acidic amino acids contain carboxyls in their R groups—**aspartic acid** and **glutamic acid**. Ionized forms of these are called aspartate and glutamate.

- Both aspartate and glutamate help cells use protein as an energy source when supplies of sugar run low or when a person goes on a low-carbohydrate diet. In cells, aspartate and glutamate are important in managing ammonia (NH_3), a toxic by-product of metabolism.

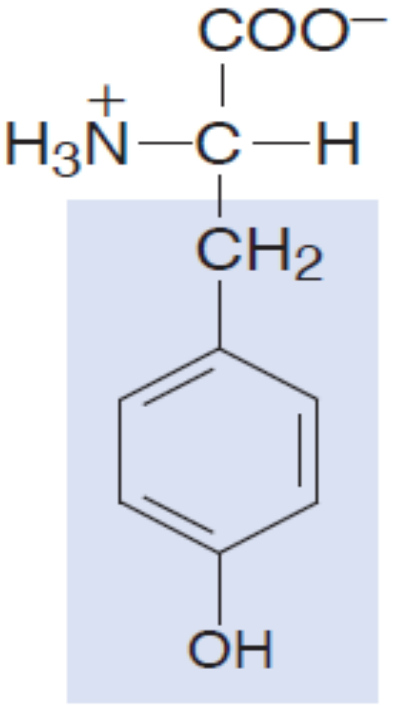


Positively Charged R Groups

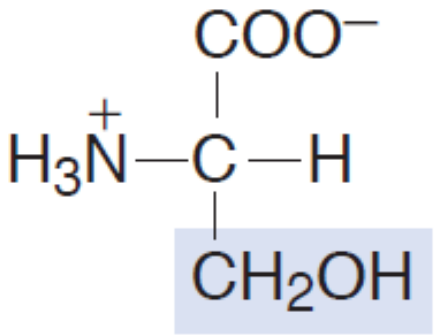
- The 3 basic amino acids—lysine, histidine, and arginine—are called basic because their R groups accept protons at physiological pH, giving them positively charged R groups.
- **Arginine** plays an important role in the urea cycle as the source of urea – (Guanidine group).
- **Histidine** is important in many enzymes and in the blood proteins myoglobin and hemoglobin.



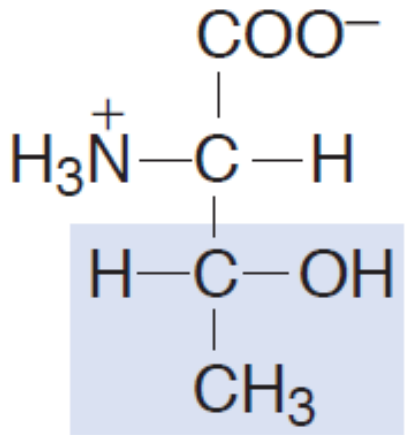
Amino Acids with Hydroxyl Group



Tyrosine
Tyr



Serine
Ser

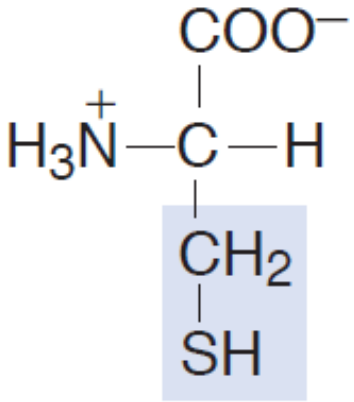


Threonine
Thr

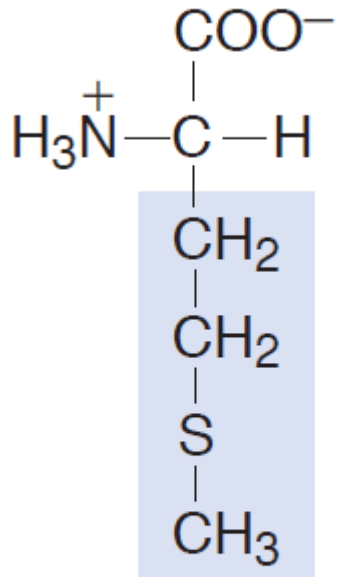
* The following 4 Slides are simply a Revision!

