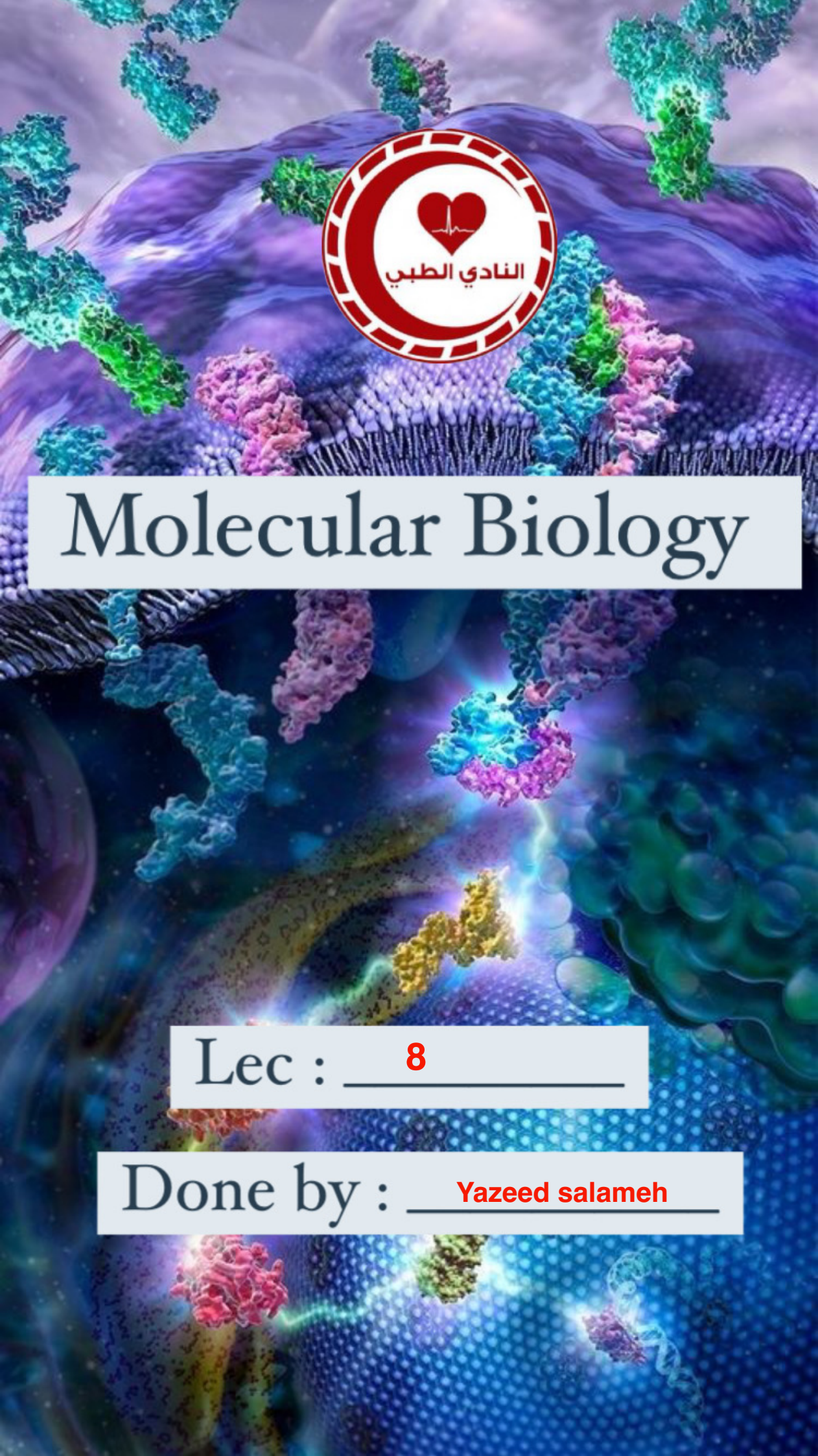


Molecular Biology

Lec : 8

Done by : Yazeed salameh

Salameh Yazid

Lipids of biological importance – Complex lipids & Steroids

Nebras Melhem

Complex Lipids

- **Complex lipids** are esters of fatty acids, which always contain an alcohol and one or more fatty acids, but which also have other groups.

They can be divided into three types:

1. **Phospholipids**

2. **Glycolipids (**glycosphingolipids**):** Contain a fatty acid, sphingosine, and carbohydrate.

3. **Other complex lipids:** These include lipids such as sulfolipids, amino lipids & lipoproteins.

Glycolipids

→ 3 compo. → Sphingosine, 1 fatty Acid, Carbohydrate.

