Lecture :.....1.....

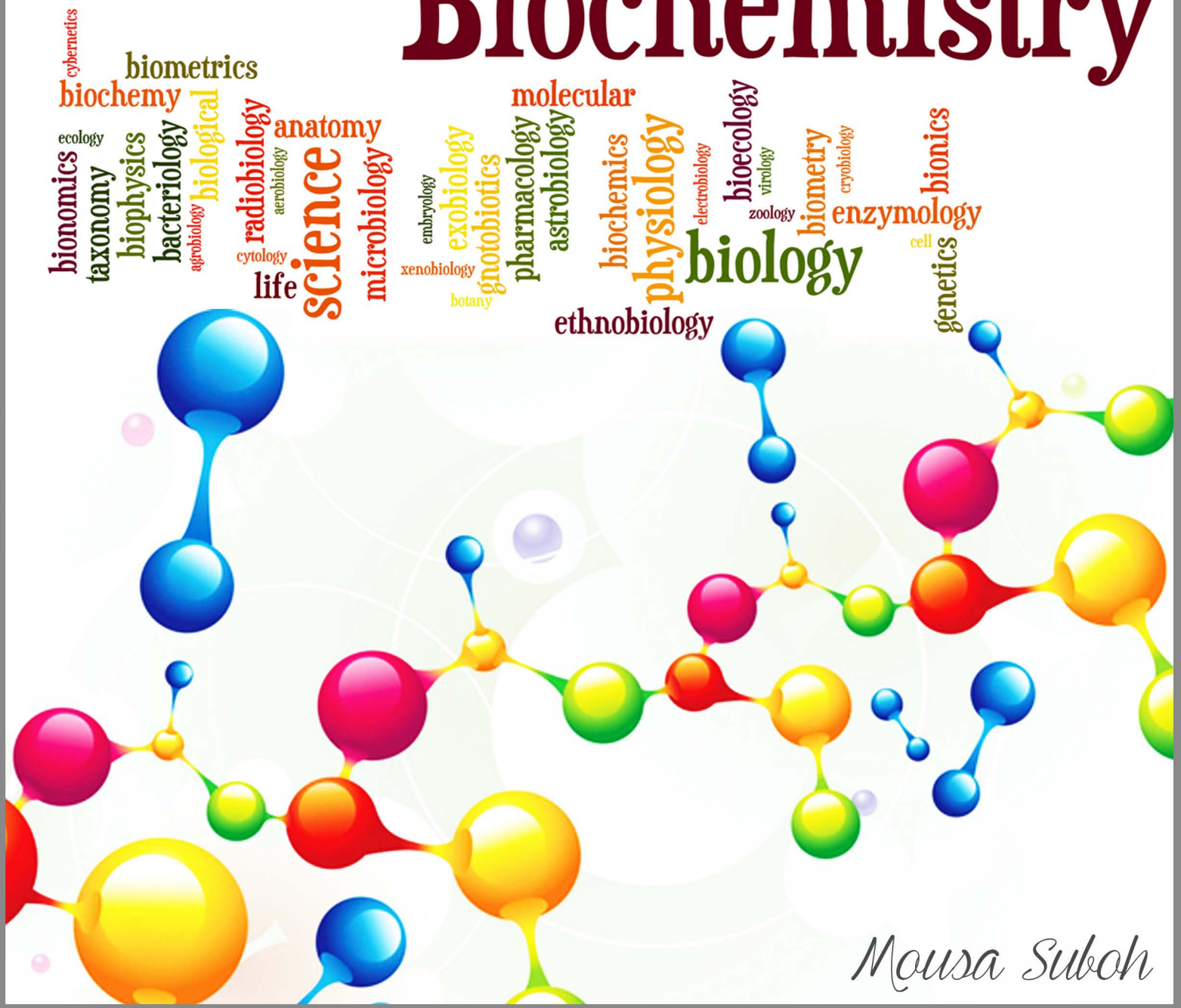
Dr. Name :.....Mamoun Ahram.....

Done By :.....Tasneem Suhail.....

