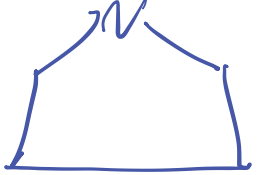
Indole and proto alkaloids

Tryptophan derived alkaloids

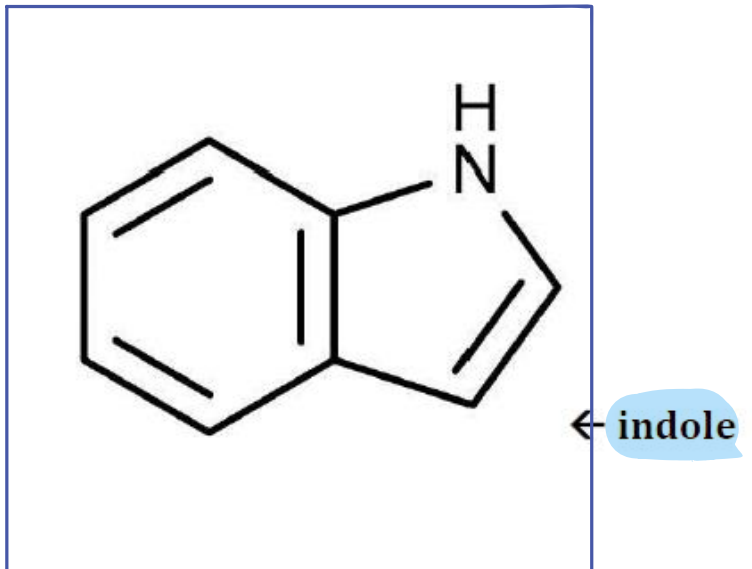
عندي نوعين من alkaloid

النوع الأول بتكون ال N جزء من الRing

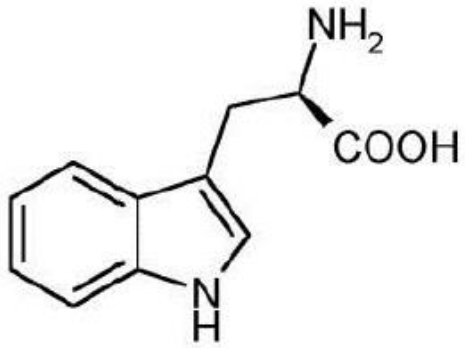
النوع الثاني ال N ما بتكون جزء من ال

indol = benzen + 

- Indole and Quinolines alkaloids are derived from the same amino acid which is tryptophan.
- Indole alkaloids are widely distributed among the Apocynaceae, Loganiaceae and Rubiaceae families.

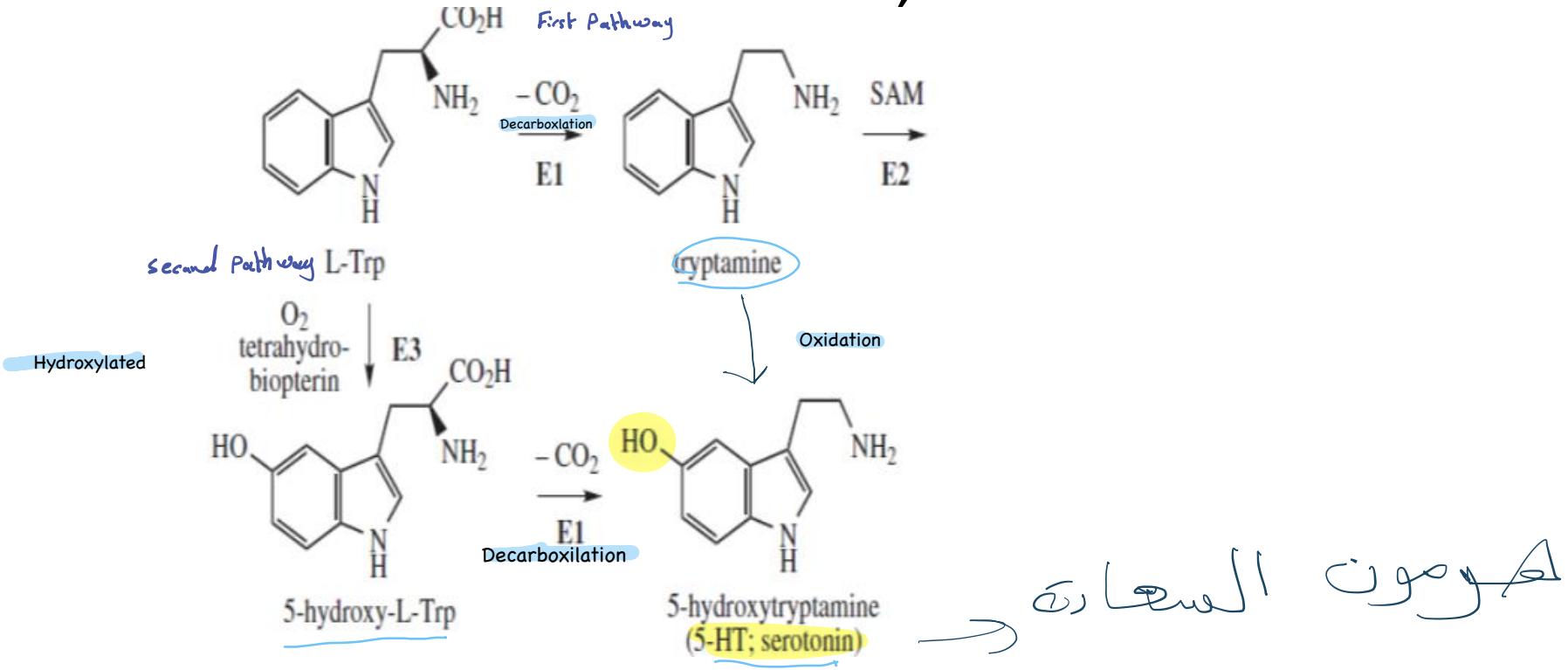


← indole



← tryptophan

- Tryptophan has 2 possible pathways to end up with the formation of our simple derivatives that we will discuss here,