← مجرد تقسيمات بطرق مختلفة

Amino Acids with Sulfur



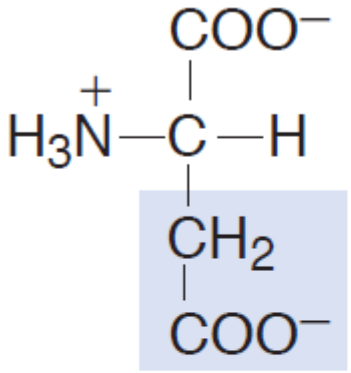
Cysteine
Cys



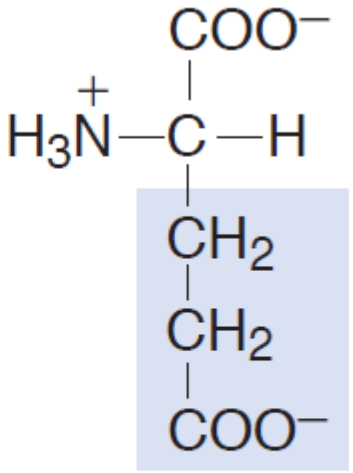
Methionine
Met

Remember: hydrophobic

Amino Acid with Amide Group

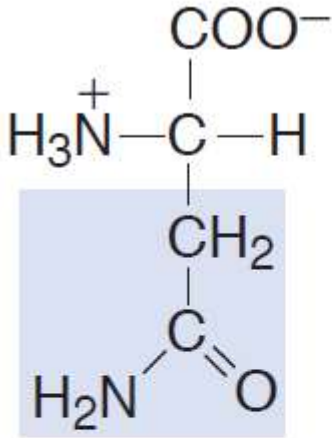


Aspartate
Asp

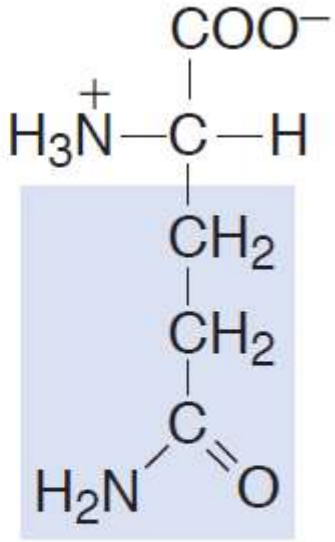


Glutamate
Glu

Brain needs glutamate, however glutamate does not cross the blood brain barrier. Glutamine on the other hand can cross blood-brain barrier entering the brain.
Inside the brain, using an enzyme, glutamine converts to glutamate so brain can use it.



Asparagine
Asn



Glutamine
Gln

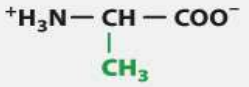
Aspartate to Asparagine,

add NH_2 + remove 1 oxygen [decarboxylation]

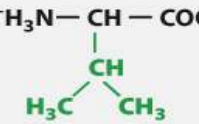
[Same for glutamate → glutamine]

* الأحماض متشابهة، مع نفرّق!

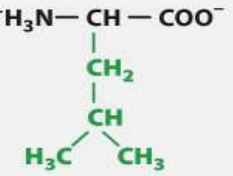
HYDROPHOBIC AMINO ACIDS



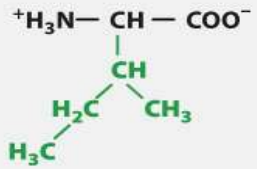
Alanine
(Ala, A)



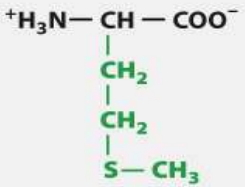
Valine
(Val, V)