☐ Slide ■ Sheet

Medical Committee
The University of Jordan

Biochemistry



Mousa Suboh

Amino Acids

Dr's office in physiology department in floor #1

Office hours: every day after 1

*How to study biochemistry for Dr. Mamoun's material:

Slides will be sent before the lecture, try to read it and familiarize yourself with it. After the class, study it very well, ask yourself questions, and then revise it with a friend.

You have finished with Dr. Diala the acids, base, buffers, titration, etc.

We are going to talk about amino acids.

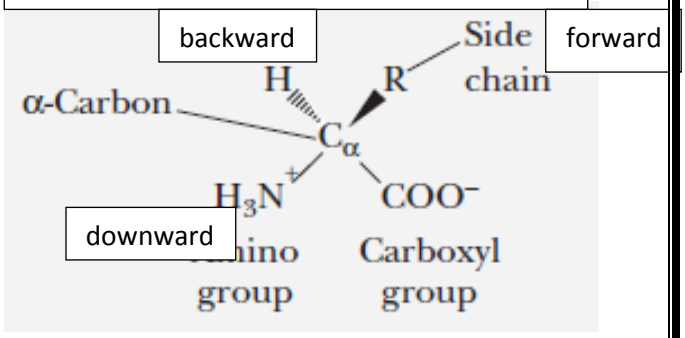
Note: the book is recommended not required.

General structure

When you think about biochemistry or molecular biology or molecules; you need to think of 3-D all the time.

Amino acid is a very simple structure, it has a central carbon which is called α carbon.

This is the general structure of amino acids.



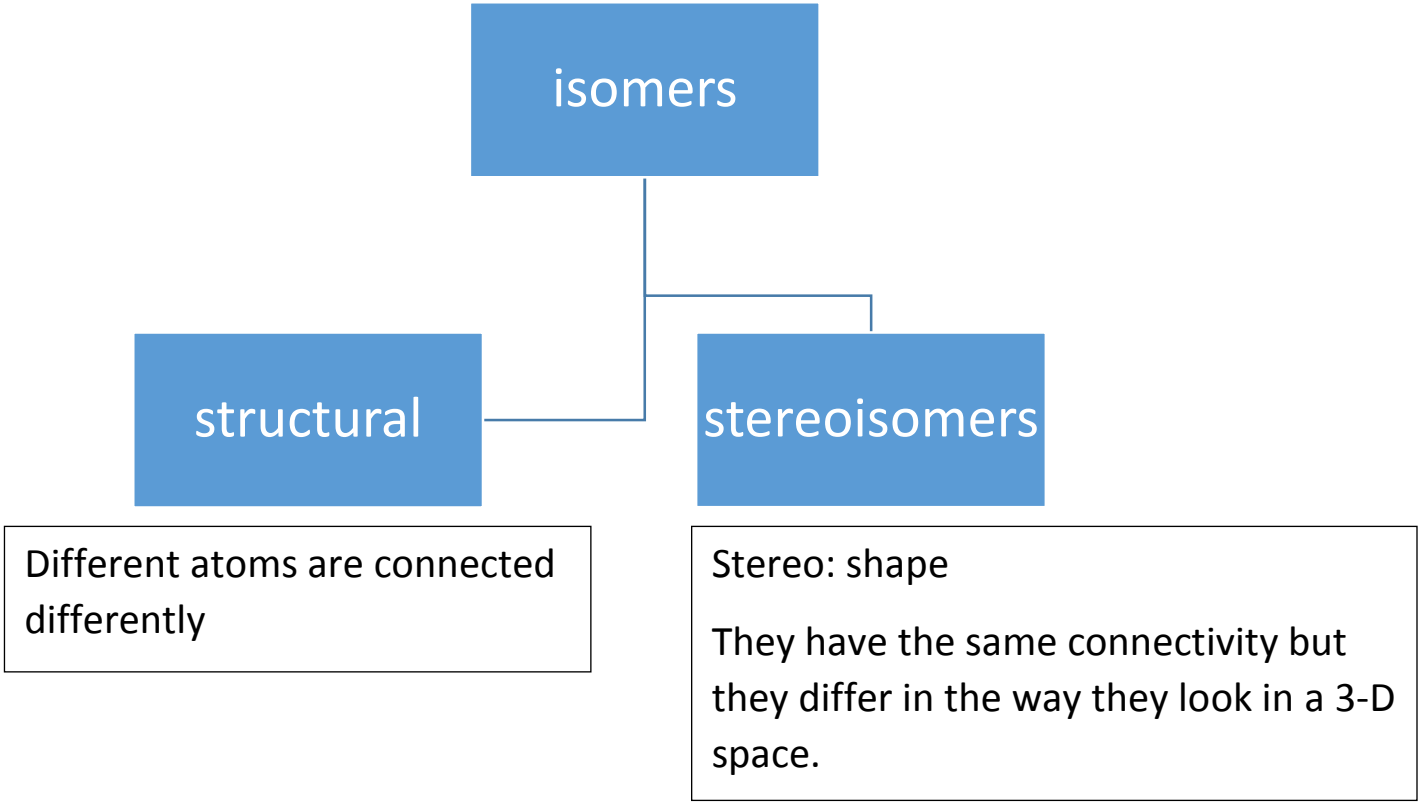
"C" can make four covalent bonds with: carboxylic, amino, hydrogen and R group. (R group: means anything that contains C, which determines the difference between amino acids)

