بسم الله الرحمن الرحيم

BioChemistry | Lecture 14

Amino acids pt.3 & Proteins pt.1

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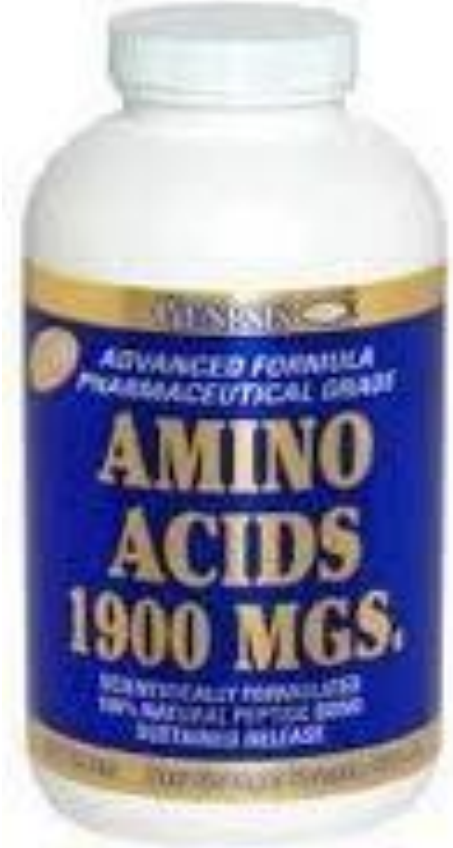
Amino Acids & life



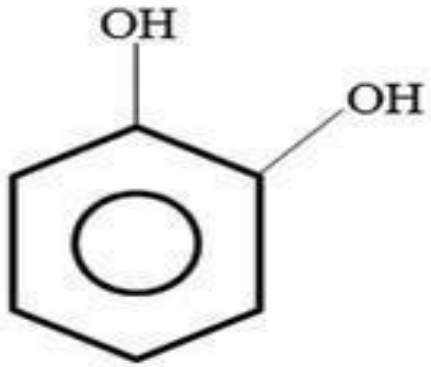
Posttranslational modification of Amino Acids

These modifications either happens **inside our body** or in **commercial (laboratory).**

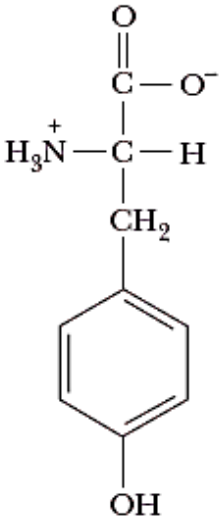
- Hydroxylation (-OH)
- Carboxylation (-COOH)
- Methylation ($-CH_3$)
- Formylation (-CH=O)
- Acetylation (CH_3CO)
- Phosphorylation ($-PO_3^{2-}$)

- These modifications significantly extend the biologic diversity of proteins by altering their solubility, stability, catalytic activity, and interaction with other proteins

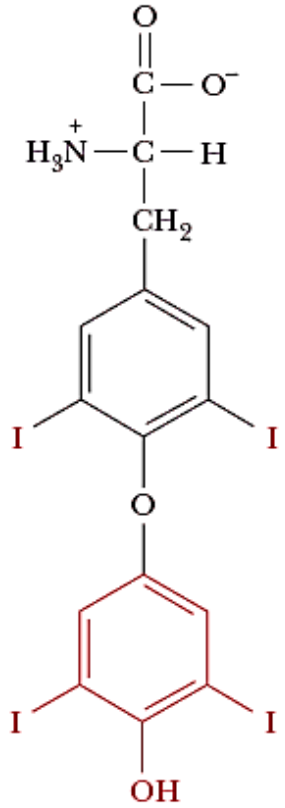
Tyrosine



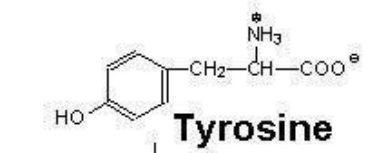
catechol

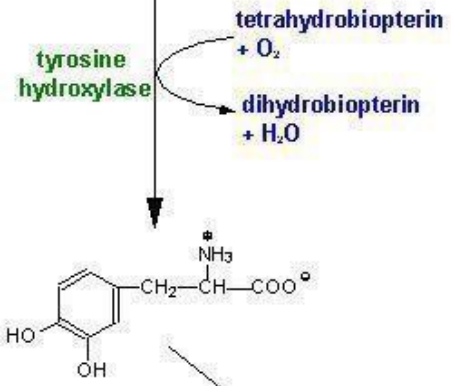


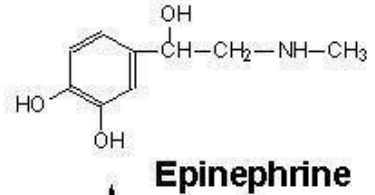
Tyrosine

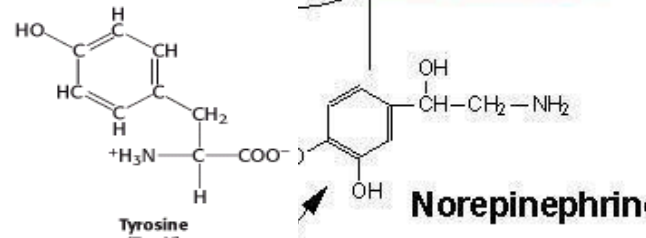


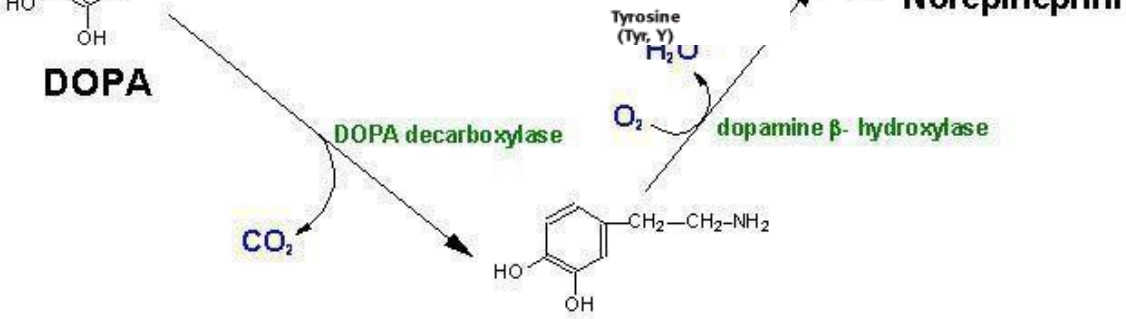
Thyroxine

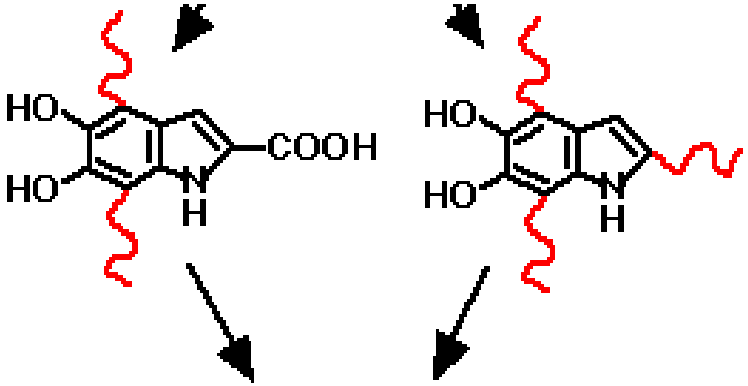




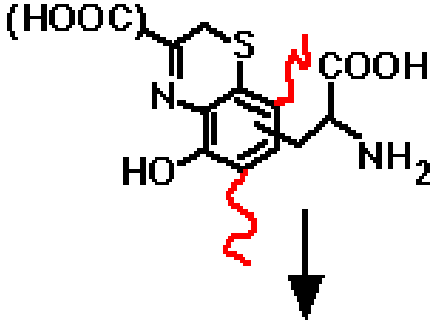




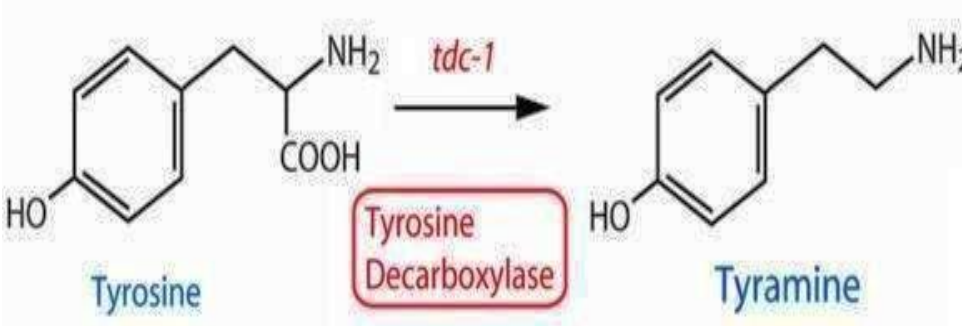




EUMELANINS



PHEOMELANINS

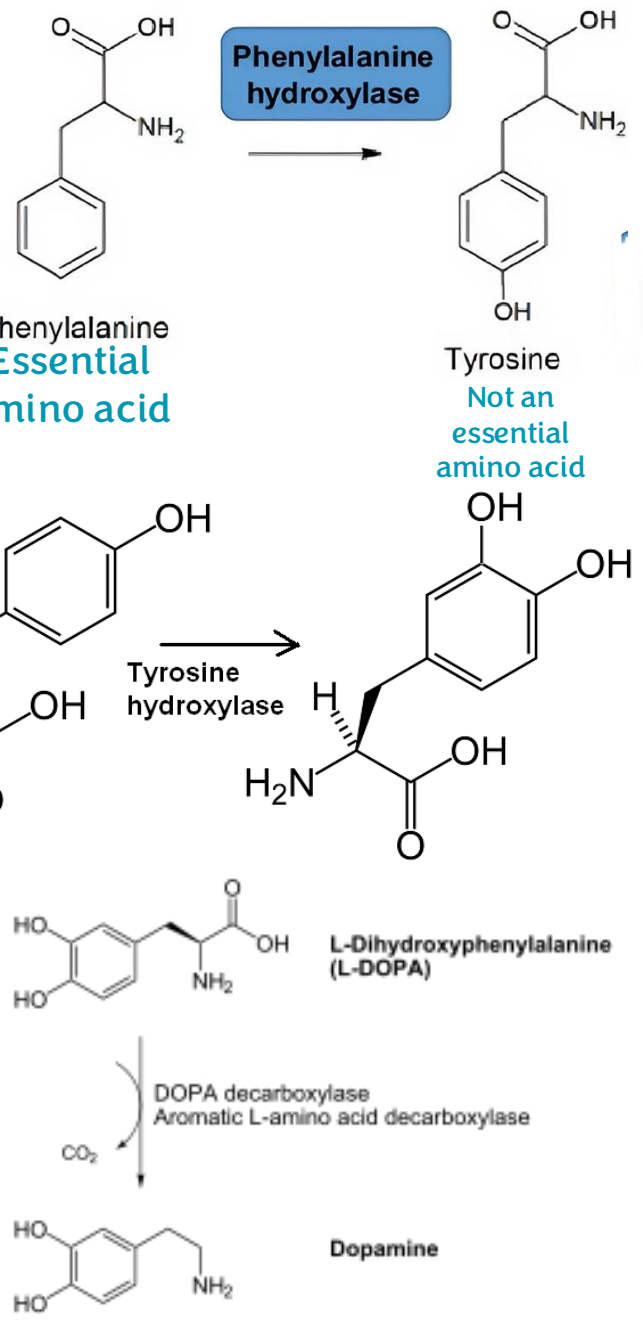


> **Tyrosine** is an amino acid that is a modification of another amino acid called **phenylalanine** by reaction happens inside our bodies called **phenylalanine hydroxylation** (catalyzed by an enzyme called **phenylalanine hydroxylase).**