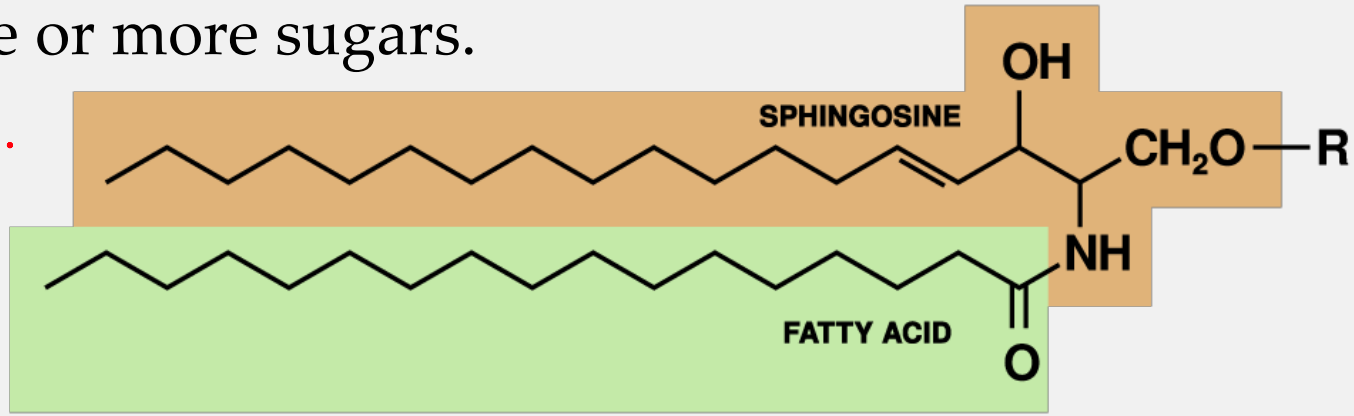
Brain, cell memb.

- Glycolipids are lipids with an attached carbohydrate or carbohydrate chain.
- They are widely distributed in every tissue of the body, particularly in nervous tissue such as brain. in cell membrane.
- They also contain sphingosine and are, therefore, classified with sphingomyelin as **sphingolipids.**
- They contain ceramide and one or more sugars.

→ Cell-Cell signalling molecule.

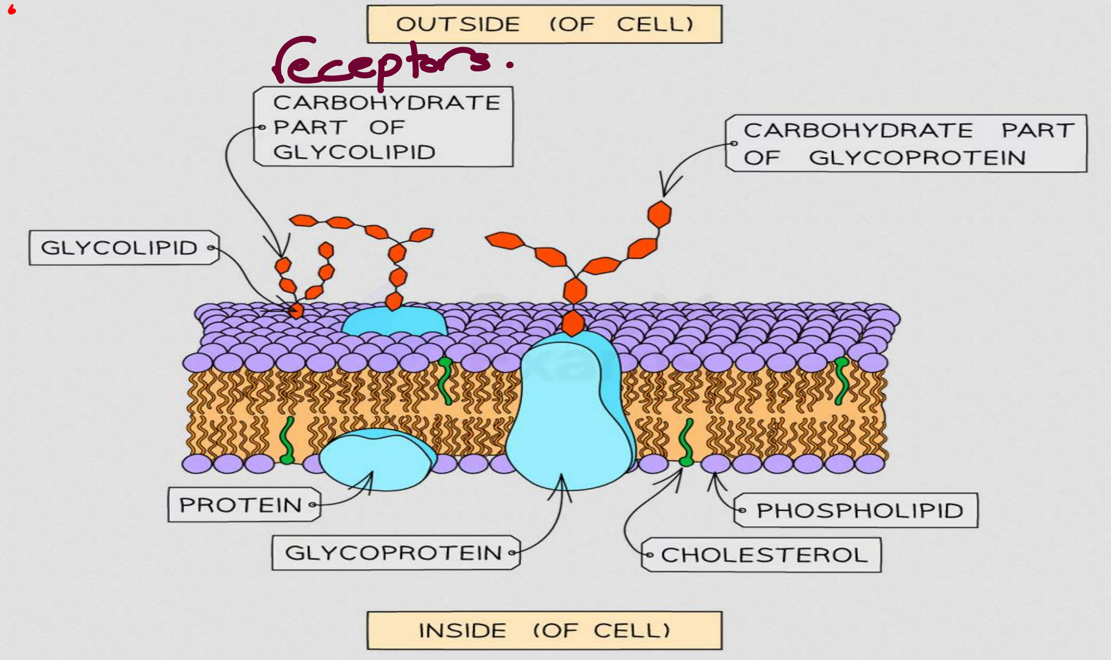
→ Receptors.

⊕ Cell Membrane.



Glycolipids

- Glycolipids are found in cell membranes, especially in myelin sheath.
- In the plasma membrane (outer leaflet), the CHO radical of glycolipids projects outside the cell and may have a receptor function (for some toxins and viruses, cellular connections).



1. Cerebrosides

Cerebrosides: These consist of sphingosine, FA (usually 24 carbon lignoceric, cerebronic, or nervonic acid), and galactose or glucose.

The FA is connected to the amino group of sphingosine in amide linkage.

The sugar is connected to the primary alcohol group of sphingosine in **β-glycosidic linkage.**

1. **Galactosylceramide** is a major glycosphingolipid of **brain** and other **nervous tissue**, found in relatively low amounts elsewhere.
   - It contains a number of characteristic C24 fatty acids, for example, cerebronic acid.