Synthesis of Seratonin

- first it can be decarboxylated to obtain tryptamine further reactions include oxidation will end up with 5-hydroxytryptamine (**serotonin** our first simple derivative)
- Or it can be first hyroxylated to 5-hydroxy tryptophan →further decaboxylation will also lead to serotonin.

- Indole alkaloids derivatives including melatonin, serotonin & physostigmine
- These are simple derivatives of the amino acid tryptophan which are primarily obtained by decarboxylation of the amino acid tryptophan to obtain typtamine and then further modification especially oxidation at position 4 or at position 5.

5-Hydroxytryptamine
5-HT, Serotonin

- 5-HT, serotonin is a monoamine neurotransmitter found in cardiovascular tissue, the peripheral nervous system, blood cells, and the central nervous system.
- **It** mediates many central and peripheral physiological functions, including contraction of smooth muscle, vasoconstriction, food intake, sleep, pain perception, and memory.
- **Although** 5-HT may be metabolized by monoamine oxidase, platelets and neurons possess a high affinity 5-HT reuptake mechanism.
- This mechanism may be **inhibited**, thereby increasing levels of 5-HT in the central nervous system, by widely prescribed **antidepressant** drugs termed **selective serotonin re-uptake inhibitors (SSRIs).**
- **PROZAC®** which contains **Fluoxetine** which is a **selective serotonin re-uptake inhibitors (SSRIs)** officially approved for treatment of depression

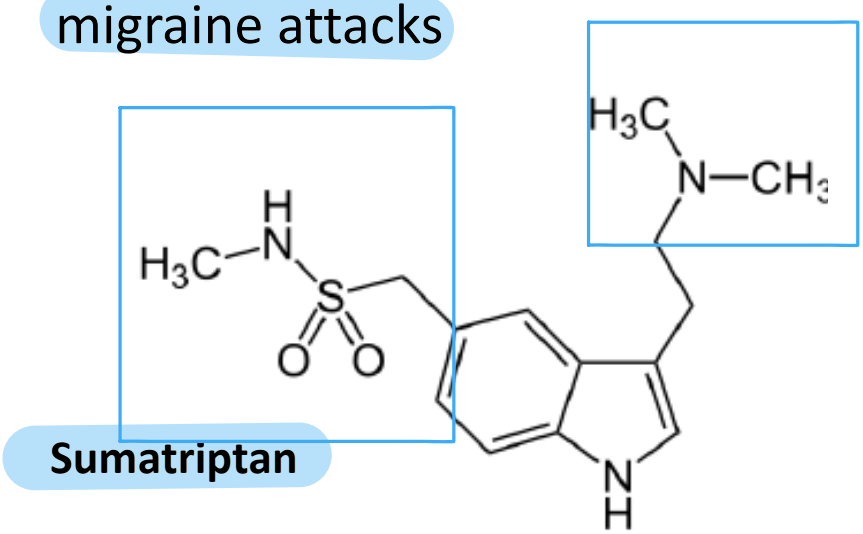
لما الواحد ياكل شوكلاته رح يرتفع هرمون السعادة serotonin ورح تضل لحظة السعدة لدقائق قليلة وبعدها بيجي عندي انزيم اسمه monoamine oxidase وبعمل metabolize لل serotonin وهيك رح يقل تركيزه بالدم

بكون عندي ادوية antidepressant ف بتعمل على ابقاء تركيز لل serotonin بالدم عالي فكيف تشتغل؟؟؟

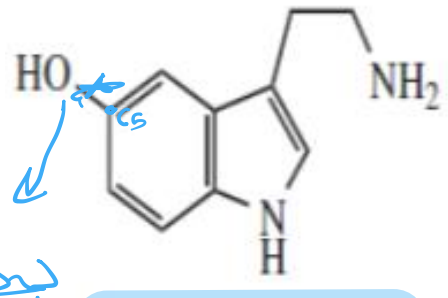
هاي الادوية تحتوي على selective serotonin re-uptake inhibitors (SSRIs). الي بتعمل تثبيط لعمل انزيم monoamine oxidase

Serotonin derivatives

- **Migraine** headaches that do not respond to analgesics may be relieved by the use of an **agonist of the 5-HT1 receptor**, since these receptors are known to mediate vasoconstriction.
- **Sumatriptan** is used to treat migraine → للشقيقة
- Sumatriptan is produced through methylation of 5-HT and turning the amino group into a tertiary one , and the hydroxyl group on carbon # 5 will be replaced by a sulphate group
- One of its benefits is that it is used for the treatment of acute migraine attacks



Sumatriptan



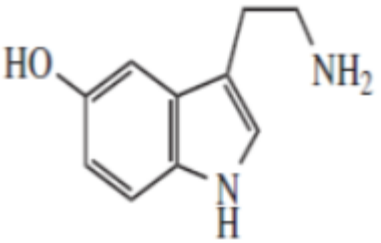
5-hydroxytryptamine
(5-HT; serotonin)

بدي اخليه Tertiary amin

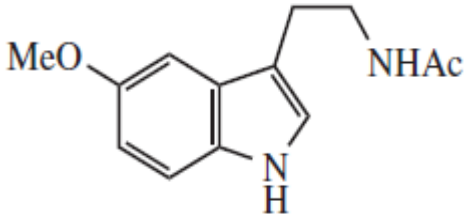
بدها sulfate group

Melatonin
(the second simple derivative)

- In animals, **melatonin** is a hormone synthesized by the pineal gland in the brain.
- it can be synthesized by methylation of the 5-OH and acetylation of the amino group of the serotonin.