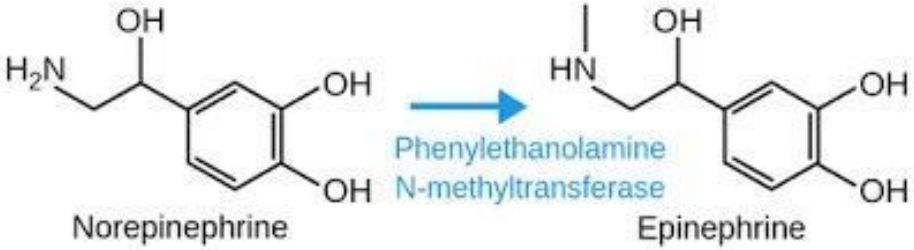
> **Tryosine** can be modified into another amino acid called **Dihydroxy phenylalanine (DOPA) by reaction called Tryosine hydroxylation (Tryosine hydroxylase**

> This amino acid (DOPA) can also be modified in to **DOPAmine** by the remove of carbolic group **(COOH)** or **(COO-) catalyzed by enzyme called DOPA decarboxylase.**

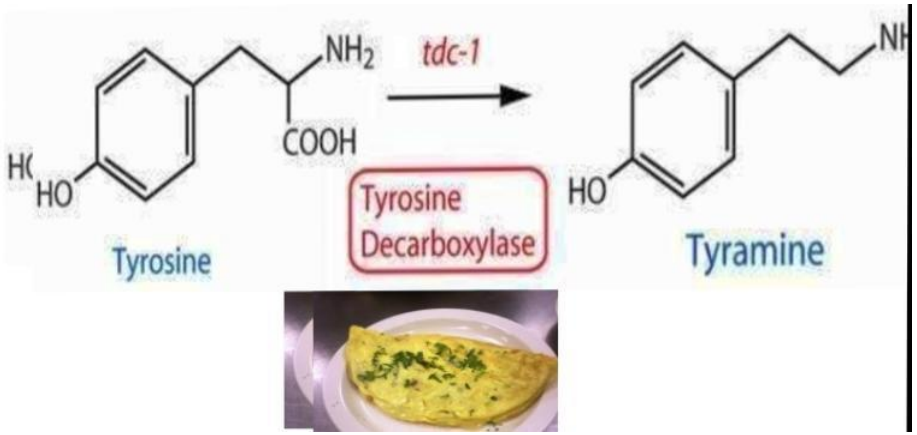
> **Dopamine** can be modified into **norepinephrine** by **beta hydroxylation reaction** (addition of hydroxyl group at the beta carbon) catalyzed by an enzyme called **dopamine beta hydroxylase.**



> **Norepinephrine** can be modified into **epinephrine** by adding a methyl group to the amino group of the backbone.



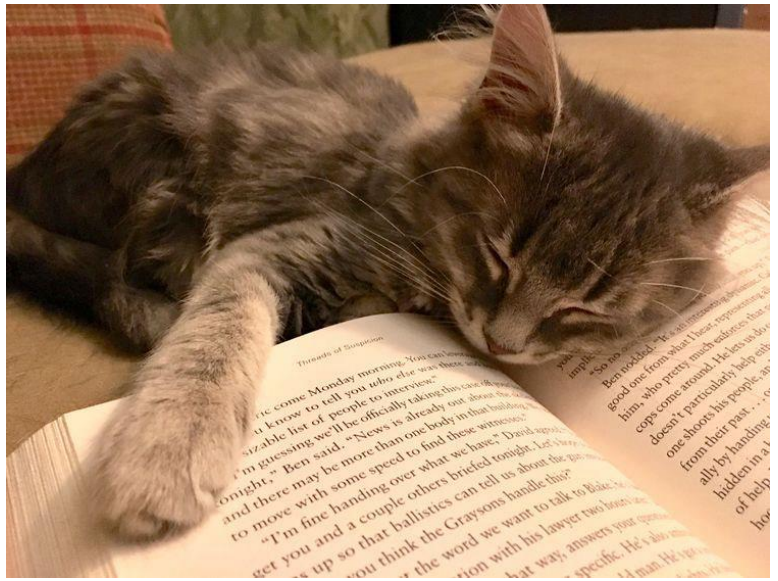
> **Tryosine** is modified into Tryamine By enzyme called **Tryosine decarboxylase**



> **DOPAmine, Norepinephrine** and **Epinephrine** are **mono amino** hermones, they can be degarded using **mono amino oxidases.**

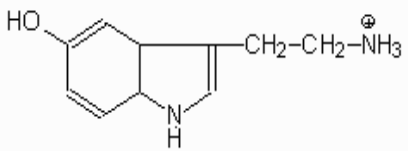
POV : انت بعد ما وعدت نفسك انك تضل صاحي طول الليل تدرس بيوكيم حتى تخلص المتراكم عليك!

انت بنفس الوقت :

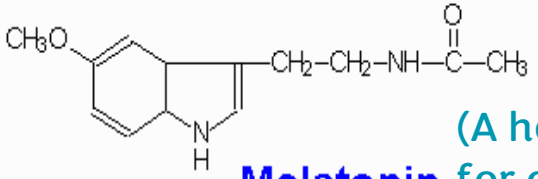


The presence of Tryptophan in Milk become in highly concentration explain why children become Happy and fail a sleep after drinking milk and it s causing addiction, and this is why (فطام الرضيع) is hard on childrens.

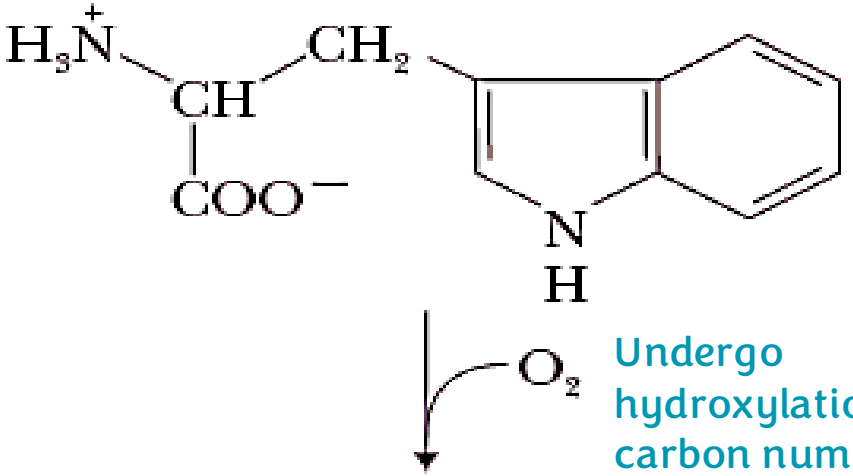
Tryptophan



Serotonin (Happiness hormone).
(5-hydroxytryptamine)

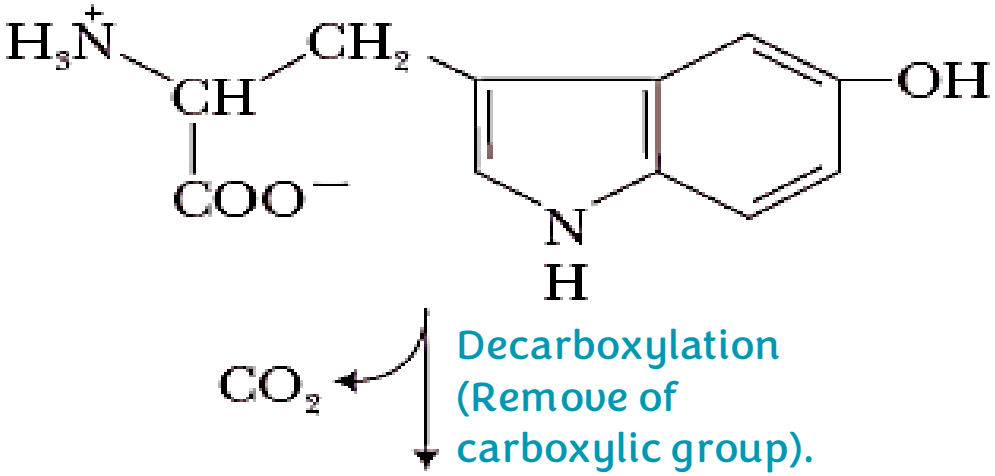


Melatonin (A hormone that induces sleep for once or twice).
Controls sleep cycle.