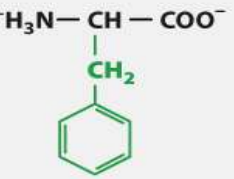
Leucine
(Leu, L)



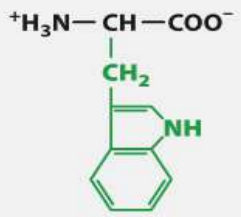
Isoleucine
(Ile, I)



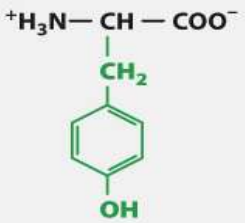
Methionine
(Met, M)



Phenylalanine
(Phe, F)

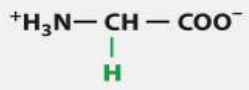


Tryptophan
(Trp, W)

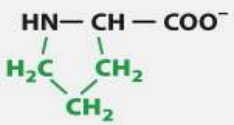


Tyrosine
(Tyr, Y)

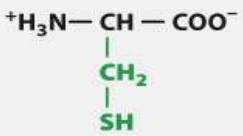
SPECIAL AMINO ACIDS



Glycine
(Gly, G)



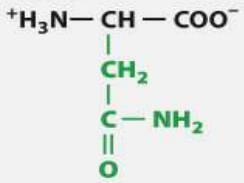
Proline
(Pro, P)



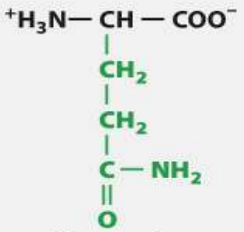
Cysteine
(Cys, C)

HYDROPHILIC AMINO ACIDS ⇒ Contain O or N

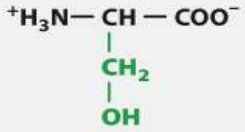
Polar



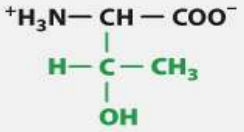
Asparagine
(Asn, N)



Glutamine
(Gln, Q)

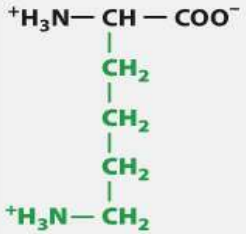


Serine
(Ser, S)

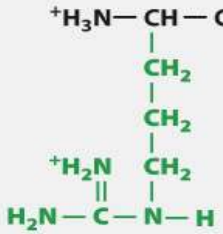


Threonine
(Thr, T)

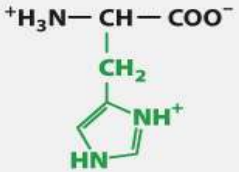
Basic



Lysine
(Lys, K)

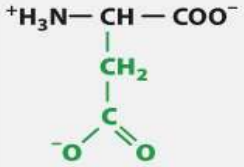


Arginine
(Arg, R)

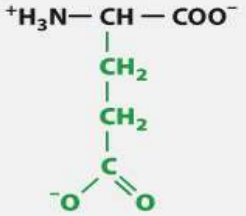


Histidine
(His, H)

Acidic



Aspartic acid
(Asp, D)



Glutamic acid
(Glu, E)

Hydrophobic amino acids

- **Phenylalanine** and **tyrosine** are precursors for catecholamines.
- **Tryptophan** can form serotonin and niacin.
- **Valine, leucine, and isoleucine** are branched-chain amino acids.

Hydrophilic Amino Acids

- Have side chains that contain O or N atoms; some of the hydrophilic side chains are charged at physiologic pH.
- The acidic amino acids (**aspartic** and **glutamic acids**) have carboxyl groups that are negatively charged, whereas the basic amino acids (**lysine, arginine**, and **histidine**) have nitrogen atoms that are positively charged.

Side notes!