5-hydroxytryptamine
(5-HT; serotonin)



melatonin

تنظيم وقت النوم
ووقت الاستيقاظ

Melatonin

- Melatonin is claimed to be effective in helping to regulate disrupted circadian rhythms and **sleep disorders**. A slow-release formulation is available for treating insomnia in older patients; melatonin production is found to **decrease with age.**

- It is currently also popular to reduce the effects of **jet-lag** by resetting the internal body clock.

الناس لما تسافر ممكن تتغير الساعة
البيولوجية للجسم ف بستخدمو الأدوية الي
فيها melatonin لتنظيم وقت النوم

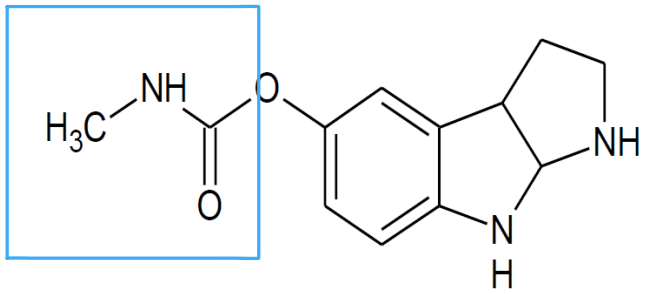
Physostigmine (eserine)

toxic effect

- Isolated from the seeds of the Physostigma venenosum ,this plant contain many alkaloids but the most important one is physostigmine.
- Physostigmine is a very unstable compound it oxidized easily,
- we can detect the deterioration of this compound by the color change that occur due to oxidation therefore the oxidized derivative (rubreserine) can be easily recognized by its red color.

3 Ring

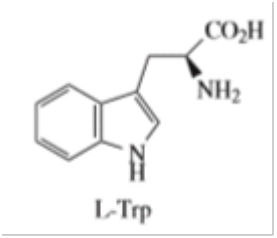
amid group

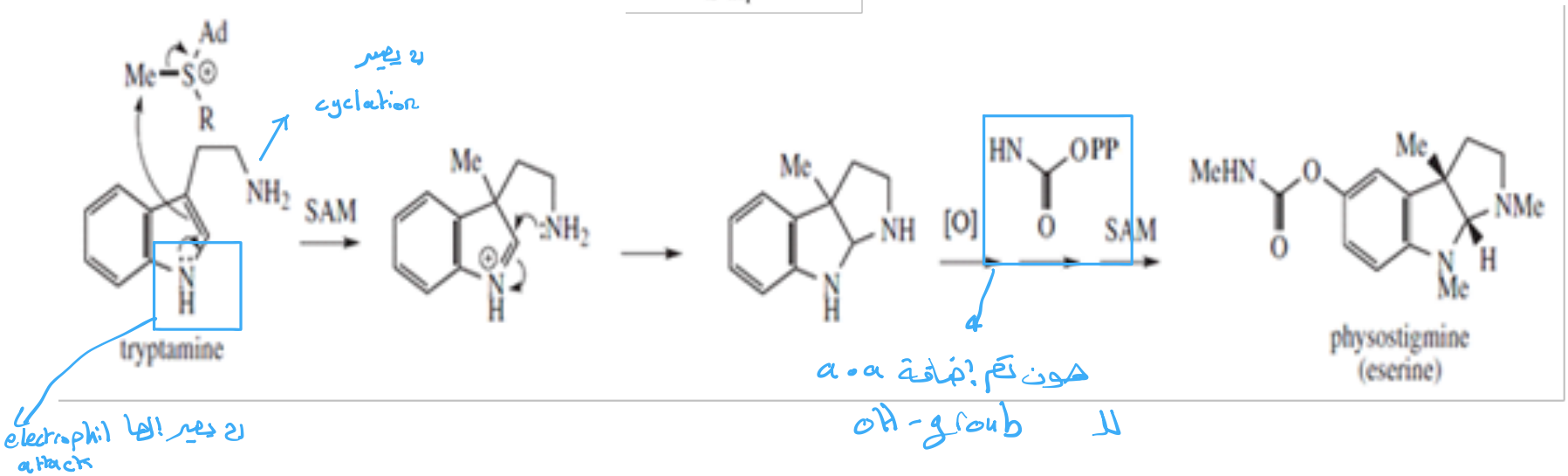


rich of electron

Physostigmine (eserine) :

- In the structure of the amino acid tryptophan (or its derivative tryptamine), there are 2 adjacent carbons (the a & b carbons) of the NH group inside the indole ring, which are important nucleophilic centers because many of tryptophan





enhance the memory

Physostigmine (eserine)

Acetylcholine esterase inhibitor

- Uses : physostigmine is the antidote for several anticholinergic compounds such as atropine hyoscyamine and related substances as well as it is an antidote for muscle relaxants like curare

يعني إذا زاد تركيز الـ Ach رح يوقف شغل

- Moreover it is a **transient (reversible)** inhibitor of acetylcholinesterase, which mean that it will cause accumulation of Ach and this accumulation will enhance the memory & it is needed in the treatment of several disease like **Alzheimer's** disease
- This drug will not reverse the disease but it will delay it.