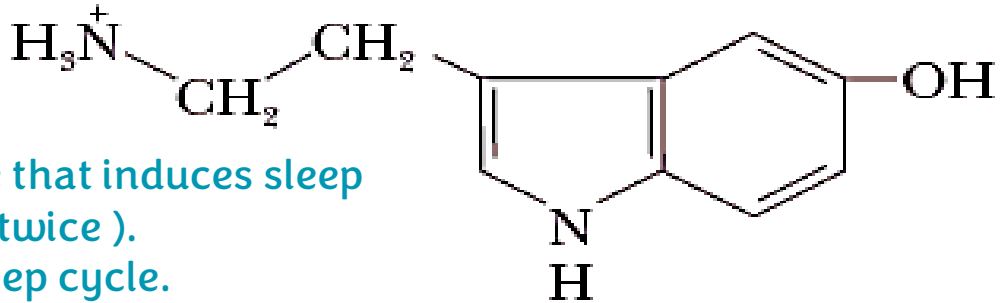
Tryptophan
(Present in high concentration in milk)

Undergo hydroxylation at carbon number 5



5–Hydroxytryp-tophan

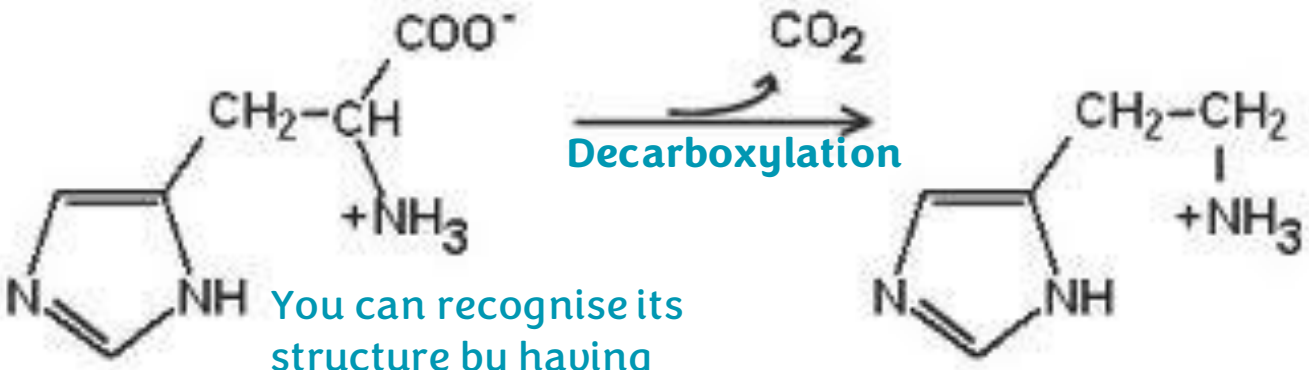
Decarboxylation (Remove of carboxylic group).



Serotonin

Histidine

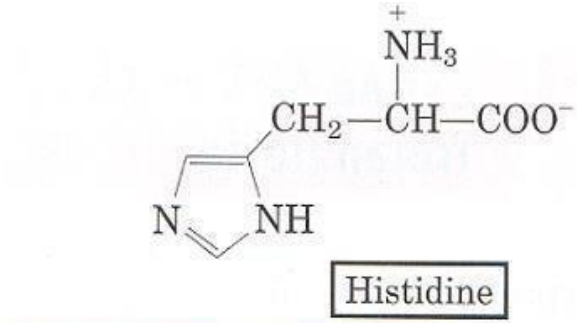
- A potent vasodilator
- Part of the immune response
- Results in swelling and stuffiness
- Most cold medications contain antihistamines

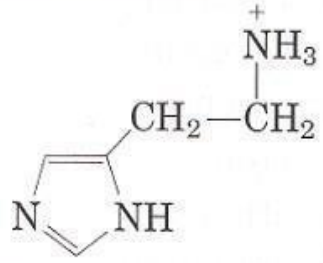


You can recognise its structure by having **Imidazole ring**

Histidine *Histamine*

It is responsible for allergic reactions. Any one who had allergy usually takes antihistamines.

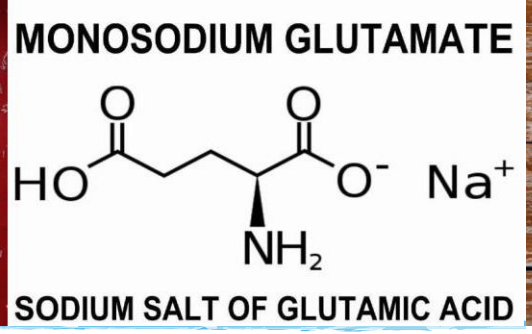




Histamine

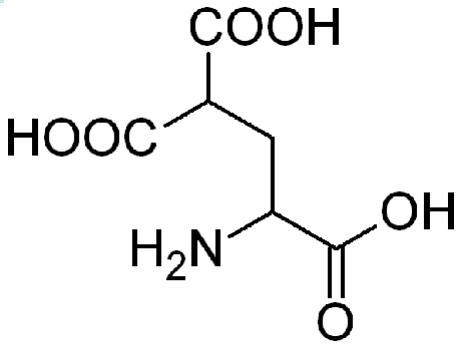
Glutamate –>
Excitatory effect

In some people it causes headache and many other syndromes –> Chinese restaurants syndrome –> cause it contains high concentration of mono sodium glutamate.

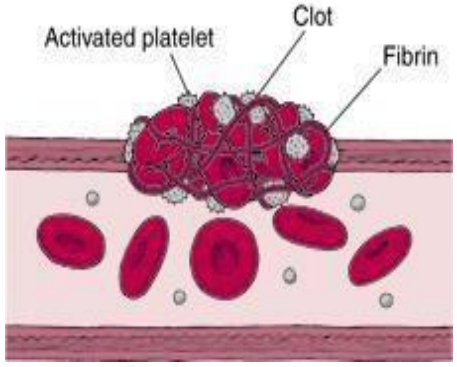


Glutamic Acid

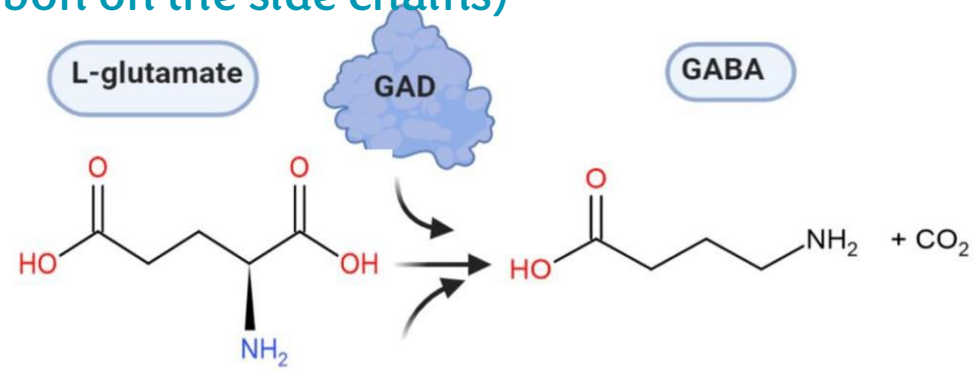
Gluta = 5 carbon

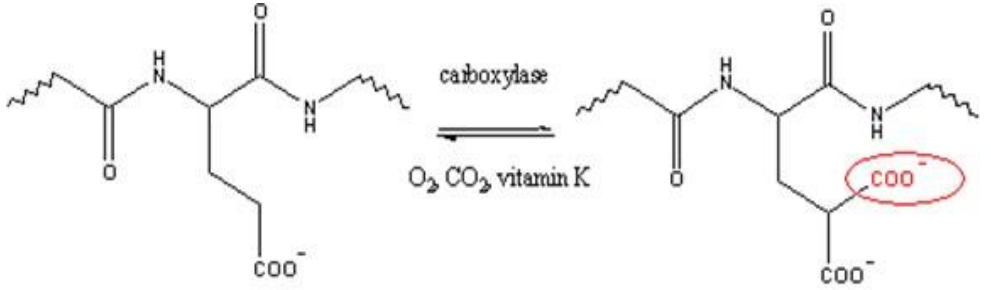


- MSG: a flavor enhancer, causes a physiological reaction in some people (*Chinese restaurant syndrome) or* MSG symptom complex: chills, headaches, and dizziness
- GABA: Inhibitory neurotransmitter (CNS), reduces neuronal excitability. Synthesized in brain because it does not cross the BBB. Have relaxing, anti-anxiety, and anti-convulsive effects
- γ- carboxyglutamate (Gla): Vitamin K is essential for the process



On the gama carbon there is another carboxylic group on the side chain (attached to the gama carbon on the side chains)





Glu

Gla

Why blood doesn't clot while it is flowing in the blood stream ?

1.Blood contains clotting factors that are not activated while the blood is flowing on the blood stream.

2.it is activated by Vitamin K which work as an enzyme that stimulates the add of carboxylic group on the gama carbon, this increases the negative charges on the glutamate (2 negative charges)

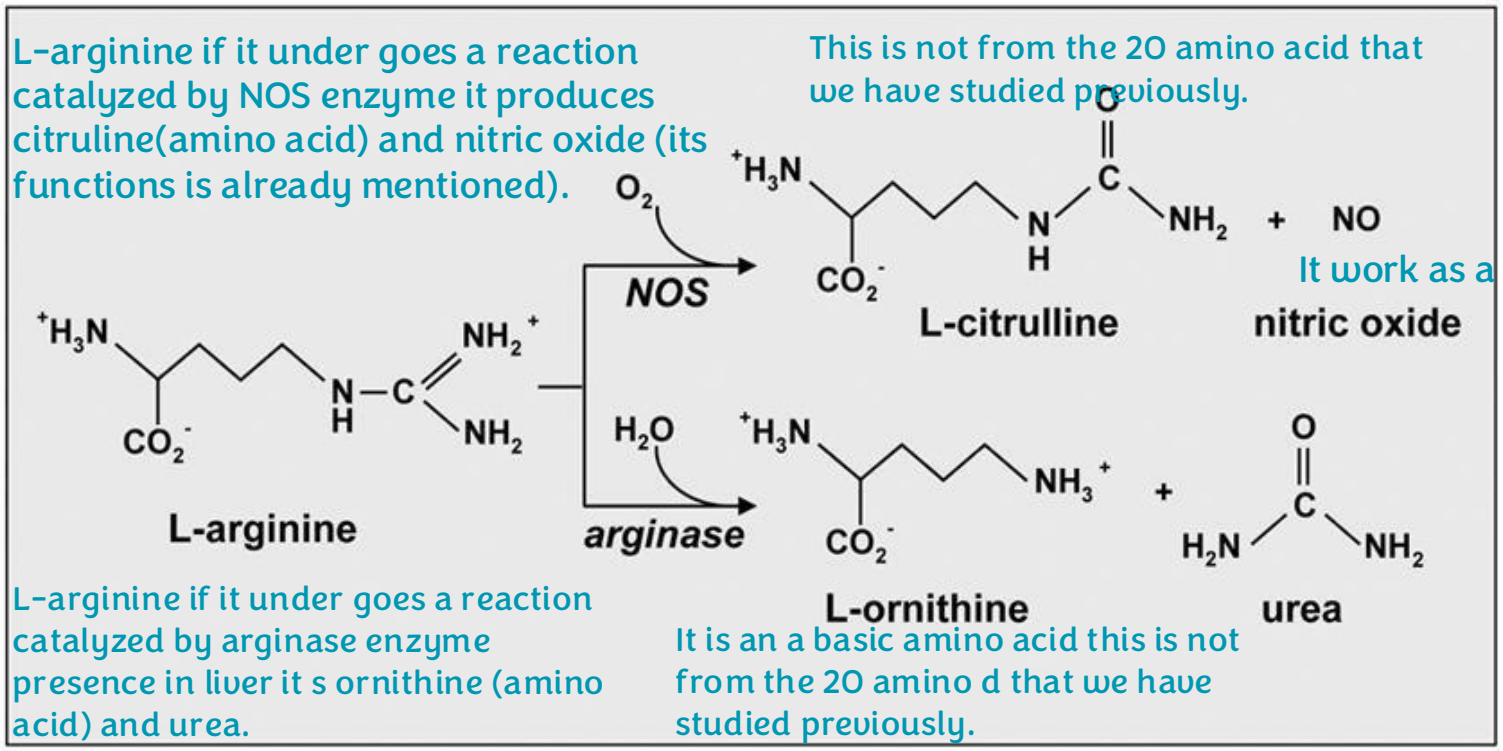
3. which means it can attract Calcium.