Note: because amino acid has a *carboxylic group* (with -VE charge) and amino .group (with +VE charge) it is called Amino *Acid*

*when a carbon is bonded to four different groups, this carbon is called: chiral carbon and the whole molecule is called chiral molecule.

Note: there is one exception of amino acids that is considered achiral (not chiral) >> it is glycine.

*Molecules that have the same molecular formula > they have the same # of atoms (C, O, N, etc) are called isomers.

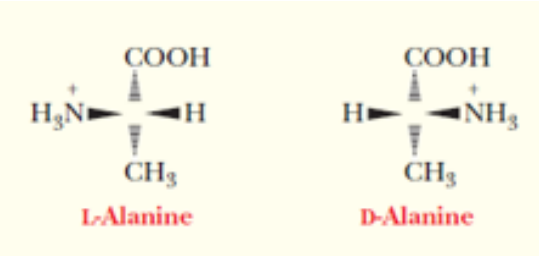


Ex: in a molecule "N" is going forward and it is going downward in another one so they are stereoisomers." He mentioned the palm as an example also.

*If two molecules superimpose on each other >> they are the same molecule, if they don`t they are stereoisomers.

Enantiomers: two stereoisomers which are mirror images of each other,

these mirror images are labeled **with designation:**



-D amino acid (with NH_3^+ on right)

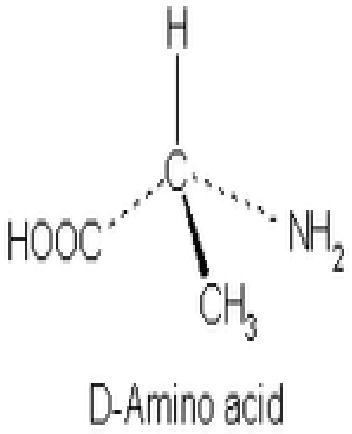
-L amino acid (with NH_3^+ on left)

How they get D and L?

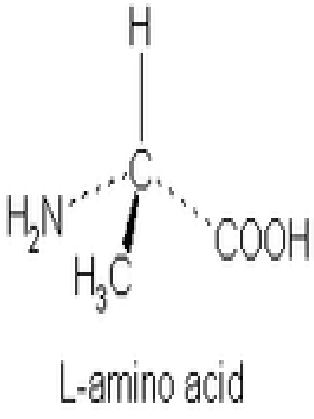
Light polarization experiment: a pure molecule is exposed to a straight light >> If the light deviates: - right>> D -Left>> L

General role: The amino acids that occur in proteins naturally are all of the L form (not the D form)