مارح يعالج المرض بس رح يأخر

Physostigma venenosum:

- From its name **venenosum**, it's **very toxic** plant, it comes from **seeds** of **calabar bean** (found in **Nigeria**), family: **Fabaceae**.
- This seeds are important as a source for **physostigmine**. It was used in **ordeal poison** by giving it to a person, if that person **vomiting** then he is **innocent**; if he **died** then he is guilty.
-
- The person who eat this plant die due to **progressive paralysis** followed by **cardiac, respiratory failure.** Nowadays it's used as **rodenticide** (the **most** important use).

كانوا زمان يستخدموا ال physostigma لحتى يكشفوا انه الشخص مذنب او لا يعني سم الحقيقية فكان بنظرهم انه الشخص اذا صار عنده vomitingيعني انه بريء اما اذا مات فهذا يعني انه مذنب وطبعا هذا الحكي غلط

السبب الي بخليهم يموتوا هو انه هاي النبته بس الواحد ياكل منها رح يصير عنده شلل وبعدها فشل بالقلب وفشل بالتنفس واخر اشي بموت بسبب التاثر بهاي الاعراض

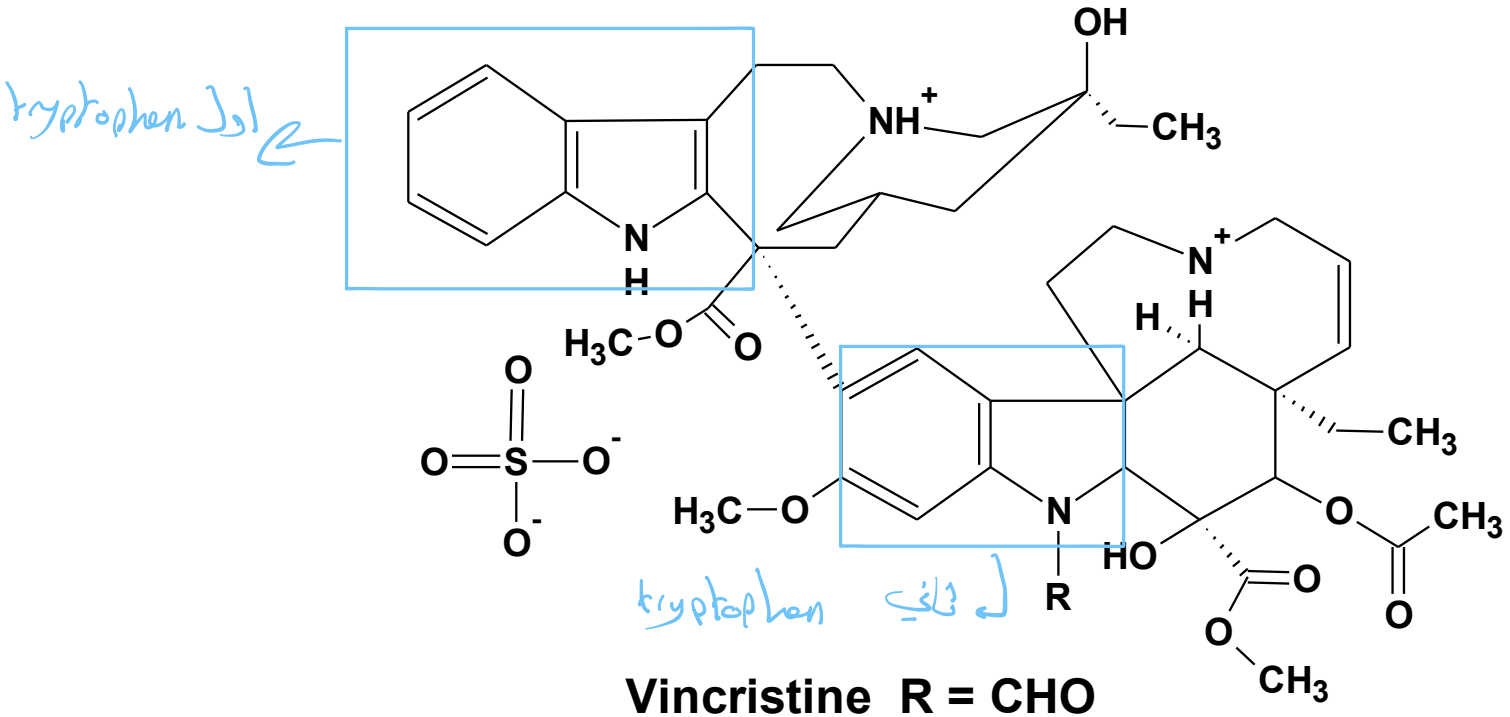
Venca Alkaloids

- **Viniblastine** and **Vincristine** are anti-cancer compounds from *Catharanthus raserus* and ***Venca rosera*** . they are antimitotic agents , but they cause serious neurotoxicity .
- other disadvantage of them is their low concentration in nature (we need 5000 Kg of their leaves to produce 1 g of them !!)
- Venicristine has more pharmacological activity than Viniblastine.

dimeric compound يعتبر

The alkaloids of the periwinkle plant (*Vinca rosea*)