4.Causing the clotting of the blood (blocking the bleeding).

Arginine

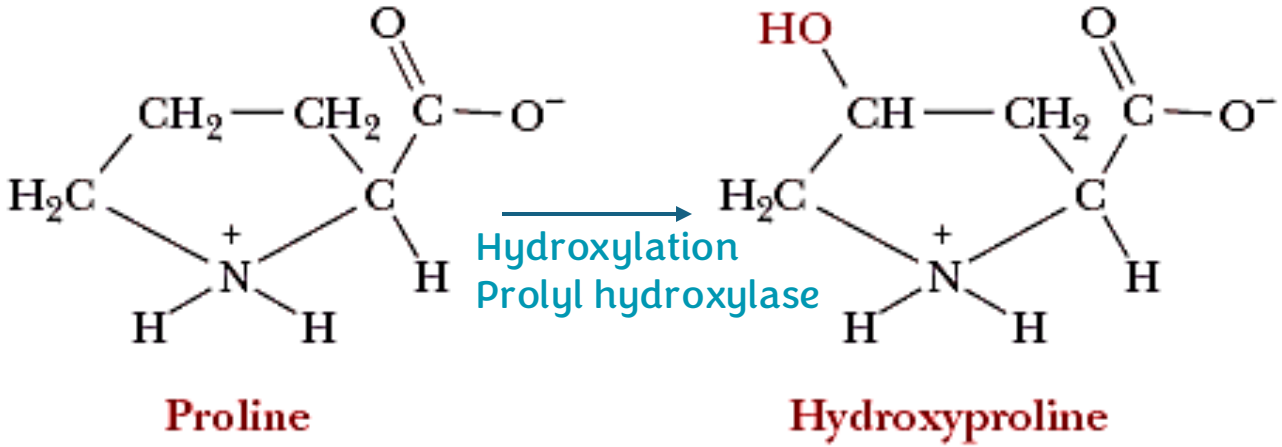
(Urea cycle is the process in which urea is produced). Urea cycle happens exclusively at the liver because it is the only place Arginie enzyme is present.

- Precursor of nitric oxide (NO) and Urea
- NO functions: Vasodilation, inhibition of platelet adhesion, anti-oxidant, anti-inflammatory



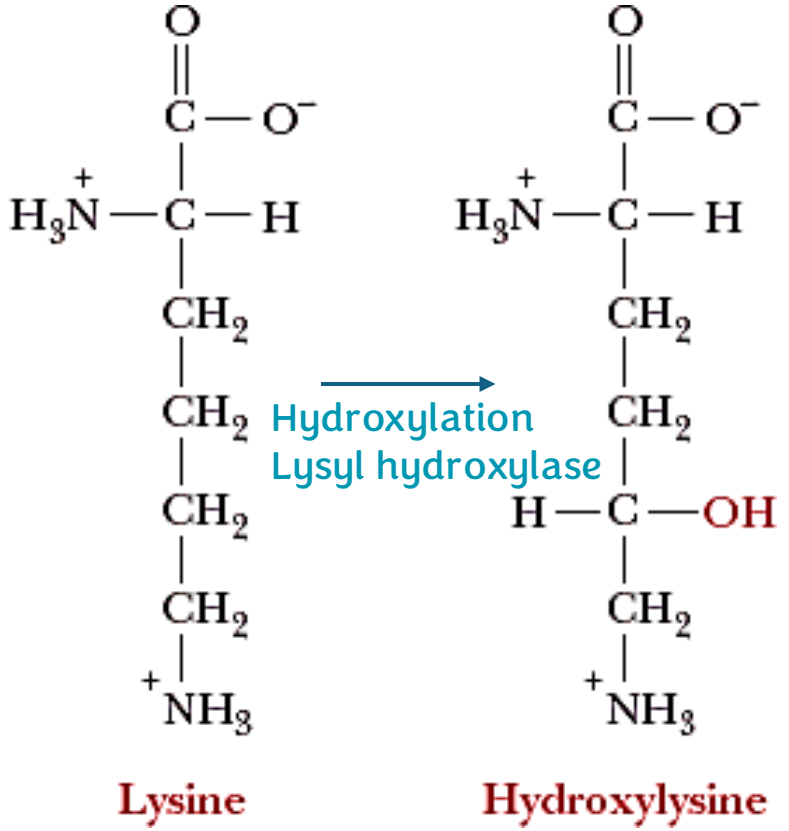
Lysine and proline

- Part of collagen structure
  The most abundant protein in our body.
  - Modified as residues (post-translational modification)
- Vitamin C relation and scurvy



➢ **Collagen is helical in shape because of H bond which may happen as a result of the presence a hydroxy proline , how it is able to keep this characteristic?**

When 2 lysine molecules from different collagen's chains are facing each other they will be bridged to each other; they both will undergo hydroxylation or one of them which means that they will be oxidized, and results in making cross linkages (covalent bonds) (which results in strengthening the collagen).
Vitamins C work as coenzyme activating the enzymes to work effectively, so they make these cross linkages, and if Vitamin C is deficient it causes scurvy.
Collagen is important in blood vessels to keep blood pressure intact .



Peptides

Sequences of amino acids, (more than one) joined together by peptide bond (not a scientific name, it's scientific name is amide bond ,since it is between carbonyl group (C=O) and Nitrogen atom.

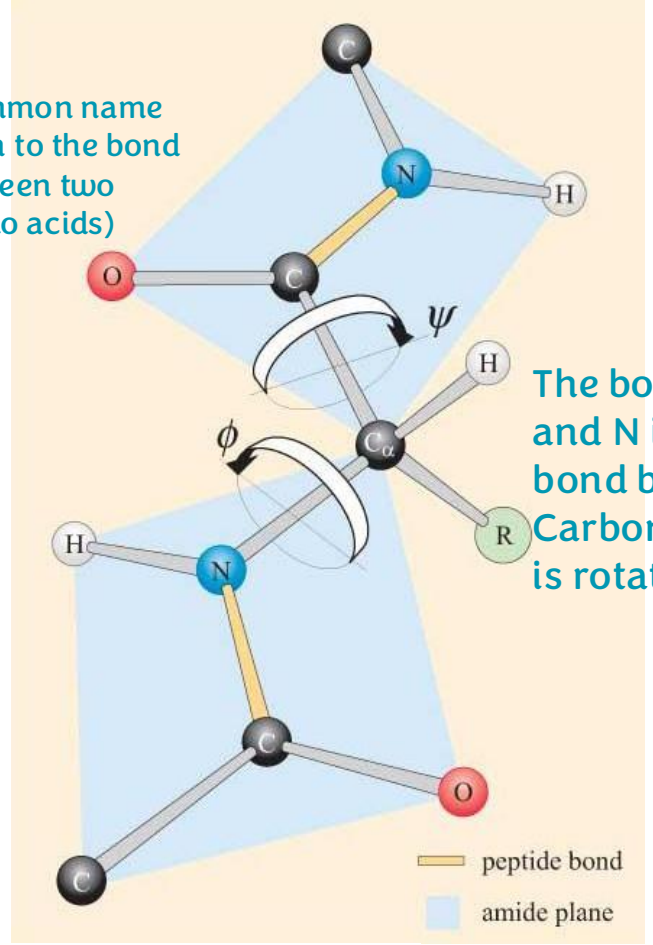
Peptide bond

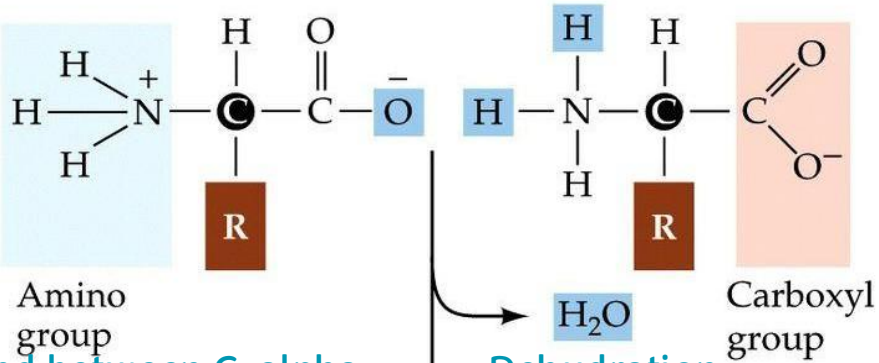
(Common name given to the bond between two amino acids)

- Amide bond (Scientific name)
- Resonance, Double bond
  - Planar, charged, Rigid, Un-rotatable

Due to the presence of resonance ;the amide bond 50% of time is single and 50% of the time is double bond , and since double bond is rigid and unrotatble it is unrotatble and rigid.