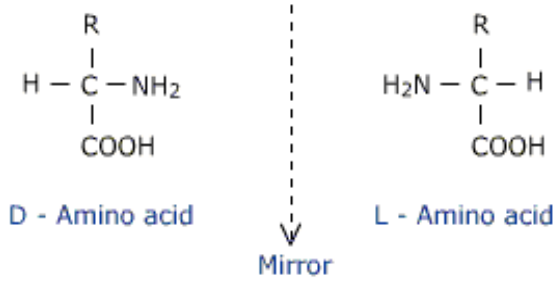
*There are exceptions; we will talk about them later on but one of them is: in one peptide combination of amino acids (which they are linked with each other) some of them are L and others are D in the same molecule.



D-Amino acid



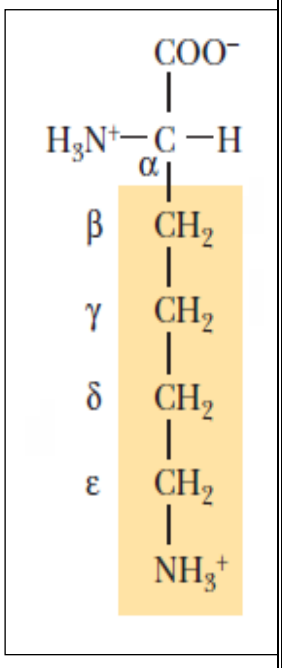
L-amino acid



Fisherman projection

** R group: is basically a bunch of carbons one after the other.

Each carbon atom in The straight chain of carbons is given a designation, the first carbon which is bounded to the carboxylic and amino group is called alpha carbon, the second one is known as beta, then gamma, delta, epsilon …



* The terminal carbon atom is referred to as the ω-carbon (omega carbon).

*Note: when the R is branched you must chose the longest chain to determine the Greek letters.

*There are many types of amino acids, but only 20 amino acids that make up proteins. ”there is another one we will learn it in molecular biology”.

*These amino acids can be divided into different categories according to their: size, shape, charged, hydrogen-bonding capacity, hydrophobic character and chemical reactivity. And they all depend on the R group.

R group: determines everything about amino acids because all amino acids have the same H, NH_3^+, and COO^-. They all differ in the R group

**Note: we are required to memorize the 20 amino acids and everything about them; to which group they belong, what is the R group and their characteristics.

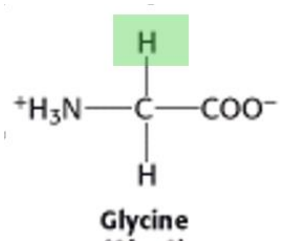
Everything about proteins and enzymes depend on your knowledge of these amino acids.

**Note: memorize the three letters abbreviation between () and forget about the single one.

The amino acids in this schedule that have this symbol # are considered aromatic amino acids

Non-polar	Polar	Charged (positive)	Charged (negative)
Alanine	Serine	Lysine	Glutamate
Valine	Threoeine	Arginine	Aspartate
Leucine	Glutamine	Histidine	
Isoleucine	Asparagine		
Methionine	Cysteine		
Proline	**Glycine**		
#Phenylalanine	#Tyrosine		
#Tryptophan			
Glycine			

#Glycine (Gly) (lovely amino acid)



Glycine

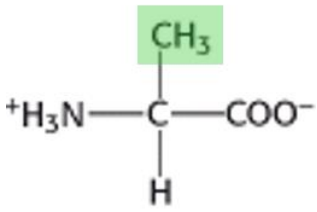
-Is the smallest amino acid because the R group is nothing but H.

-It is the only achiral amino acid.

-It is polar, why? Because the "H" is too small to have an impact on the polarity of this amino acid, so it is considered as a polar amino acid. But in the categorization we consider it as nonpolar amino acid

Nonpolar, aliphatic amino acids

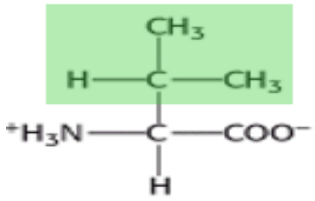
1-Alanine(Ala)



Alanine

R group >> CH_3 influence on the other groups around the αC so it is nonpolar.