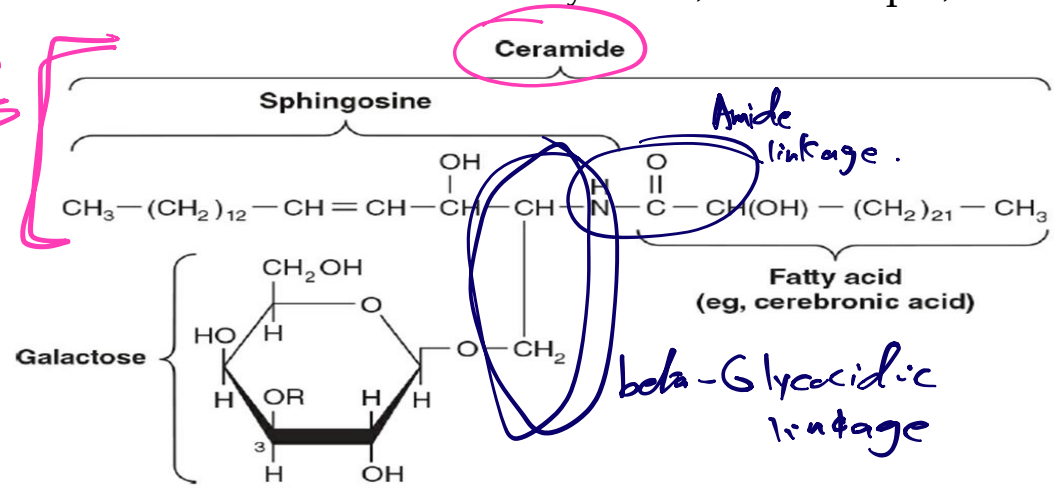
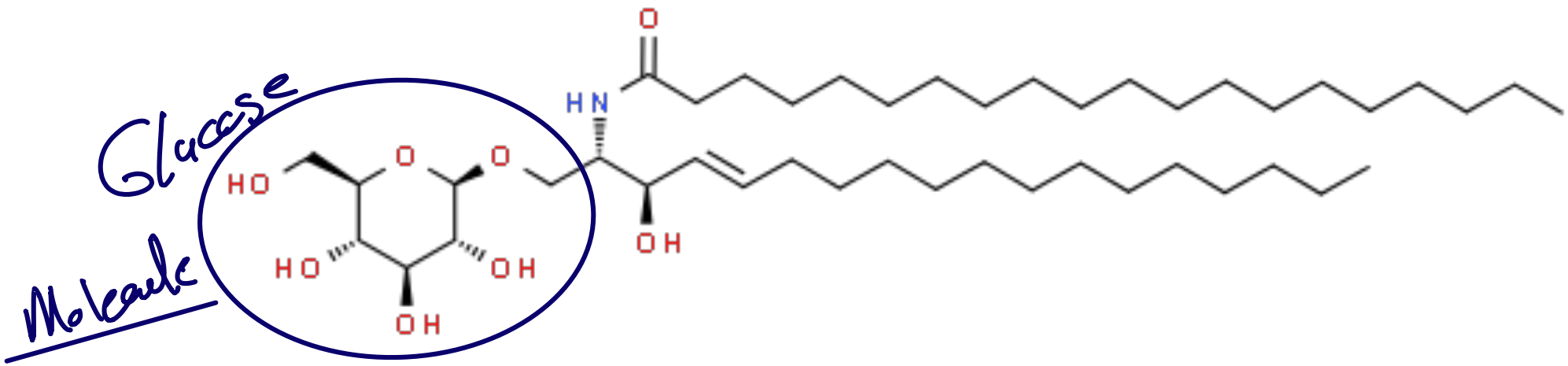


FIGURE 21–14 Structure of galactosylceramide.

1. Cerebrosides

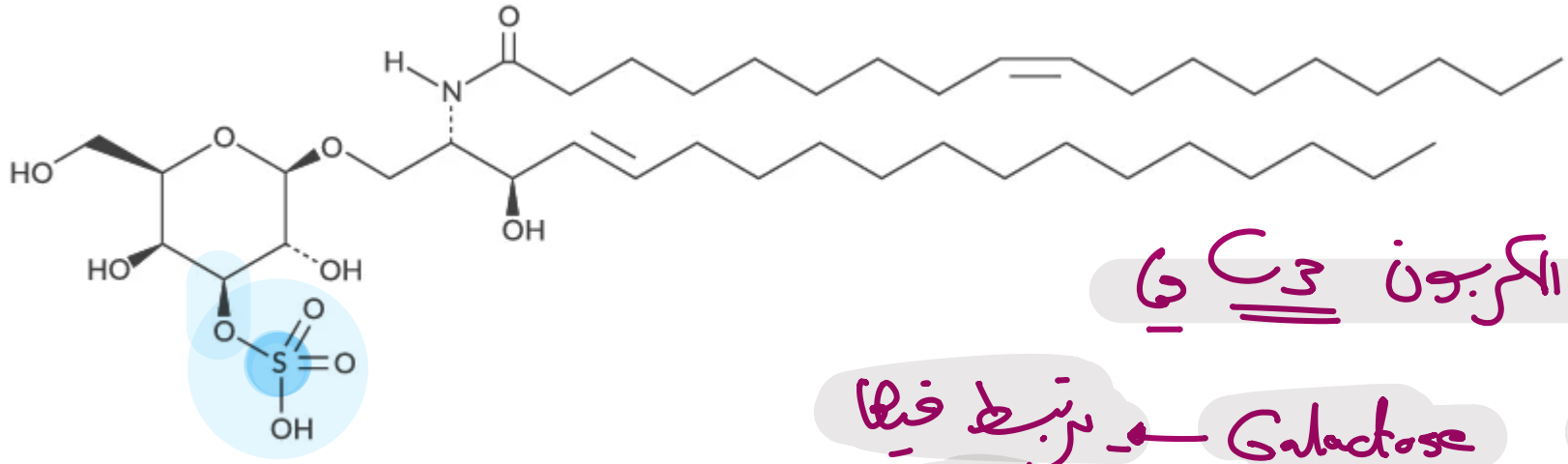
2. **Glucosylceramide** resembles galactosylceramide, but the head group is glucose rather than galactose.