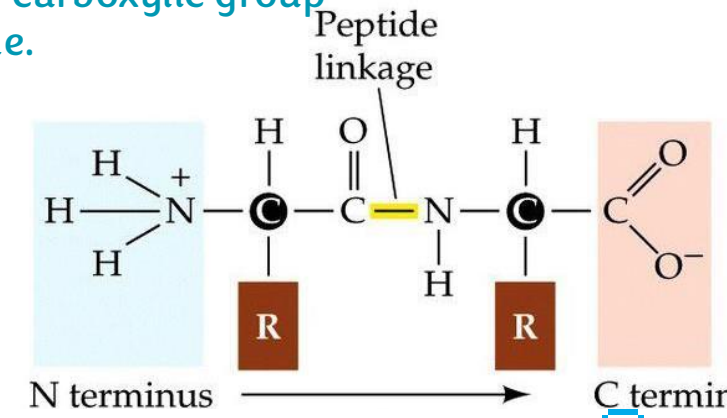
- Hydrogen bonding; Except proline

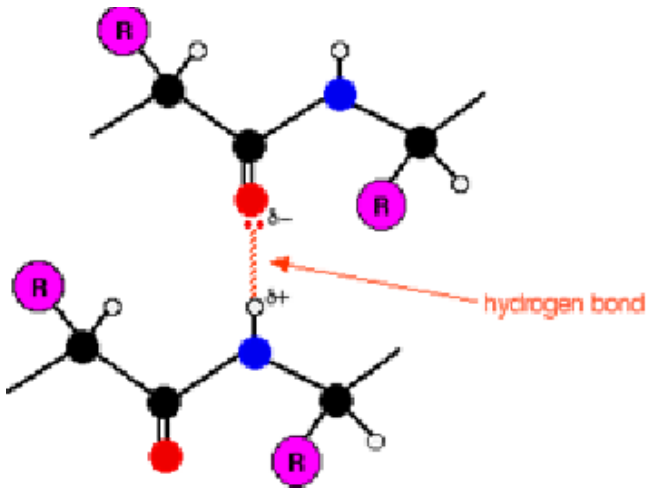


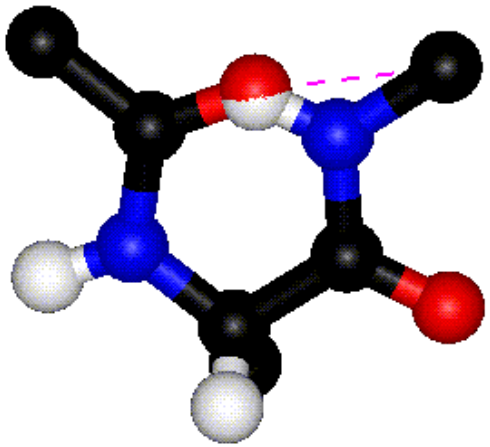


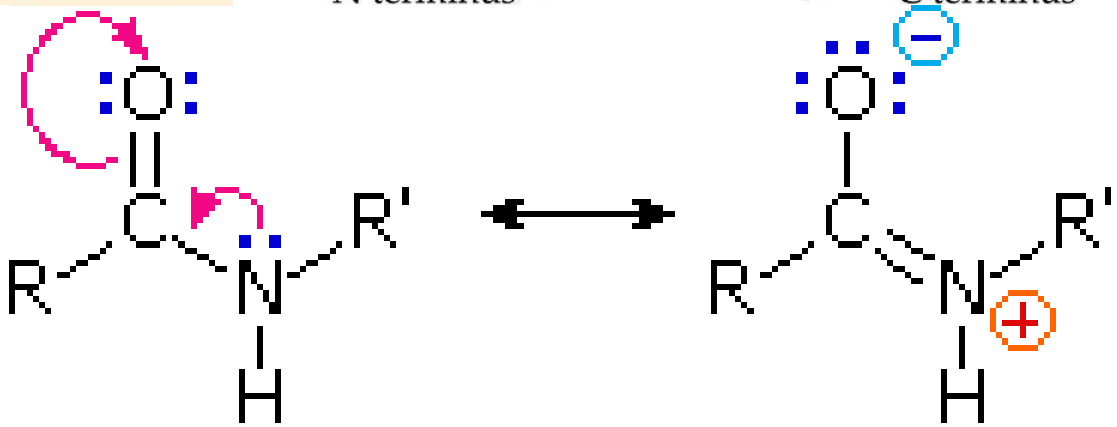
Dehydration reaction

The bond between C-alpha and N is rotatable and the bond between C-alpha and Carbon of carboxylic group is rotatable.

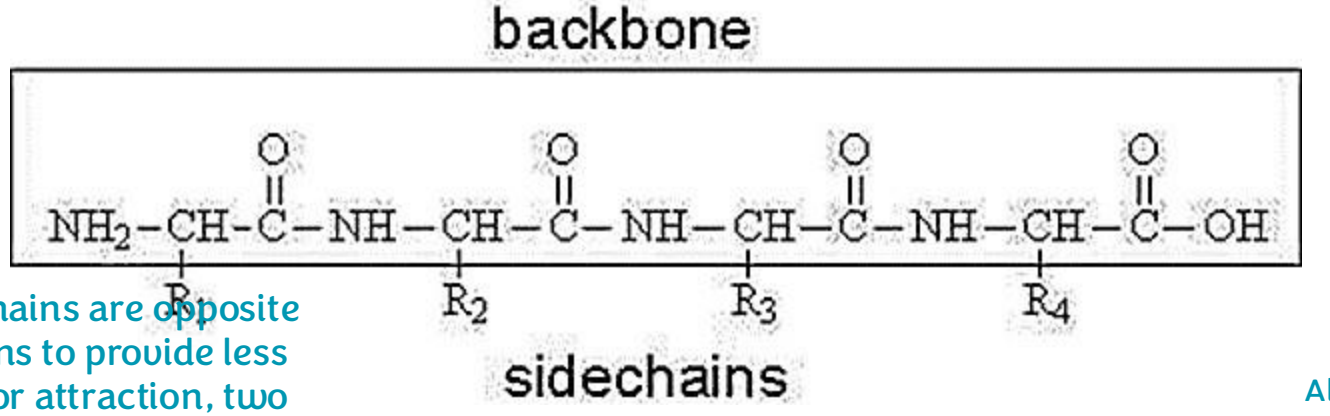






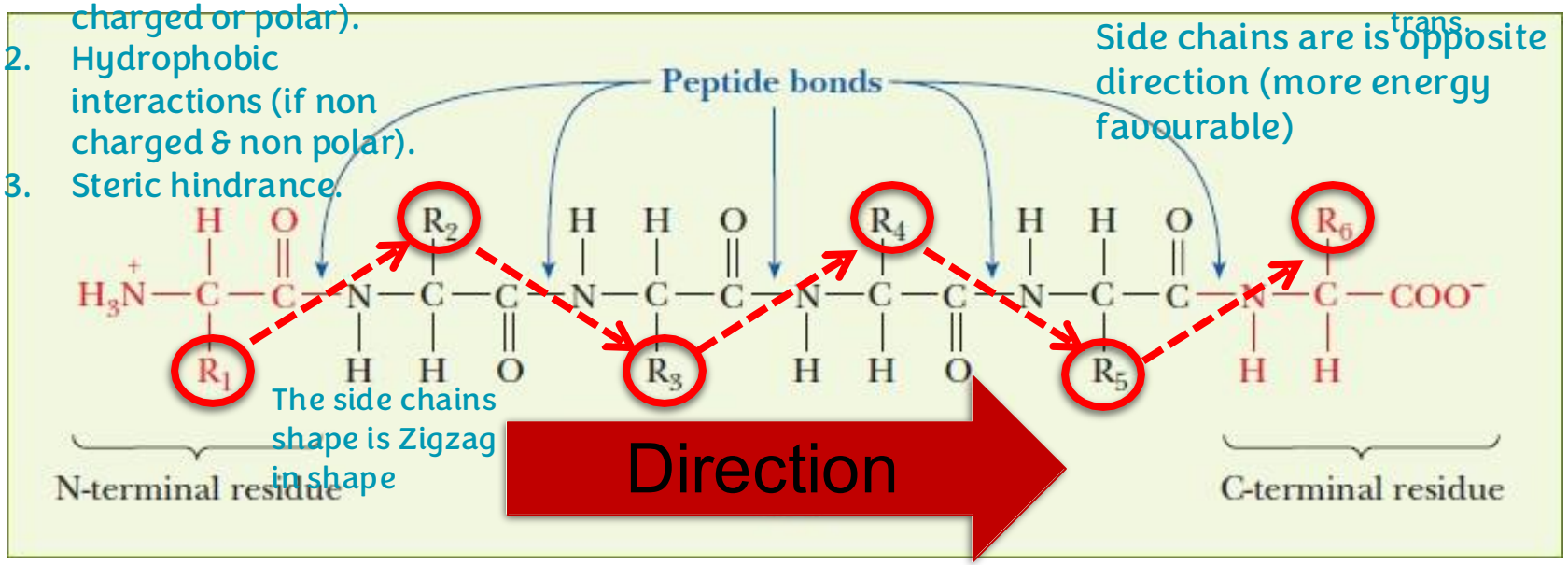


Backbone, orientation and directionality



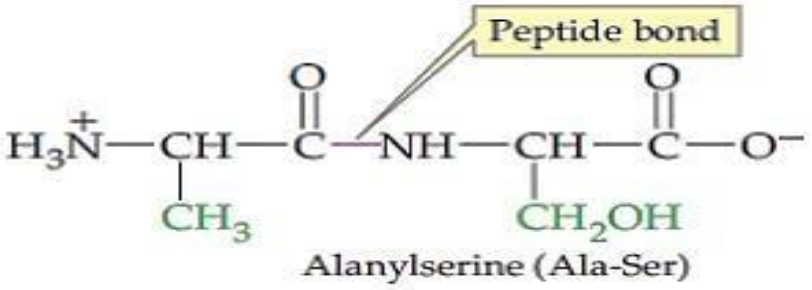
The side chains are opposite in directions to provide less repulsion or attraction, two types of repulsion :

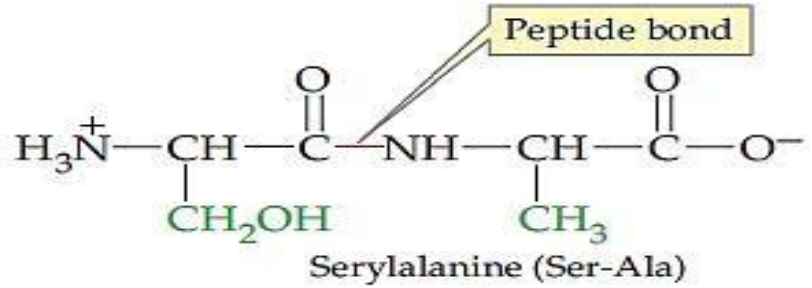
1. Electrostatic repulsion or attraction. (if charged or polar).
2. Hydrophobic interactions (if non charged & non polar).
3. Steric hindrance.