2-valine (Val)



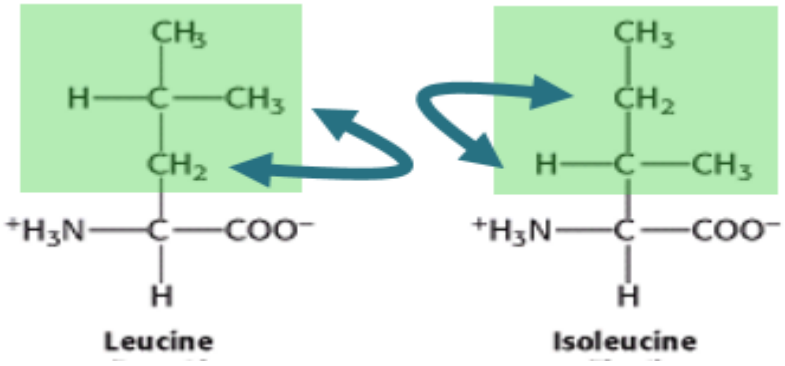
Valine

Put an ethyl group between the CH_3 and the Cα in Alanine.

3-leucine (leu)

.Put a methelene group (CH2) between the isopropyl and the Cα in valine

4-*I*soleucine(*I*le)



Leucine Isoleucine

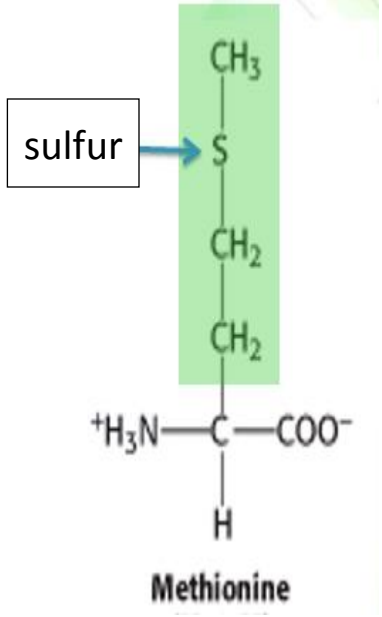
1- βC in leucine is not branched like valine and isoleucine.

2- (2+3+4) these amino acids are essential amino acids >> we have to take them from diet because our body cannot synthesis them.

5-Methionine(Met) "sulfur-containing amino acid"

Straight chain

- The R group is a straight chain that contains a sulfur atom, this sulfur is not really reactive ("S" is an electron negative atom that make the molecule reactive), but because "S" is located between 2 groups it is not really reactive unless there is strong oxidizing agent.

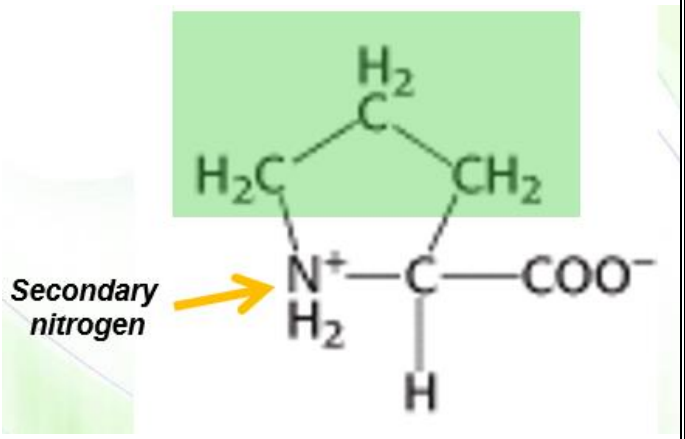


Methionine

6-Proline (pro) (iminoacid)

-contains imino group (which is the ring, actually)

-to memorize: it is already chain then it is wrapped to make another covalent bond between the branch and the amino group of the amino acid >> that makes the "N" of the NH_3^+group 2◦ N.