- It is the predominant simple glycosphingolipid of extraneural tissues, also occurring in the brain in small amounts.



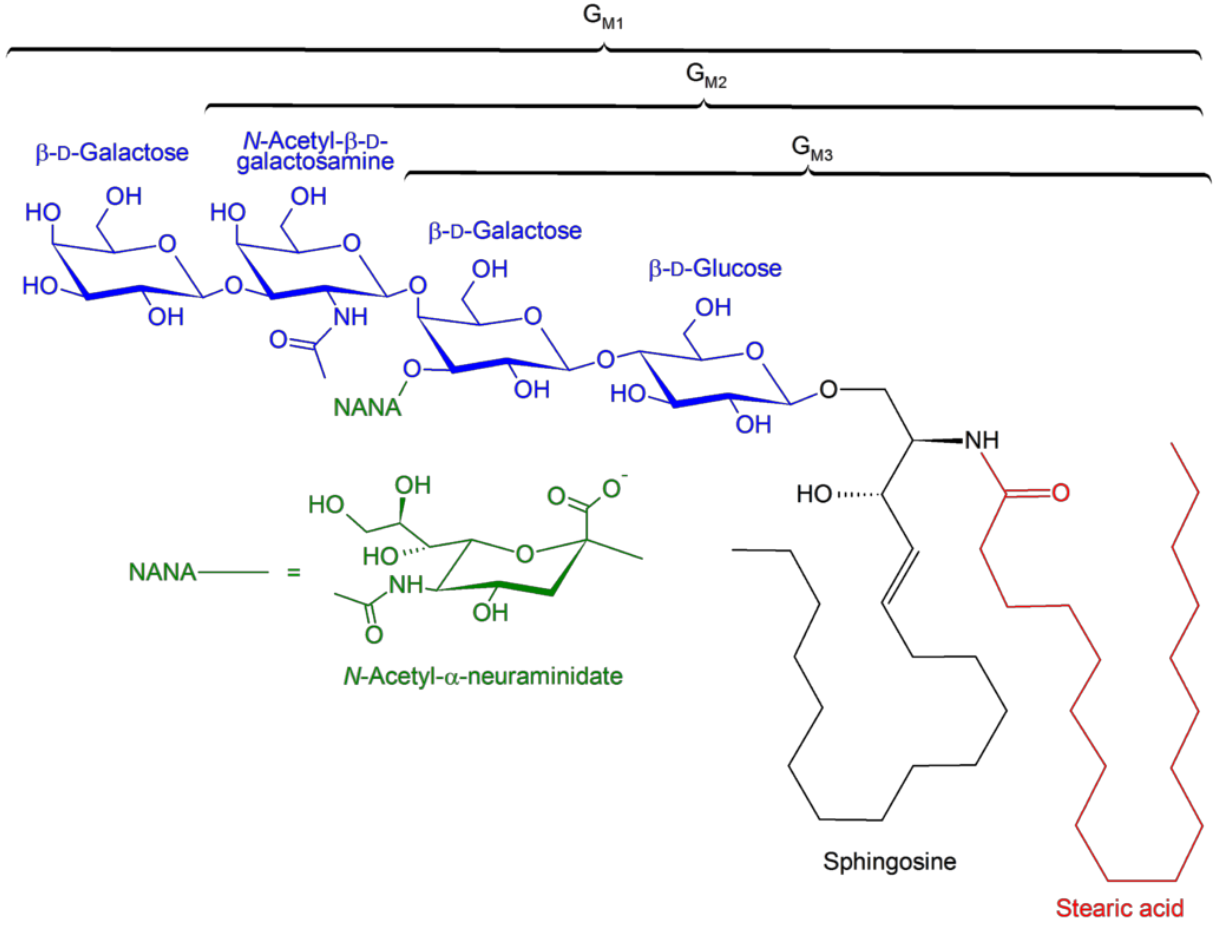
2. Sulpholipids

- **Galactosylceramide** can be converted to sulfogalactosylceramide **(sulfatide)** which has a sulfo group attached to the O in the three position of galactose and is present in high amounts in **myelin.**



3. Gangliosides

- **Gangliosides** are complex glycosphingolipids derived from glucosylceramide that contain in addition one or more molecules of a **sialic acid**.
-
- **Neuraminic acid** is the principal sialic acid found in human tissues.
- Gangliosides are also present in nervous tissues in high concentration.
-
- They function in cell–cell recognition and communication and as receptors for hormones and bacterial toxins such as cholera toxin.