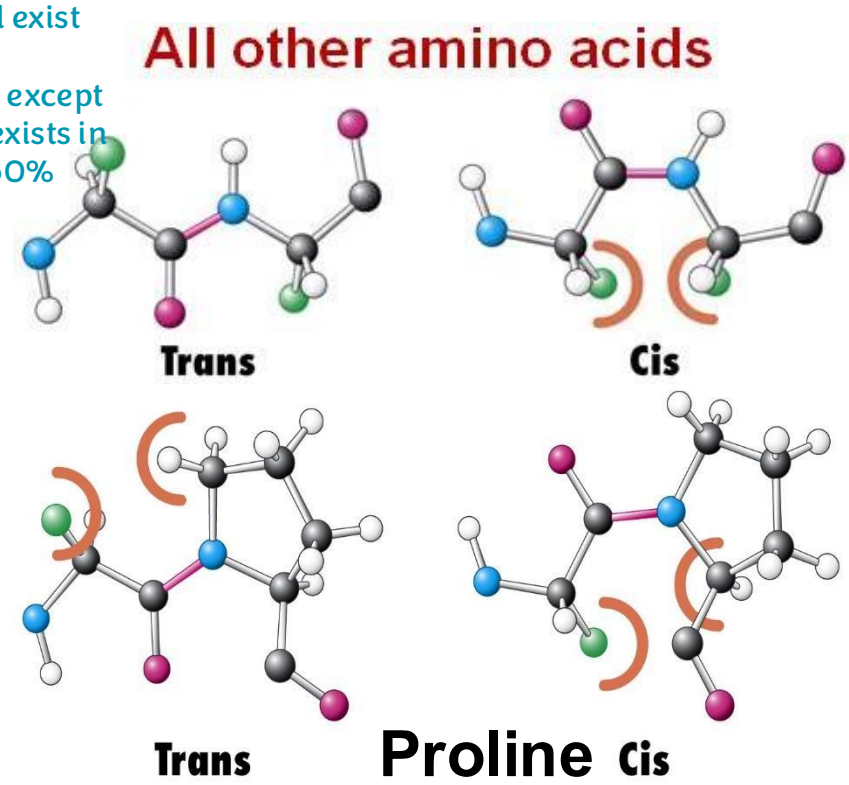
Side chains are is opposite direction (more energy favourable)

The side chains shape is Zigzag in shape





All amino acid exist in trans configuration except for proline it exists in 50% cis and 50% trans



If we have two amino acids, how many peptides can we make?

The answer is two , why not one? Because order of amino acids matter.

Why order matter ?

Imagine that we have two amino acids foe example : proline,glycine if the order was pro-gly then the amino group of proline will be free and the carboxylic group of glycine will be free, while in the other order we will have the amino group of glycine free and the carboxylic group for proline is free, is this difference really matter? Yes, how ? Recall he table of ph for carboxylic group and amino group at the back bone of amino acids, we assumed that the are equal for all amino acids , the truth is that they differ limitaly and this differ contribute to the whole nature of peptide (at which Ph it donate its protons or keep them).
Differ sequences- differ isoelectric point-differ Pka value so the behaviour for them in a solution will also be different

Amino Acid	Abbreviation		pK_1	pK_2	pK_R	pI
	3-Letters	1-Letter	-COOH	$-NH_3^+$	R group	
Alanine	Ala	A	2.34	9.69	-	6.00
Arginine	Arg	R	2.17	9.04	12.48	10.76
Asparagine	Asn	N	2.02	8.80	-	5.41
Aspartic Acid	Asp	D	1.88	9.60	3.65	2.77
Cysteine	Cys	C	1.96	10.128	8.18	5.07
Glutamic Acid	Glu	E	2.19	9.67	4.25	3.22
Glutamine	Gln	Q	2.17	9.13	-	5.65
Glycine	Gly	G	2.34	9.60	-	5.97
Histidine	His	H	1.82	9.17	6.00	7.59
Isoleucine	Ile	I	2.36	9.60	-	6.02
Leucine	Leu	L	2.36	9.60	-	5.98
Lysine	Lys	K	2.18	8.95	10.53	9.74
Methionine	Met	M	2.28	9.21	-	5.74
Phenylalanine	Phe	F	1.83	9.13	-	5.48
Proline	Pro	P	1.99	10.60	-	6.30
Serine	Ser	S	2.21	9.15	-	5.58
Threonine	Thr	T	2.09	9.10	-	5.60
Tryptophan	Trp	W	2.83	9.39	-	5.89
Tyrosine	Tyr	Y	2.20	9.11	10.07	5.66
Valine	Val	V	2.32	9.62	-	5.96

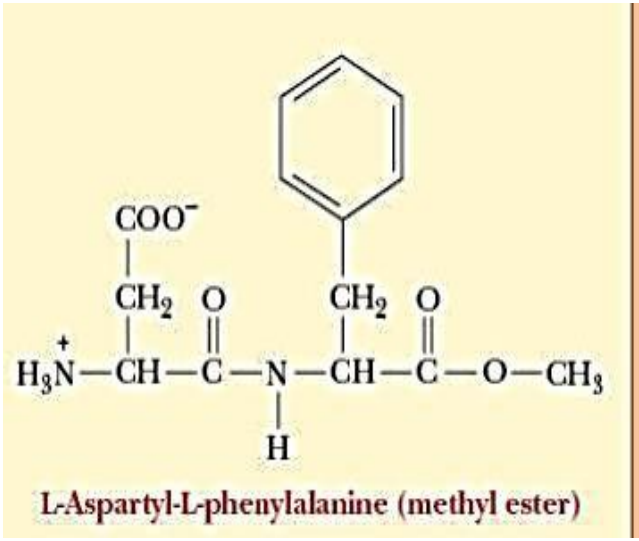
It is made by the binding of these 2 amino acids :

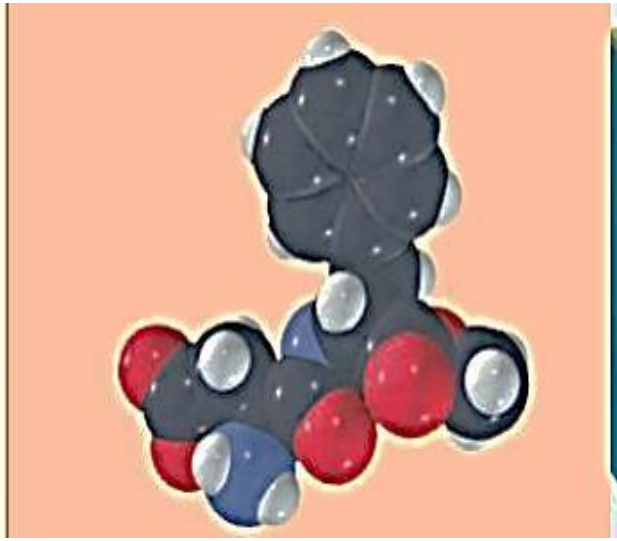
Aspartame, the Sweet Peptide

Amino acid Amino acid

- L-aspartyl-L-phenylalanine
- Commercial importance
- The methyl ester derivative is called aspartame
- 200 times sweeter than sugar

Both are L-amino acids.
If we have one of these amino acids in D configuration it will be bitter taste

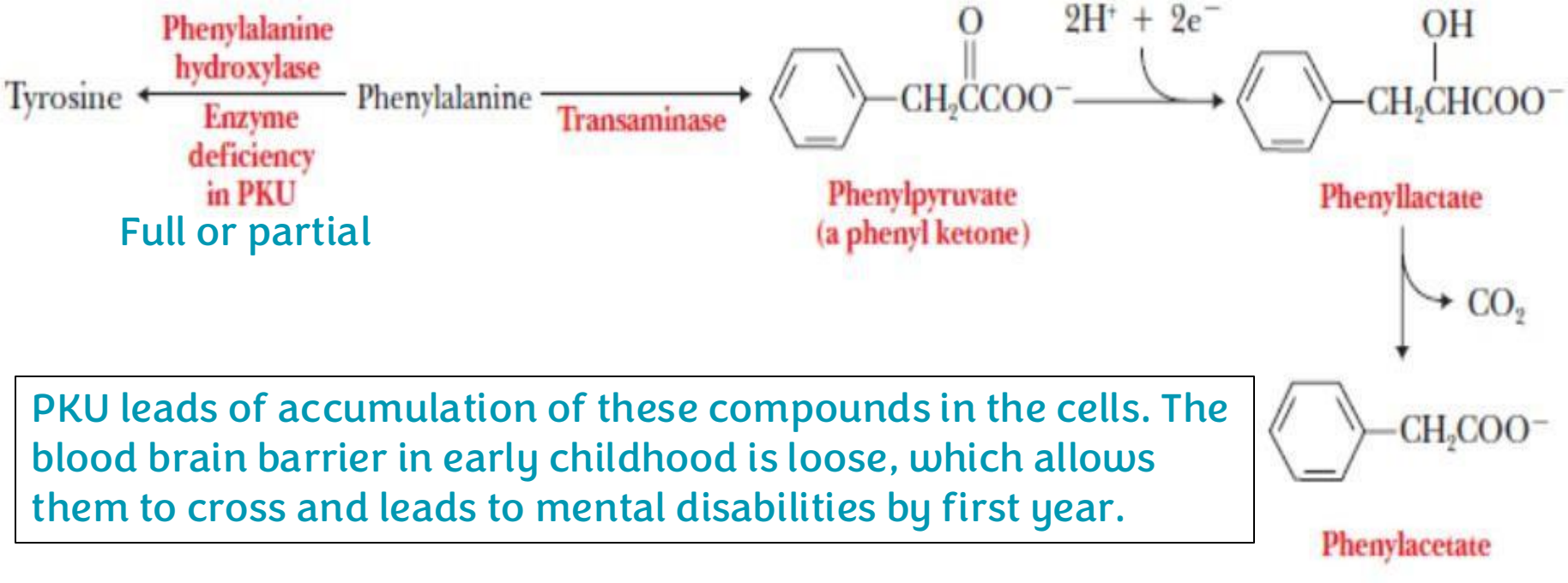




Phenylketonuria

- Inborn errors of metabolism; errors in enzymes of amino acids metabolism
- PKU can be easily detected and managed in newborns
- Aspartame carry a warning, Alatame (Ala instead of Phe) is a substituent