2 tryptophan منتج

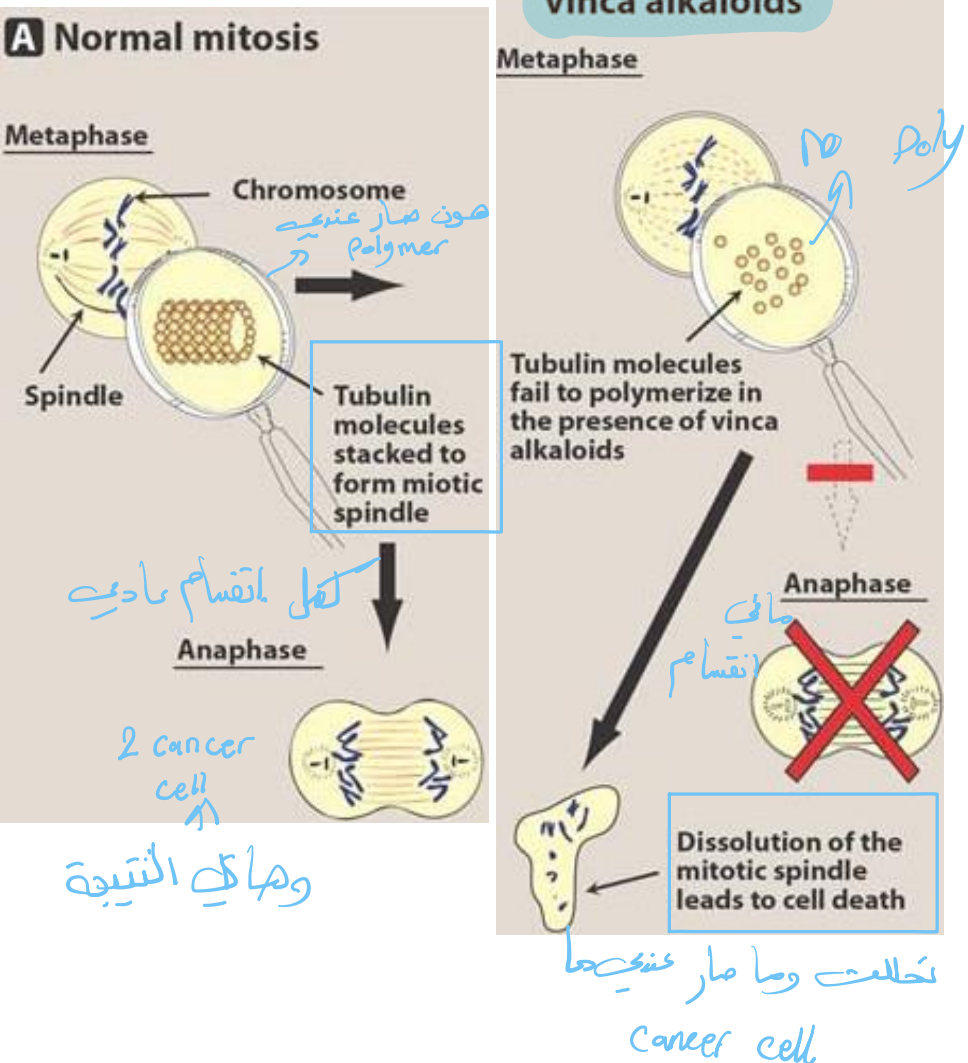


Vincristine R = CHO

Vinblastine R = CH_3

They are dimeric indole-dihydroindole derivatives

Vinka alkaloids (Vinblastine, vincristine)



- These drugs block the formation of mitotic spindle by preventing the assembly of tubulin dimers into microtubules
- ***They act primarily on the M phase of cancer cell cycle

Ergot alkaloids ergoline

- Ergot alkaloids are isolated from infected plants (fungal infection).
- They are tryptophan derivatives

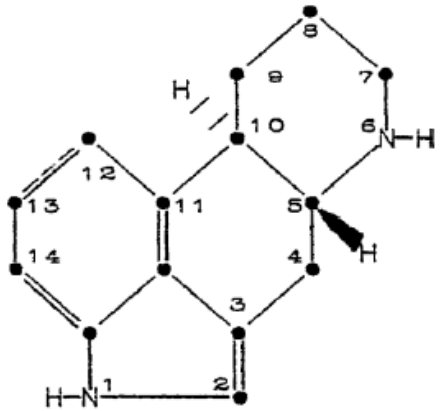
Ergot alkaloids

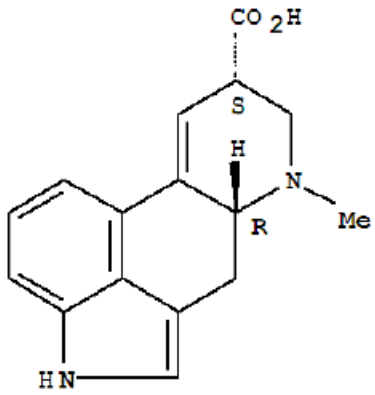
- Ergot alkaloids aren't naturally occurring; it's synthesis in response to infection by Claviceps purpurea fungus.
- **Ergot Alkaloids** in general are classified into **2** gp:
- 1. **water soluble gp** :due to presence of **amino alcohol** functional gp, it forms **20**% of total alkaloids, an example **ergometrin**, **alcohol** alkaloids contain what is called **lysergic acid**, this acid has **2** forms: **dextro**(+) which is the **active** form and **levo (-)** form is inactive

نسبتها عالية

Lysergic acid

- **Lysergic** acid which is the **active** ingredient for **ergot** alkaloids may exposed to some changes which is **enolization** (**heat or alkaline effect**), this will convert it to **inactive** compound called **isolysergic** acid.