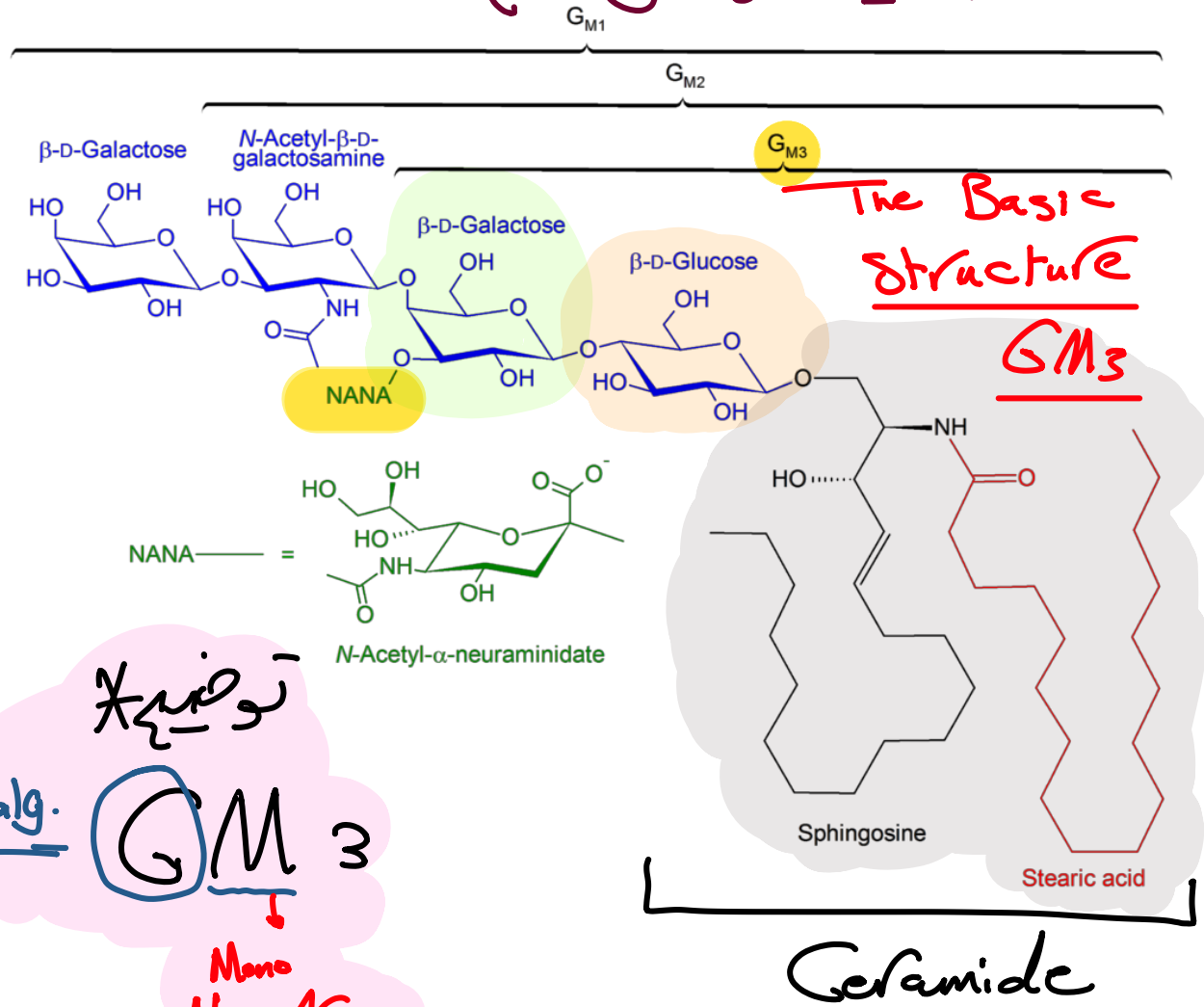


ابسط نوع → Ceramide

GM3 + Glucose + Galactose + Nuaric Acid

3. Gangliosides

- The simplest ganglioside found in tissues is GM3, which contains ceramide, one molecule of glucose, one molecule of galactose, and one molecule of NeuAc.
- In the shorthand nomenclature used, G represents ganglioside; M is a monosialo-containing species; and the subscript 3 is a number assigned on the basis of chromatographic migration.
- **GM1**, a more complex ganglioside derived from GM3, is of considerable biologic interest, as it is known to be the receptor in human intestine for **cholera toxin**.



توضيح

Galg. GM3

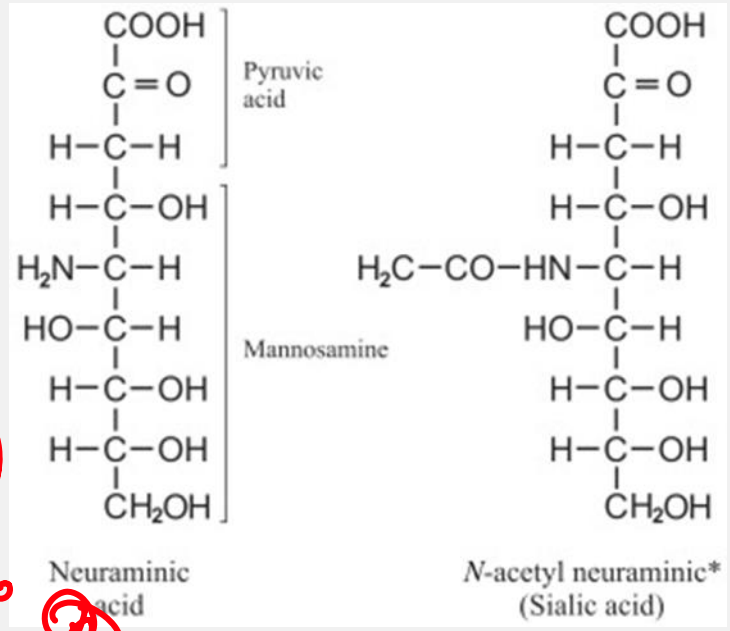
Mono Nua AC.