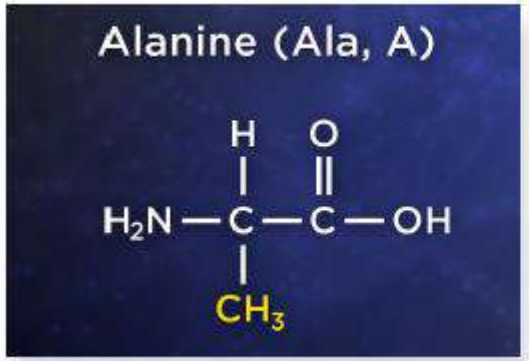
non-polar معظم الدهاري بتعتبرها

- **Tyrosine** can be considered nonpolar or polar because of the ability of the -OH group to form a hydrogen bond.
- **Methionine** can be considered nonpolar or polar because it contains a sulfur.

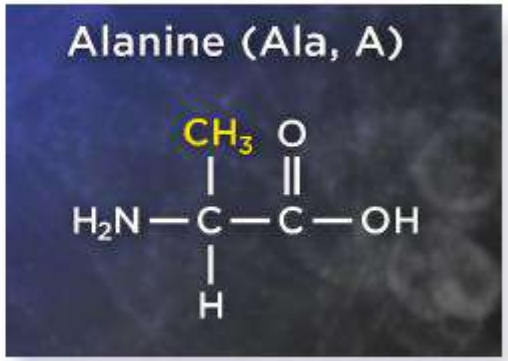
Optical Activity

- All amino acids except glycine can exist in 2 mirror image forms.
- These differ in the arrangement of the 4 groups around the alpha carbon.
- It's like right and left hands that cannot be superimposed on each other.
- The 2 forms are called stereoisomers: the L form and the D form.
- Glycine is different from all the other amino acids in having an H across from another H, so there's **only one form of glycine.**

L FORM



D FORM

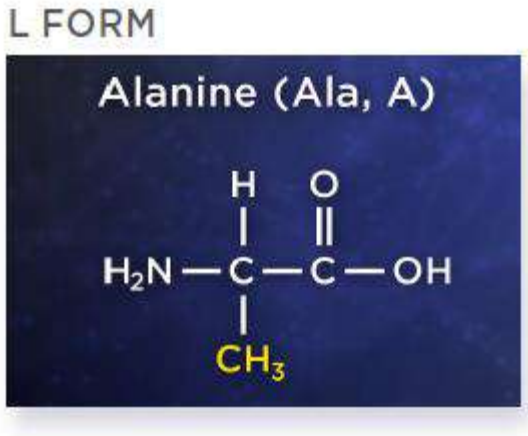


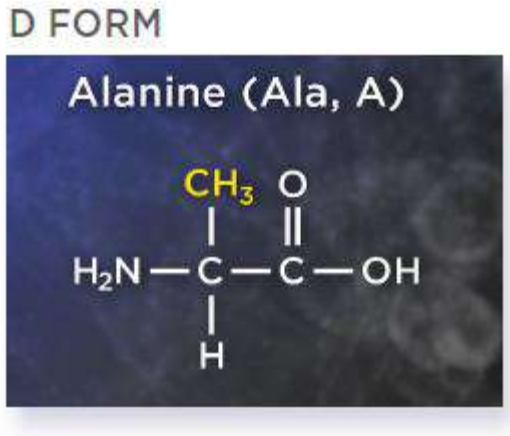
* تقريبًا كل ال amino acids في جسمنا موجودين بال L form

* في ممكن تكونا ال D form بال Bacteria

Optical Activity

- All chiral compounds, such as amino acids when made apart from cells, have a 50/50 mixture of the D and L forms.
- However, amino acids made in cells for use in protein synthesis are **almost completely in the L form.**





BASED ON NUTRITIONAL REQUIREMENT

20 amino acids are needed for protein synthesis.

- **Essential**: Those amino acids which cannot be synthesized in the body. Hence these amino acids are to be supplied in the diet.
- **Semi-essential**: Growing children require them in the food, but not essential in adults (ex: Arginine).
- **Nonessential**: Amino acids which can be synthesized in the body, hence not required in the diet.