after one week after birth if phenylalanine levels are higher than normal

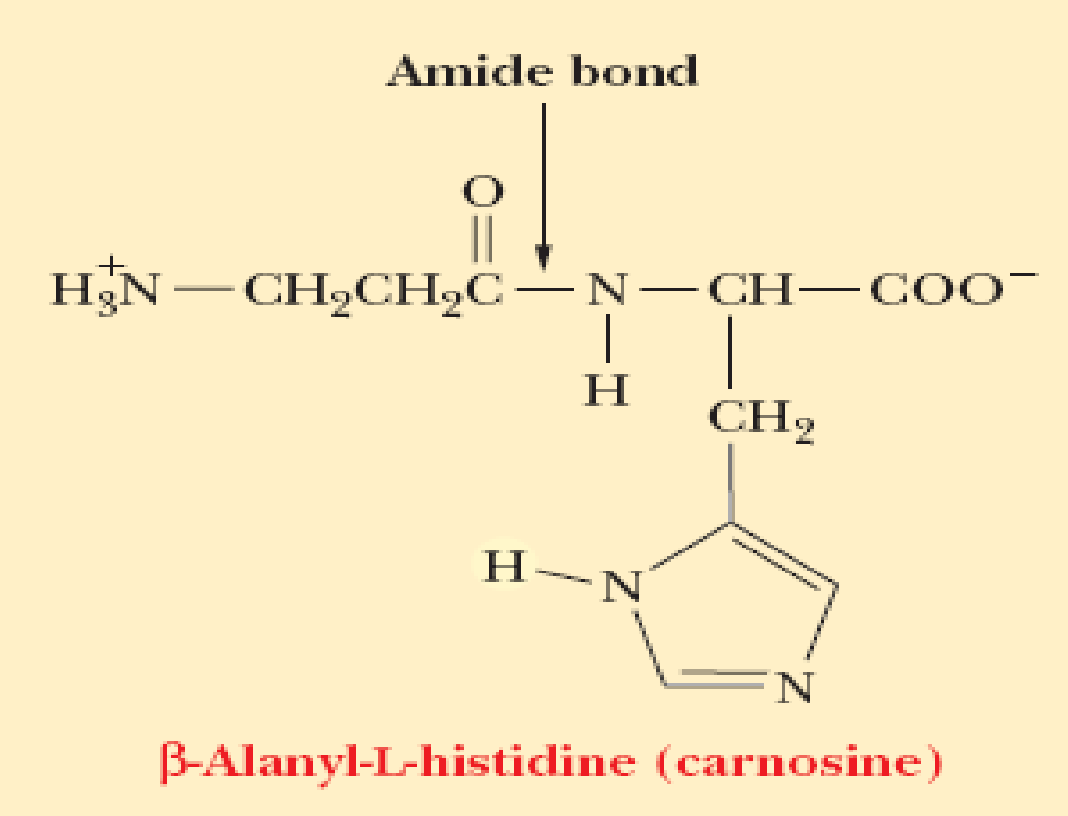


PKU leads of accumulation of these compounds in the cells. The blood brain barrier in early childhood is loose, which allows them to cross and leads to mental disabilities by first year.

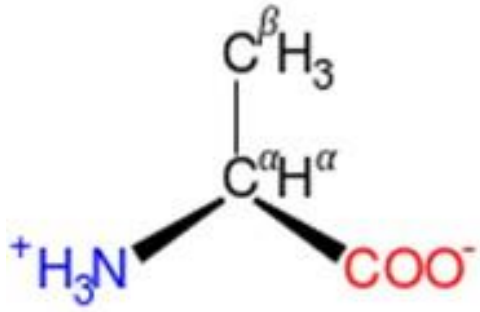
Carnosine

Dipeptide which produced in our bodies by joining two amino acid (alanine and histidine) to produce ester peptide which functions as an anti oxidant and as a chelating agent (bind with positive charge metal) metal)

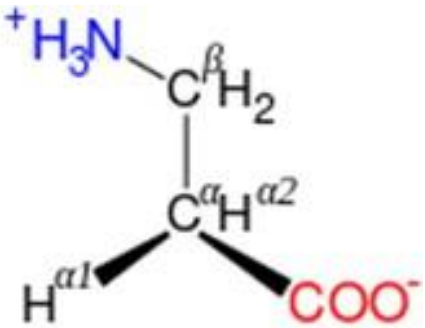
- Dipeptide: found in muscle tissue, (β-alanyl-L-histidine), anti-oxidant, chelation of heavy metals



β-Alanyl-L-histidine (carnosine)



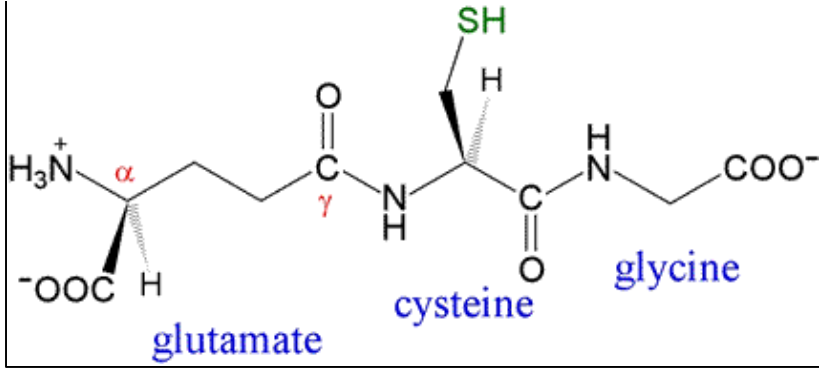
L-α-alanine



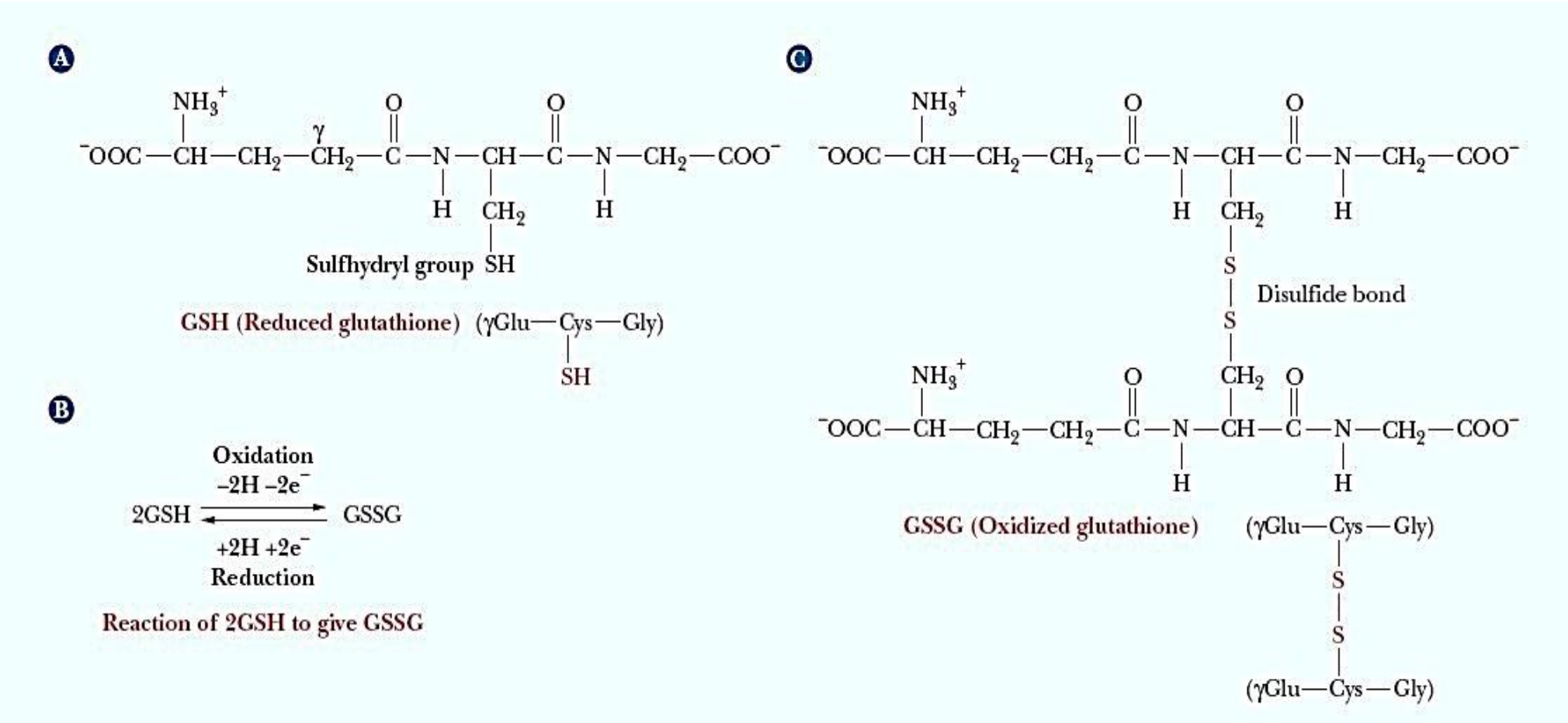
β-alanine

Glutathione

Most common anti-oxidant in the body



- Tripeptide: (γ-glutamyl-L-cysteinylglycine); a scavenger for oxidizing agents



Most functional part is cysteine due to presence of thiol group (-SH)

Many antioxidants feature cyclic (ring) structures because these configurations provide more stabilization of free radical intermediates compared to open-chain molecules. The delocalization of unpaired electrons across the ring system helps neutralize reactive species more efficiently without generating highly unstable byproducts.

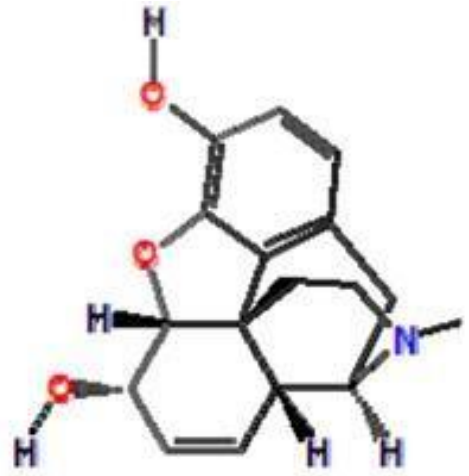
In cases where antioxidants lack a ring structure—such as glutathione—alternative mechanisms are required. For example, glutathione donates hydrogen atoms and electrons from its thiol group (-SH), forming a stable disulfide bond (S-S) upon oxidation. This reversible oxidation-reduction process allows glutathione to be regenerated enzymatically, maintaining cellular antioxidant defenses.