-it is a rigid amino acid (rigid means صلب, قاسي) ;because it is a ring structure, bonded and tightly wrapped, so it`s not a flexible amino acid

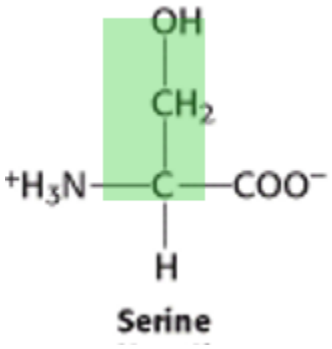
#if the R group is a chain then the flexibility increases.

Polar amino acids

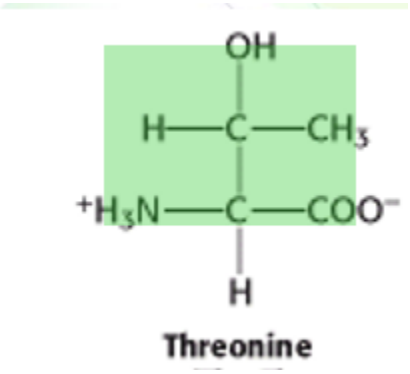
1-Glycine

2-Serine(Ser)

3-Threonine(Thr)



Serine



Threonine

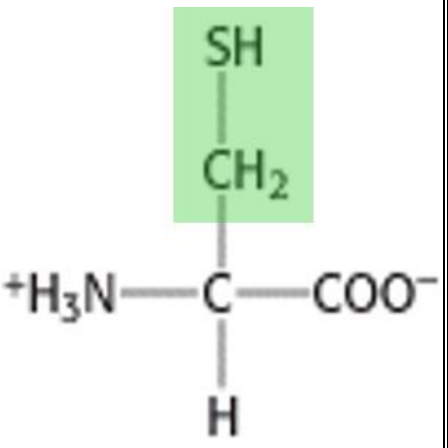
(2+3) they are polar amino acids that contain a hydroxyl group at the end of R and that what makes them polar.

Notice the resemblance between:

*serine and alanine>> they are exactly the same except: alanine has a (CH_3) group one of the H in (CH_3) is replaced by OH in serine.

*threonine and valine>> threonine looks like valine except that :the omega carbon ".with the 3 H atoms attached to it (CH3) in (valine) is replaced by OH in threonine

4- Cystine (Cys)



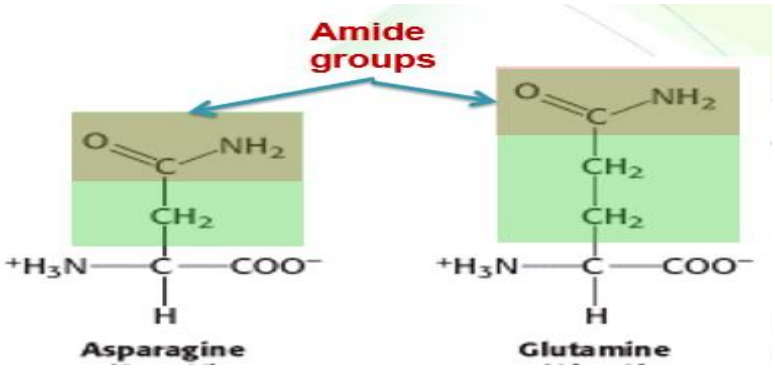
-a very critical and important amino acid.

-the second amino acid with sulfur “S” { the first one is methionine (met)} But the difference >>thiol group ”S” here is terminal (at the end of R group), that’s what makes the R group of (Cys) a reactive one.

-“S” can form a covalent bond.

5-*As*paragine(*Asn*)

6-*Gl*utamine(*Gln*)



(5+6).. they end with "ine" because they have an amino group in R (the amino group with Carbon double bonded to Oxygen are called an Amide group).

.. they are derived from Aspartic acid and glutamic acid, respectively.