من برا الجسم بوخدلي

Essential Amino Acids

"**A**ny **H**elp In **L**earning **T**hese **L**ittle **M**olecules **P**roves **T**ruely **V**aluable"
This stands for
Arginine, Histidine, Isoleucine, Leucine, Threonine, Lysine, Methionine, Phenylalanine, Tryptophan and Valine in that order.

Branching amino acids

Try T.His V.I.P M.A.L.L

Try::Tryptophan
T::Threonine
His::Histadimine → Semi - essential
V::Valine
I::Isoleucine
P::Phenylalanine
M::Methionine
**A::Arginine → Semi - essential Can't be synthesized in babies.
L::Leucine
L::Lysine

Non-essential Amino acids

- The remaining 10 amino acids are non-essential, because their carbon skeleton can be synthesized by the body.
- The non-essential amino acids are **Alanine**, **Asparagine**, **Aspartate**, **Cysteine**, **Glutamine**, **Glutamate**, **Glycine**, **Proline**, **Serine** and **Tyrosine**.

Essential & Non-Essential Amino Acids

Essential Amino Acids:

- Arginine
- Isoleucine
- Histidine
- Leucine
- Methionine
- Lysine
- Phenylalanine
- Tryptophan
- Threonine
- Valine

Non-Essential Amino Acids:

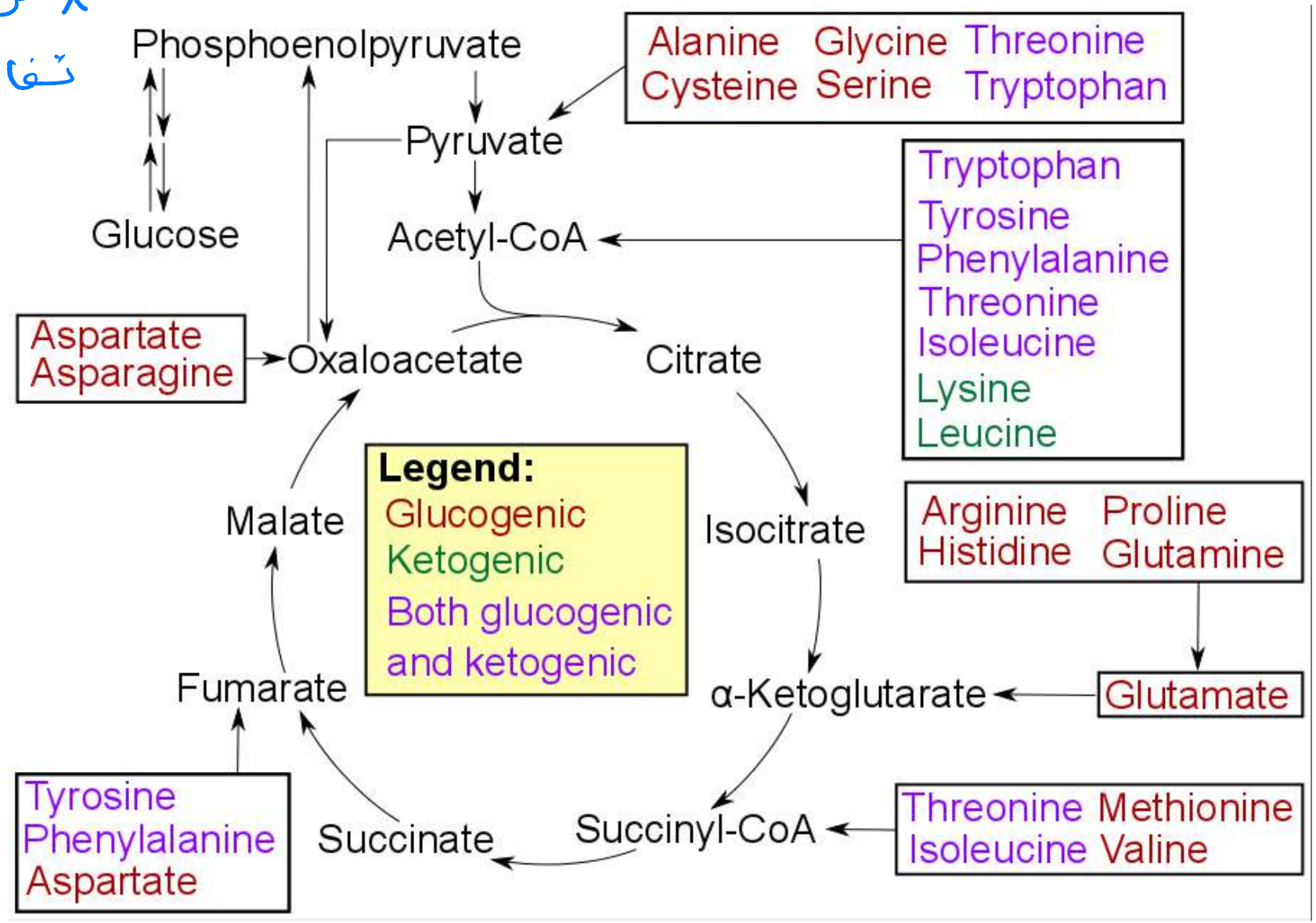
- Alanine
- Arginine
- Asparagine
- Aspartic Acid
- Cysteine
- Glutamic Acid
- Glutamine
- Glycine
- Proline
- Serine
- Tyrosine