لو بدنا نخليه معقد أكثر نضيف + (Sugar)

The Basic structure GM3

Amino sugar acids

- Formed by addition of acids to aminosugars.
- They are occurring in glycoproteins, glycolipids.
- Examples include **neuraminic acid** (pyruvic acid and mannosamine).
- Neuraminic acid is unstable and so, it is present in an acetylated form called sialic acid (NANA)



Lipoproteins

Derived lipids

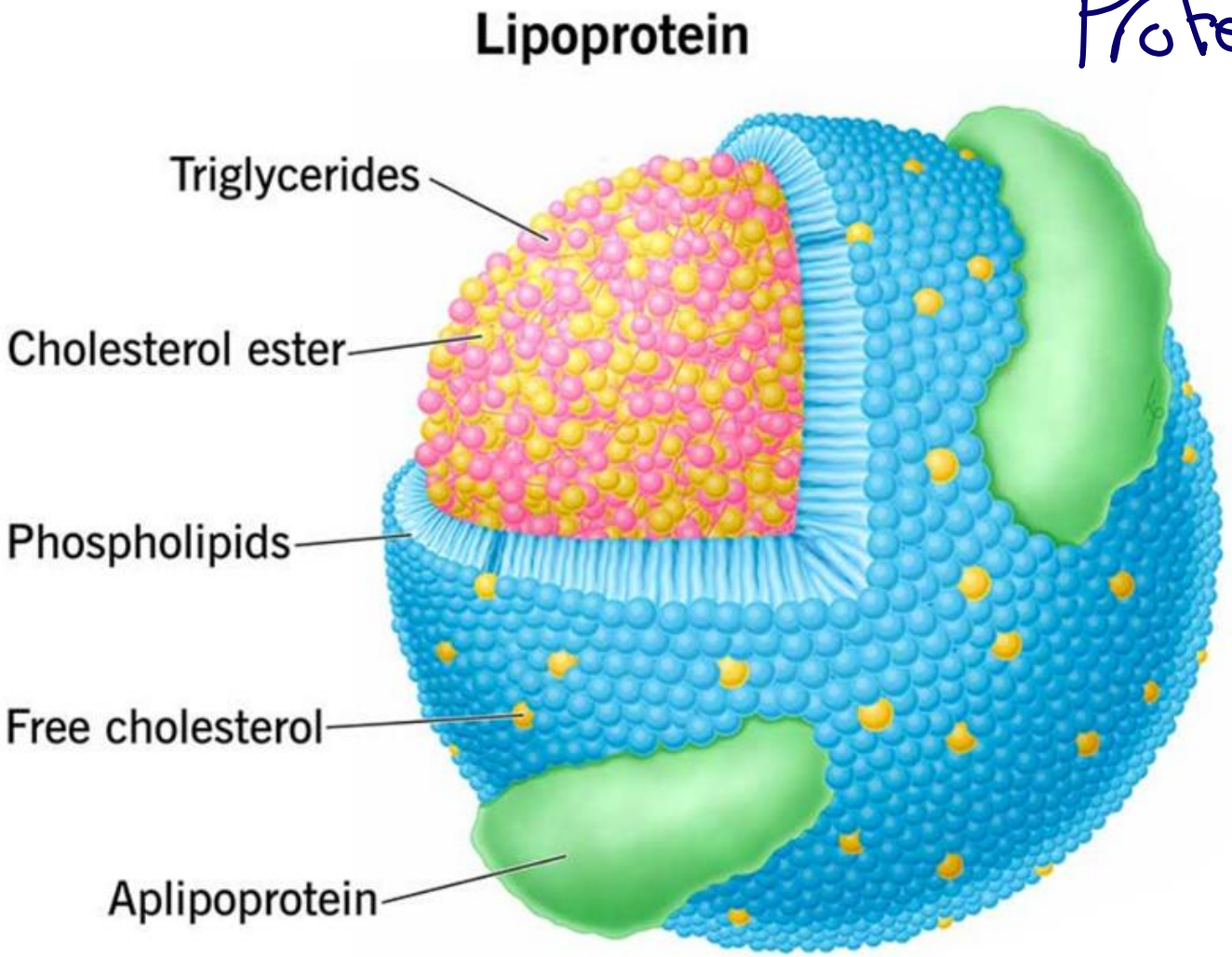
- Lipoproteins are arranged as:
  - lipid part to the interior of the molecule
  - protein part to the exterior of the molecule

- This gives the structure a property of its solubility in water (lipoproteins are water soluble).

- Used to transport lipids in plasma. ← وظيفة

Lipid → inside

Protein → outside



Derived lipids

Type:

- These lipids are derived from both simple & compound lipids.

1. **Alcohols**, such as:
   - **Glycerol**, it is the backbone of glycerol phospholipids.
   - **Higher alcohols**, E.g. myricyl alcohol.
   - **Sterols**, as cholesterol, ergosterol. Their esters with fatty acids are waxes.
   - **Vitamins**, as vit. A (retinol) & D. Their esters with fatty acids are waxes.
   - **Sphingosine**, This alcohol as previously mentioned in sphingomyelin & glycolipids.