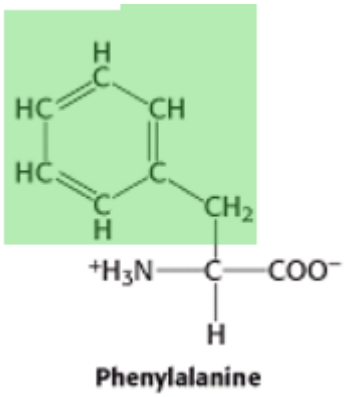
Aromatic amino acids

Amino acids contain a ring structur (that's why they are called aromatic amino acids)

-They are bulky(large)

1) phenylalanine (Phe)

-Replace the H in CH3 of Alanine and put a phenyl group

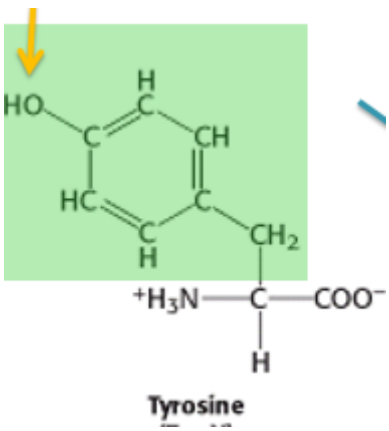


2) Tyrosine (Tyr)

-Phenylalanine with OH

-OH makes the Tyrosine a polar amino acid

-contains a phenyl group with OH => phenol



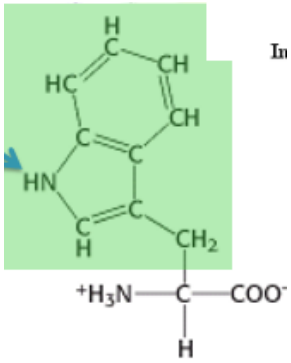
3)Tryptophan (Trp)

- you can find it in milk

- a large bulky amino acid contains a ring structure known as Indole ring structure (a ring contains N)

Even though it is an electro negative group , it does not make Tryptophan a polar amino acid because we have a large ring structure and

that makes Tryptophan hydrophobic nonpolar amino acid.

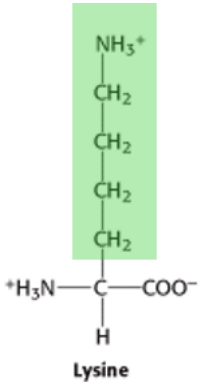


Positively-charged amino acids

They have a positive charge.

1)Lysine (Lys)

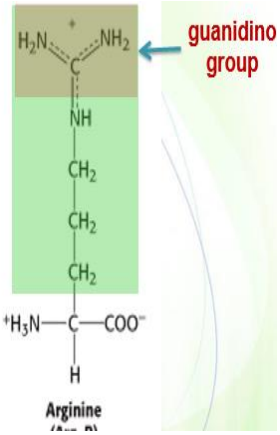
The R group is a straight chain but it contains a charged amino group at the end.



2)Arginine (Arg)

-it contains guanidino group.

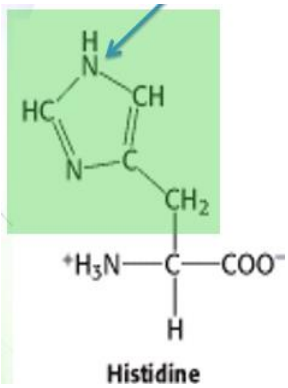
-there is a dotted line so the double bond can be resonated (move from one group to another group) so it can flip.



3)Histidine (His)

-it contains a ring structure known as Imidazole.

-Imidazole is very important because it contains an amino group which can be positively charged. (we will know why it is very important when we talk about the titration)



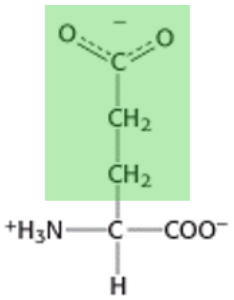
Histidine

Negatively-charged amino acids

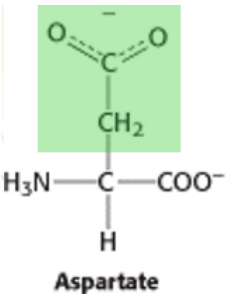
1)Asparatic acid (Aspartate) Asp

2) Glutamic acid (Glutamate) Glu

1+2 contain in their R group a carboxyl group
-they differ from Asparagine and Glutamine by replacing the N of amide group.