BASED ON METABOLIC FATE

- **Purely ketogenic: Leucine** & **Lysine** are purely ketogenic because they are converted to ketone bodies
- **Ketogenic and glucogenic: Isoleucine**, **Phenylalanine**, **Tyrosine** and **Tryptophan** are partially ketogenic and partially glucogenic. During metabolism, part of the carbon skeleton of these amino acids will enter the ketogenic pathway and the other part to glucogenic pathway.
- **Purely glucogenic:** All the remaining 14 amino acids are purely glucogenic as they enter only into the glucogenic pathway

Ketogenic Amino Acide	Glucogenic and Ketogenic Amino Acides	lucogenic Amino Acid
• Leucine • Lysine	• Tyrosine • Tryptophan • Threonine • Isoleucine • Phenylalanine	• Rest all are Glucogenic

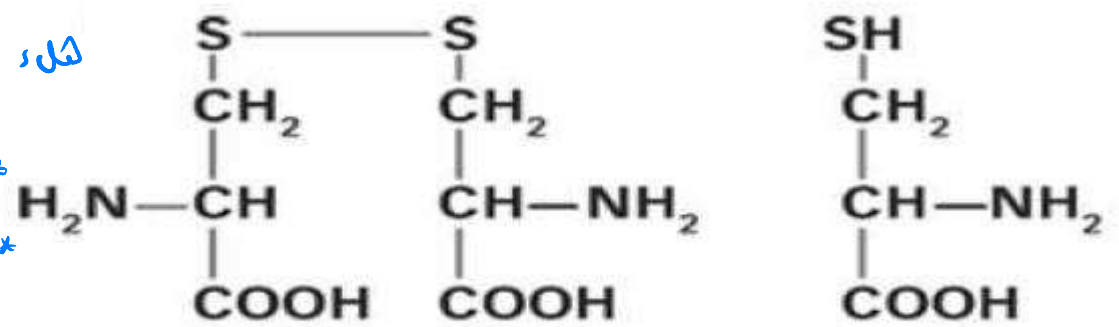
* مو لازم نحفظ تفاصيل الـ cycle



PROPERTIES OF AMINO ACIDS

- Solubility: all amino acids are soluble in water.

- However, cystine is poorly soluble; that is why excretion of large amounts of cystine in urine (cystinuria) leads to stone formation.



Cystine

Cysteine