Enkephalins

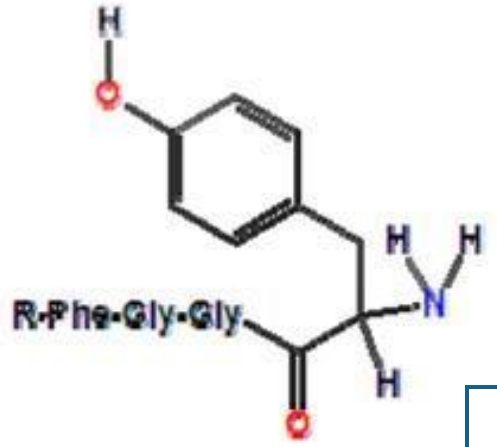
- Pentapeptides: naturally occurring analgesics
  - Tyr—Gly—Gly—Phe—Leu (Leucine enkephalin)
  - Tyr—Gly—Gly—Phe—Met (Methionine enkephalin)

Differ in the last amino acid

- Similarities of three-dimensional structures to opiates (e.x, morphine)



Morphine

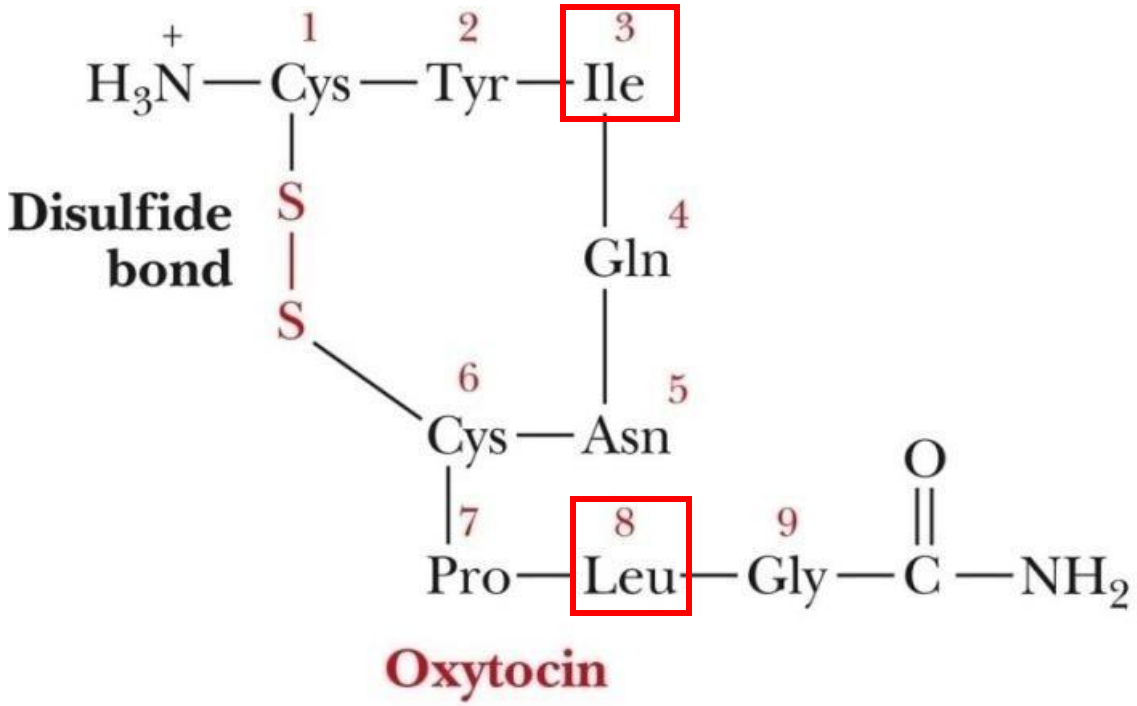


Enkephalins

Enkephalins are produced in the body as analgesics (pain reducers).

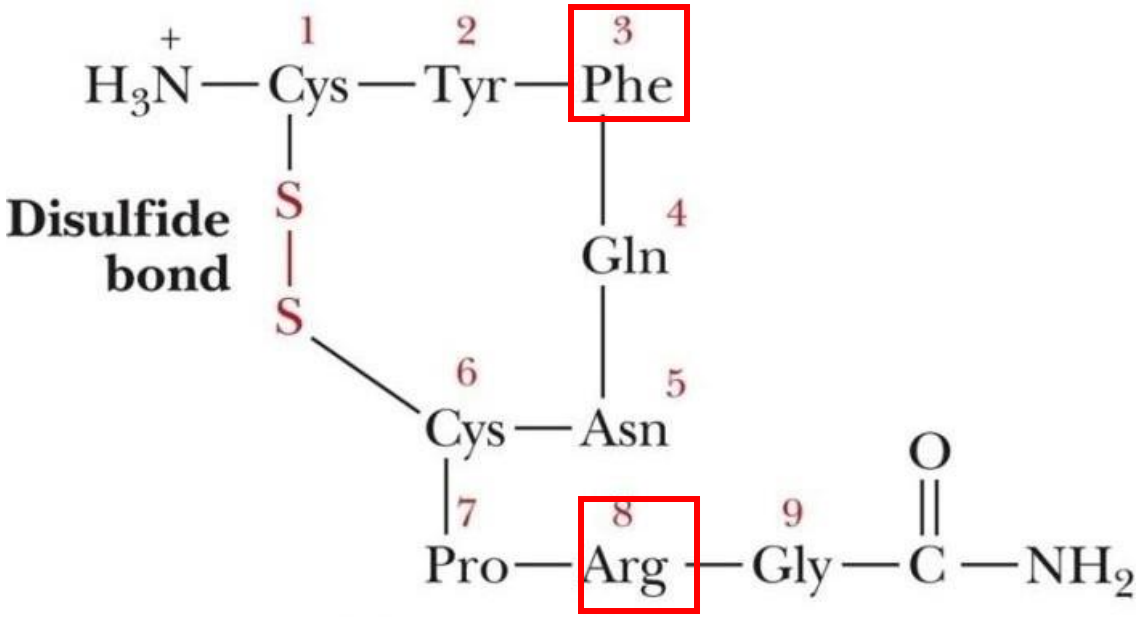
Cyclic structures

Nonapeptides (9 amino acids) that are hormones stored in the posterior pituitary gland. Similar in 7 and differ in 2 amino acids



Oxytocin

Oxytocin causes uterine contractions, triggers milk ejection. Vasopressin retains water, raises blood pressure, and controls body fluid balance.



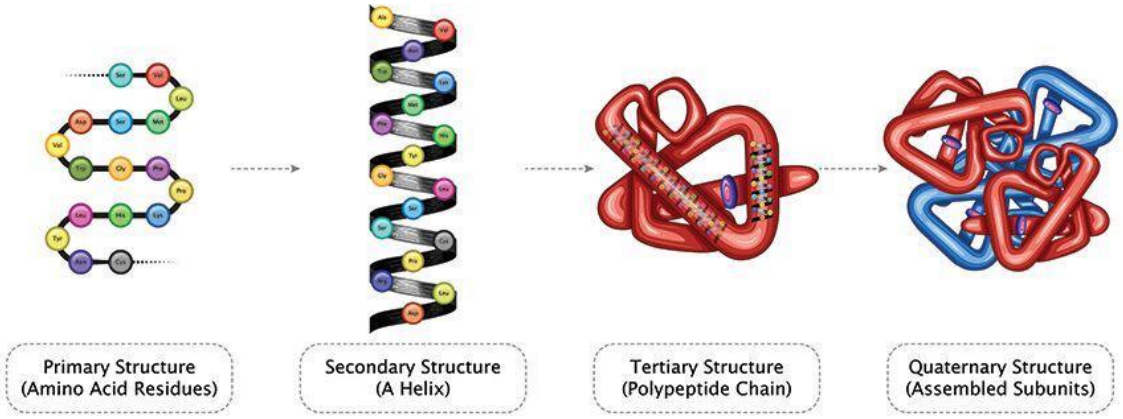
Vasopressin

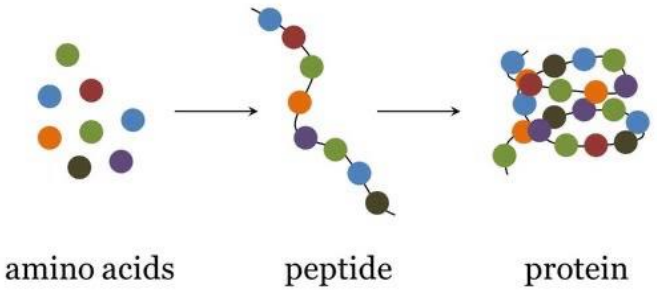
Also know as ADH (anti diuretic hormone)decreases the amount of water which release to urine .

Proteins:

- Proteins can change their conformation .
- They are not static (rigid) but **dynamic** in their nature giving huge number of conformations.
- The conformations of a protein that are fully active, which is referred to as the native conformations of that protein.

- Protein has primary, secondary, tertiary and quaternary structures





For any feedback, scan the code or click on it.

Corrections from previous versions:

Versions	Slide # and Place of Error	Before Correction	After Correction
V0 → V1	5th slide ; The last note 16th slide ; the answer if "why order matter" question 6th slide ; last note.	DOPAmine can modified into Norepinephrine by dehydroxylation reaction (remove of Hydroxyl group from the back bone(from the carboxylic group)). Imagine that we have two amino acids foe example :serotonin ,glycine if.... DOPAmine, Norepinephrine and Epinephrine are mono amino hermones, they can be degarded using mono amino hydroxylase.	Dopamine can be modified into norepinephrine by beta hydroxylation reaction (addition of hydroxyl group at the beta carbon) catalyzed by an enzyme called dopamine beta hydroxylase. Imagine that we have two amino acids foe example :proline ,glycine if... DOPAmine, Norepinephrine and Epinephrine are mono amino hermones, they can be degarded using mono amino oxidases.
V1 → V2			

رسالة من الفريق العلمي:

دعاء سيدنا موسى عليه السّلام :

"قَالَ رَبِّ ٱشۡرَحۡ لِي صَدۡرِي (25) وَيَسِّرۡ لِيٓ أَمۡرِي (26) وَٱحۡلُلۡ عُقۡدَةٗ مِّن لِّسَانِي (27)يَفۡقَهُواْ قَوۡلِي (28)"