Glutamate



Aspartate

MonoSodium Glutamate in food

In Chinese food there is a flavor “its MSG” which leads to Chinese restaurant syndrome[causing chills, headaches and dizziness for the one who eat it]

Q : the following amino acid is achiral ? Glycine
-the Dr might ask us about the name of the ring, charge of an amino acid or the type of it , etc.
"A student asked the doctor: If we have a branched Beta carbon how do we name the next two carbons?
The doctor answer was: we leave the branch and name the longest chain"

Specialized and uncommon amino acids

Amino acids as single molecules can be used in the body to produce many other molecules derivatives.

They can be used to make:

1-Hormones

2-Neurotransmitters

3-Biologically active peptides

*Tyrosine:

From it we can make hormones and neurotransmitters known as catecholamines. Why are they called like that? Because the structure of their ring contains catechol.

A) Hormones or neurotransmitters: Dopamine, norepinephrine and epinephrine.

*epinephrine=adrenalin (fight or flight hormone) when the body secretes it; it produces energy

B) Tyrosine also converted into:

Melanin (pigment that is produced in our skin, it gives us the dark color) types:

1) pheomelanins (reddish skin and hair).

2) Eumelanins (dark skin, a lot in Africans but we have less).

Thyroxine(thyroid hormone that contains 2 types of molecules as well as Iodide "I")

>>Cheese contains high amounts of tyramine which is similar to epinephrine. Tyramine is made by tyrosine; so people love to eat cheese .Because tyramine is similar to epinephrine which gives us energy, that's why we eat it in breakfast.

***Tryptophan:** can be used to make neurotransmitters:

1) Serotonin (sedative) makes us relaxed.

2) Melatonin: hormone that is produced by Pineal Gland. It controls our sensation of day and night circadian cycle.

When it is high –especially in children- leads to sleep.

- As we get older, the synthesis and secretion of melatonin decrease>> sleep less.
- Melatonin in: elderly (low), children (high).

<<Tryptophan is found in milk, so anyone who cannot sleep just drink milk which contains tryptophan that will be transformed into serotonin> calms the body.

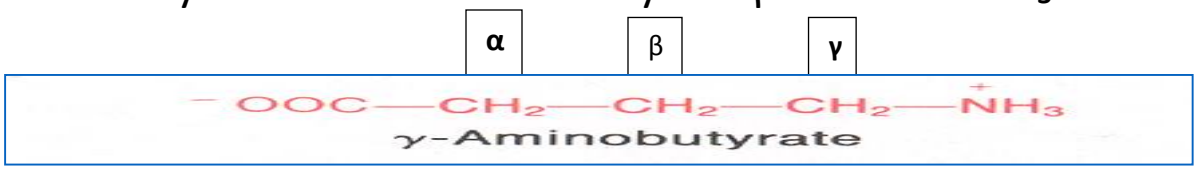
***Histamine:** is a molecule that is produced from histidine.

-It is responsible of allergies (allergic reactions); that is why we take drugs that are antihistamine.

-It can also act as neurotransmitter causes allergy and inflammation.

*Glutamate:

-Glutamate can be used to produce γ-aminobutyrate, which is an excitatory neurotransmitter. Why it is γ? Because NH_3^+ bind to γ carbon.



Glutamate —carboxylation→ α-carboxyglutamate

-carboxylation of Glutamate : (carboxyl group addition) depends on vitamin K.

α-carboxyglutamate very important in blood clotting.

***Arginine:** can be used to produce a gas "Nitric Oxide".

When Nitric Oxide is released from endothelial cells or macrophages (inflammatory cells), it makes vasodilation.

***Lysine and Proline:** can be hydroxylated, so we have hydroxylysine, hydroxyproline. We will take about them at fibrous protein lecture.