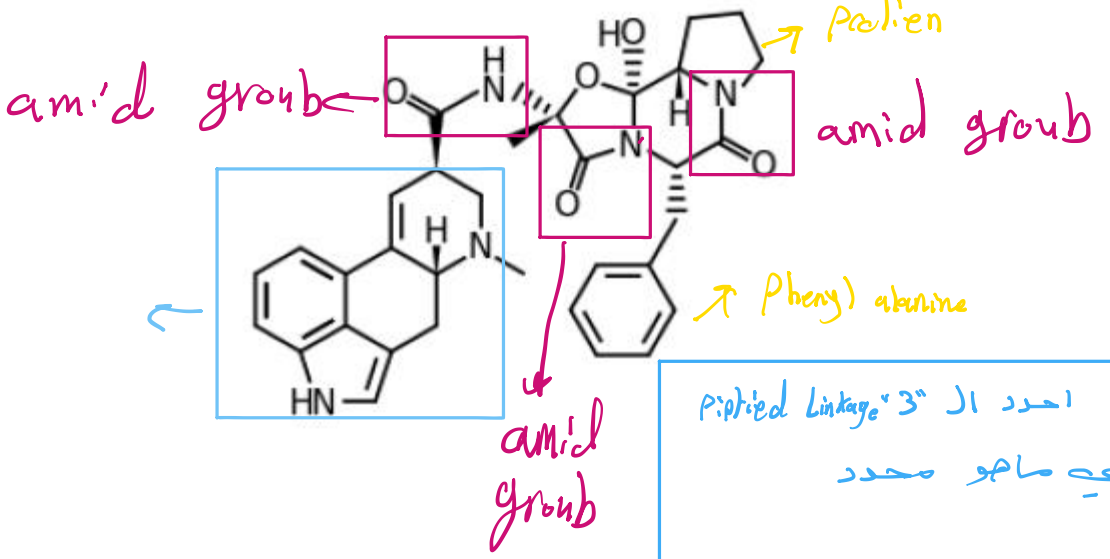
Isolysergic acid

in active form from Lysergic acid

Ergotamine:

- 2. **Water insoluble gp**:It's a **peptide** derivative(contain an **amide group** and parts of **protein** and **amino acid**).

- **Ergotamine:**
- It's a **peptide** derivative contain **tripeptide** fragments **bonded** to lysergic acid via **amid** link. It's used for migraine
- the **hydrolysis** of **peptide ergot** alkaloids will produce **lysergic acid** + **proline** +**phenyiaianine** + **pyruvic acid** +**ammonia**



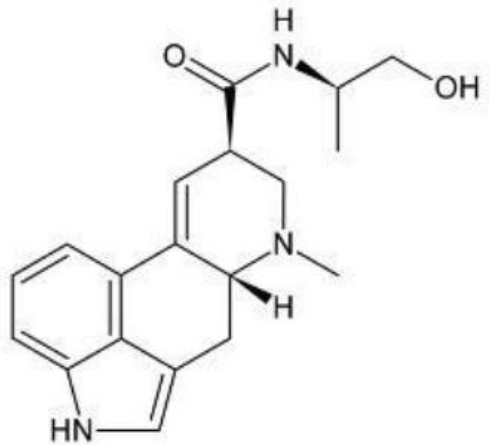
Ergometrine

أخر مرحله من الولادة عشان امنع الـ bleeding

- Ergometrine is used during the final stages of labour and immediately following childbirth, especially if haemorrhage occurs. Bleeding is reduced because of its vasoconstrictor effects, and it is valuableafter Caesarian operations.

العملية القيصرية

ـ (3) حلقات سداسية
ح حلقه خماسية فيها (N)



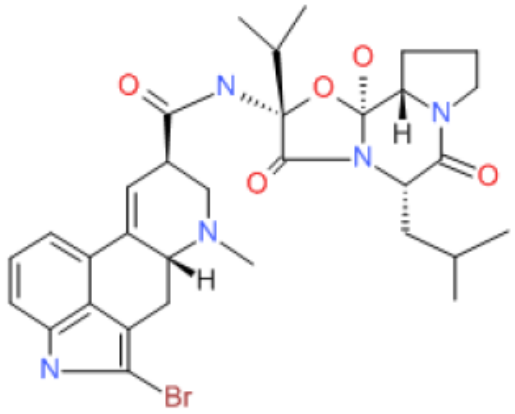
Ergometrine

Bromocriptine:

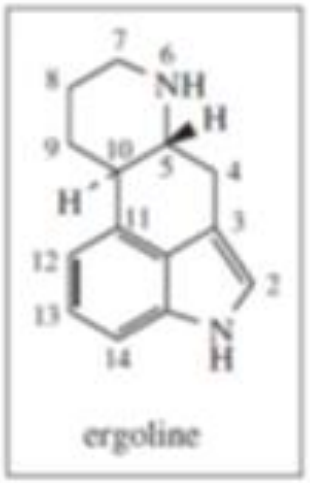
- It's very **cheap** compound, It's used to **inhibit prolactine** production, also useful in treatment of **Parkinson disease**
- It is a dopamine agonist that is used in the treatment of pituitary tumors, Parkinson's disease (PD), hyperprolactinaemia, and type 2 diabetes.
- It has **bromine** (Br) at **C2**, **2 isopropyl** moiety at **peptide** compound..

Bromocriptine is a semisynthetic derivative of a natural ergot alkaloid

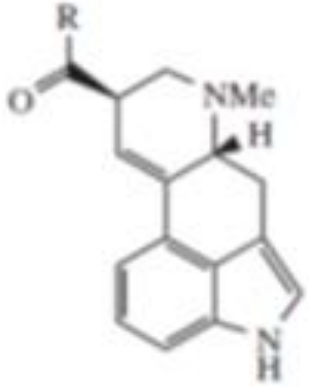
(Br) تميزه اسهل اشي لانه الوحيد اللي صعب



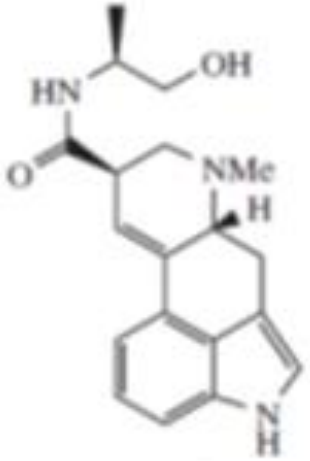
Bromocriptine



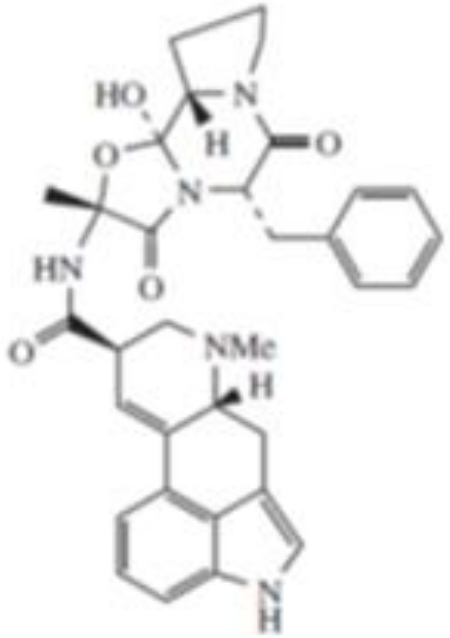
ergoline



R = OH, (+)-lysergic acid
R = NH_2, ergine



ergometrine



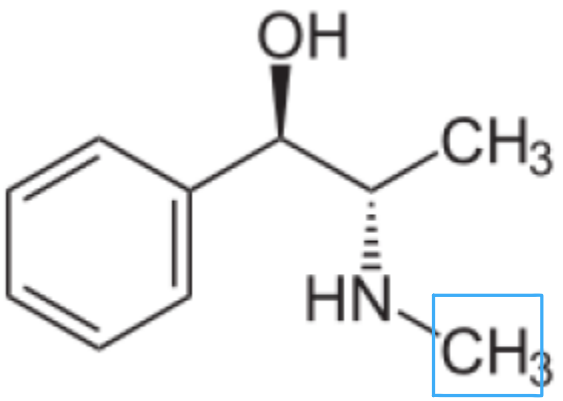
ergotamine

Proto alkaloids

- **proto** alkaloids(means the **nitrogen** is **not part** of heterocyclic structure) **derived from Phenylalanine**
- **Ehpedra: (family: Asteraceae)**
- It's very long plant, **leaves**, and **flowers** are considered as a **source** for **ephedrine**.
- Now it's known as **herbal ecstasy** because it has **CNS stimulant** and **hallucination**.

Ephedrine (norephedrine)

- Synthesis from **phenylalanine** that provide **C6C3** structure, or **C6C2** (by **removing** of **carboxylate** gp), or **C6C1**. So **phenylalanine** goes **several steps**, the **first** is **removing of carboxylate** gp then we add **amino gp** or **alkyl** gp to produce **norephidrine** then we add **methyl** gp to produce ephedrine.
- **NOTE**: the **active** form of **ephedrine** is **levo** (-) form.



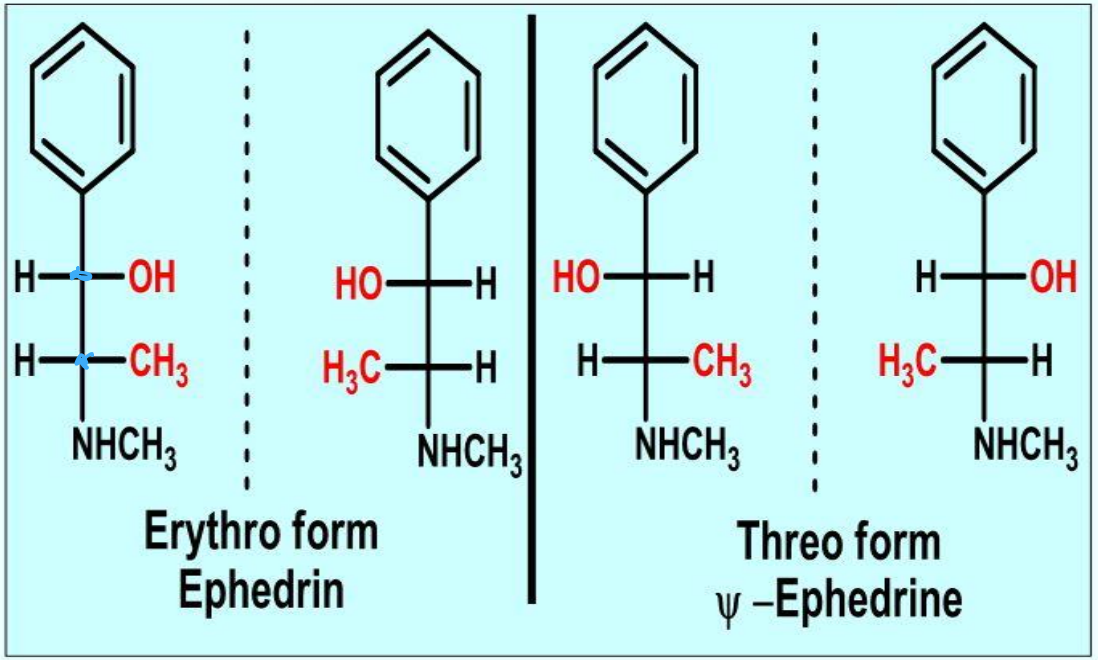
Ephedrine

Ephedrine

Ephedrine has two (asymmetric) chiral carbons: so four stereoisomers (4 optically active isomers that exist as two pairs of enantiomers.)

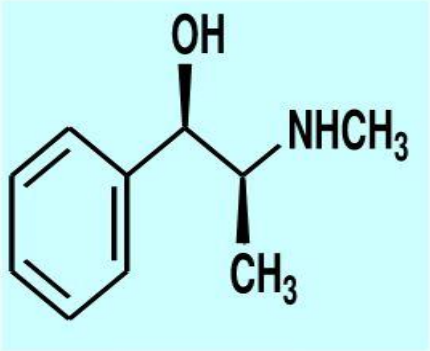
- The *erythro* pair is known as ephedrine.
- The *threo*- is known as pseudoephedrine (ψ-ephedrine).

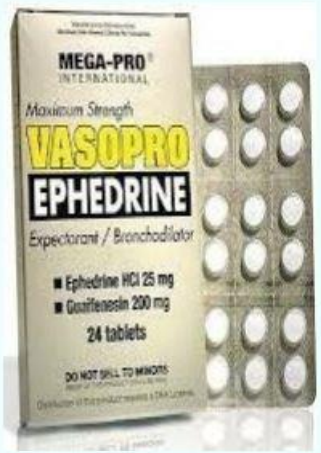
2 chaival carbon



See introductory part about stereochemistry of drug molecules

Ephedrine

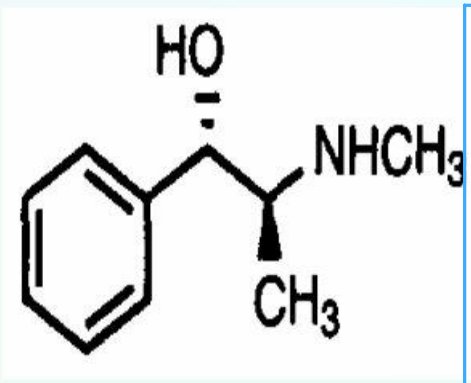




(-)-*Erythro*-2-(methylamino)-1-phenyl-1-propanol
(-)-*Erythro*-α-[(1-methylamino)ethyl] benzyl alcohol.

- It is available as HCl or as Sulphate. Can U draw ???
- Used by injection and orally.
- Used as adrenergic, as vasopressor, cardiac stimulant, nasal decongestant and bronchodilator and CNS stimulant activity .
- in hypotensive conditions
- In allergic disorders, colds, nasal congestion
- In asthma
- in narcolepsy

Pseudoephedrine



(+)-*Threo*-2-(methylamino)-1-phenyl-1-propanol

(+)-*Threo*-α-[(1-methylamino) ethyl] benzyl alcohol

syrpe موجود على شكل او Capsule

- Pseudoephedrine is the *threo*-diastereoisomer of ephedrine
- HCl and Sulphate salts
- has virtually no direct activity
- Mainly indirect action.
- widely used as nasal decongestant. → إحتقان

القات اليمني

Catha edulis (celastraceae) قات

+ chathin

- A flowering plant contains alkaloid cathinone, a stimulant, which is said to cause excitement, loss of appetite, and euphoria

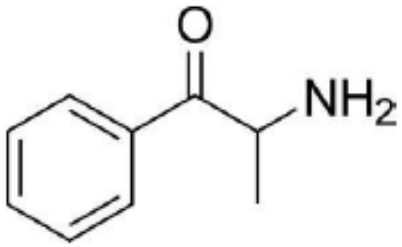
حماس

السعادة

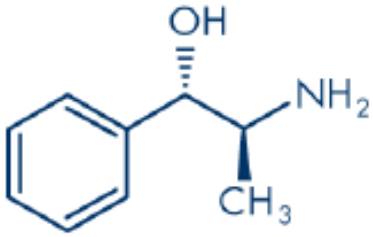
The main compounds in this plant are

CNS

Cathinone: (ketonic) which is very similar to norepinephrine?



Cathine: (alcoholic or reduced) form of pseudoephedrine.



- These two compounds have an effect on the brain barrier in the CNS, due to the similarity in structure with amphetamines (a compound already found on the nerve barriers); some people may take amphetamine supplements to have euphoria, restlessness and to stay awake for a long time. People can gain this effect by suckling the leaves of this plant.
- only fresh leaves contain cathinone and cathine, while the dried ones don't, and upon drying cathinone is converted to another derivative.

- **Mechanism of action :** when cathonine attacks the barrier in the CNS,this attack will lead to high secretion of catecholamines ,with time, as a result tolerance might happen and the person need to take higher amount than the previous one. So who usually take cathonine for a long periods of time, will need higher doses due to tolerance. To stop the effect of Khat, take a CNS depressant; like barbiturates or opioids (compounds from opium like morphine) that terminate the effect of

- Khat is not used for its pharmacological effect anymore. In the past they used to use khat in the treatment of addiction, now it's abused because of the psychological dependence and some people may die because of the tolerance.

ان شاء الله أكون شملت كل اشي

بالتفريغ و بالتونيت

H. Rahaf Zyoud