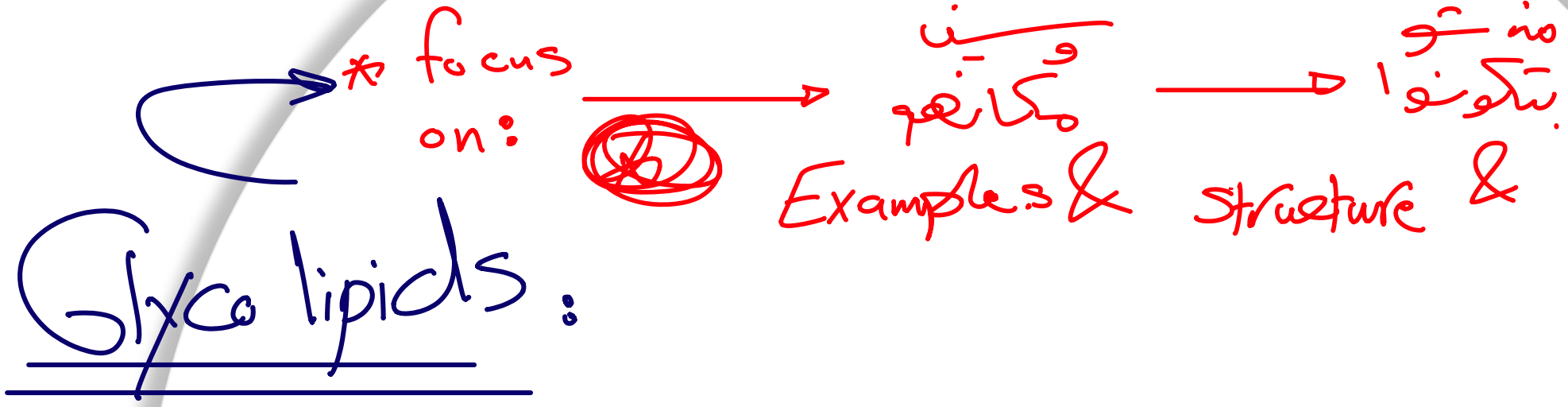
Derived lipids

- These lipids are derived from both simple & compound lipids.

2. Fatty acids

3. Substances associated with lipids

- Vitamins: vitamins E & K are fat soluble & are associated with food fat
- Carotenoids: important precursors of vitamin A



Steroids & Eicosanoids

Steroids

Substances which are derived from C17 cyclopentanoperhydrophenanthrene ring **(steroid nucleus)**

- Steroids include **sterols**, **bile acids** and **steroid hormones**

Comments on the terminology used for steroids:

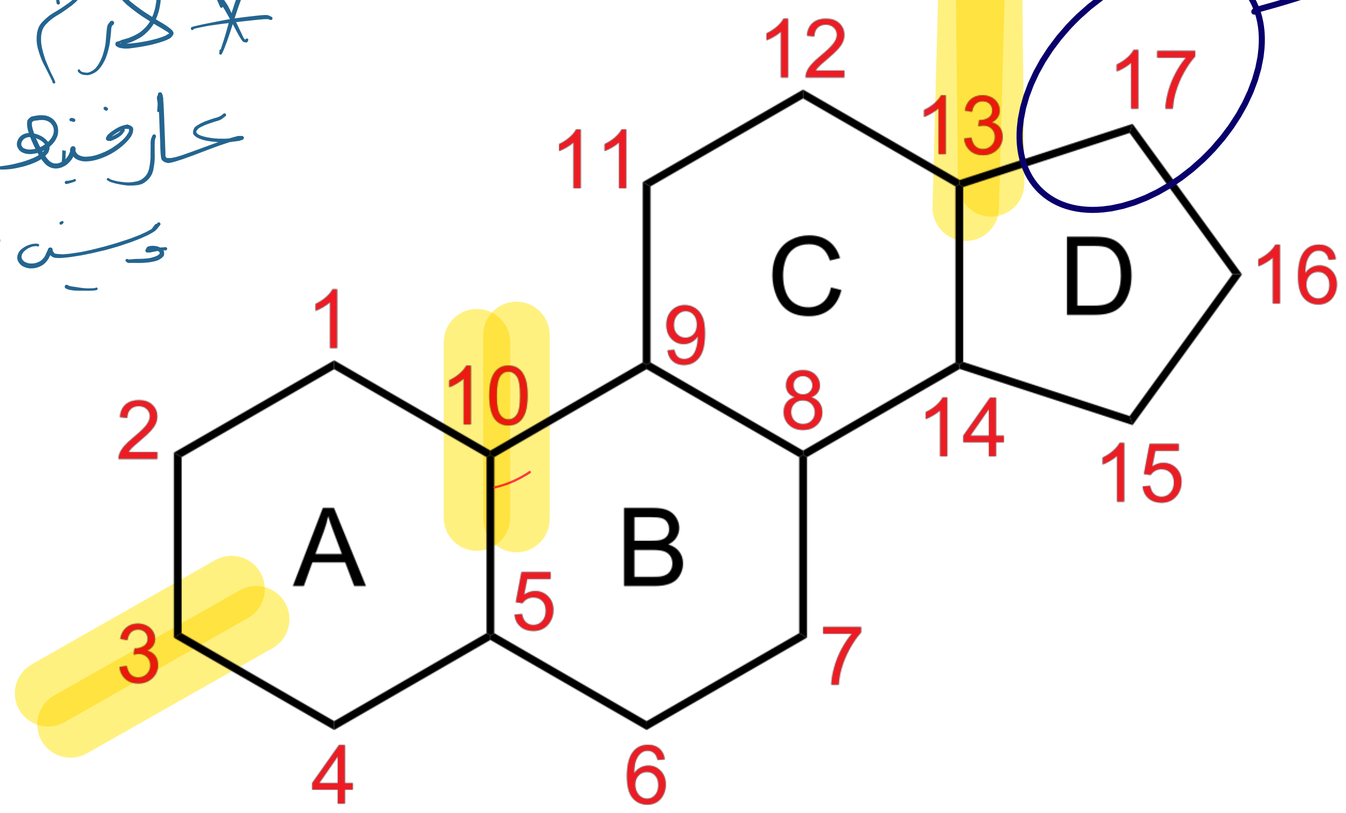
Cyclopentanoperhydrophenanthren ring is due to:

- Cyclo → cyclic
- Pentano → 5 carbon ring (ring D)
- Phenanthrene ring → 3 hexagonal rings (A, B & C)
- Perhydro → saturated with hydrogen (unless noted otherwise)

* لازم نكون عارفينه + نعرف وين مكان الاضافة

* Methyl.

* Side Chain.



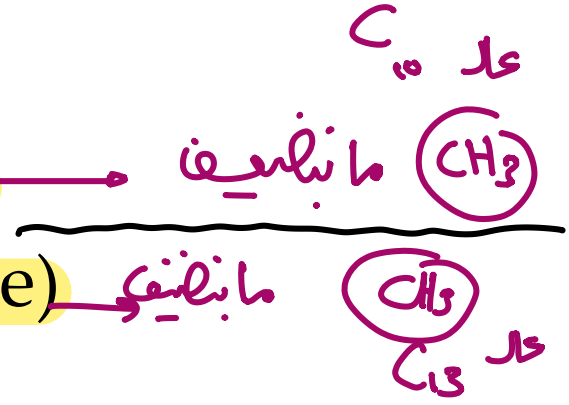
Side Chain → Hydroxyl. / Oxigen.

Cyclopentanoperhydrophenanthrene ring

ring — مشبع satur. — 3 rings (hexose)

General criteria of the steroids:

1. All steroids are derived from cyclopentanoperhydrophenanthren nucleus
2. Natural steroids contain:
   - Methyl group attached to C10 (except estrogens)
   - Methyl group attached to C13 (except aldosterone)
   - Side chain at C17 or oxygen or hydroxyl group
   - ***Ring C & D are always saturated*** but ring A & B may contain double bond



C & D → Saturated

A & B → UnSaturated.

* Methylated

يعني

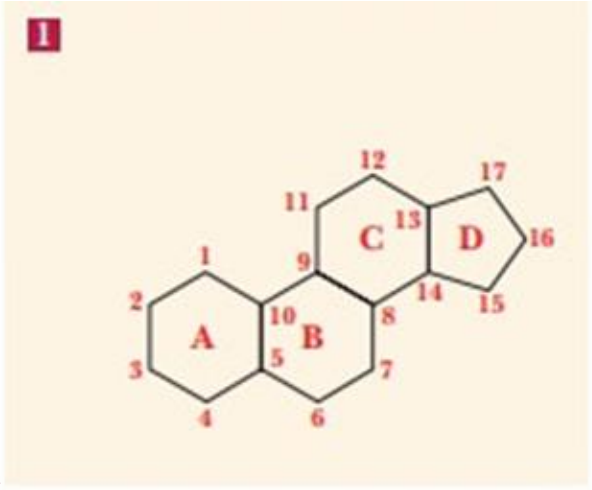
يعني عندها

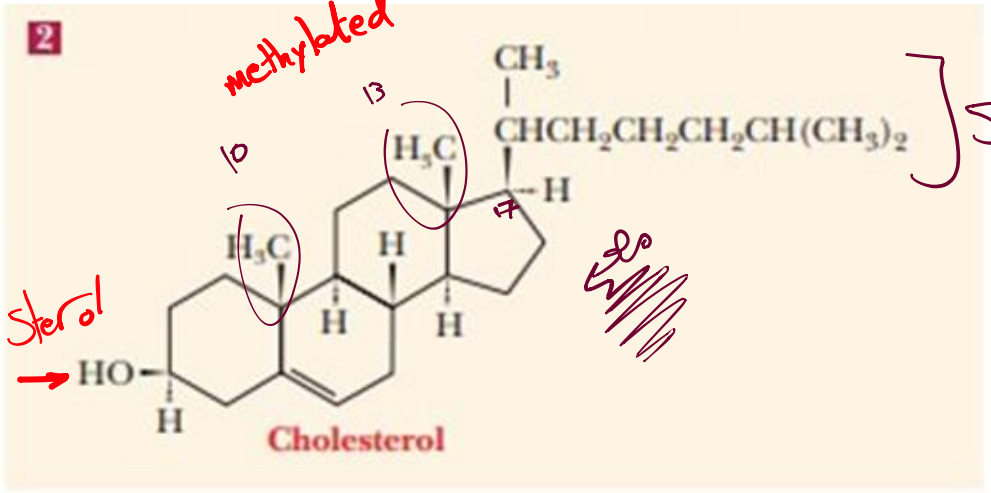
H_3C

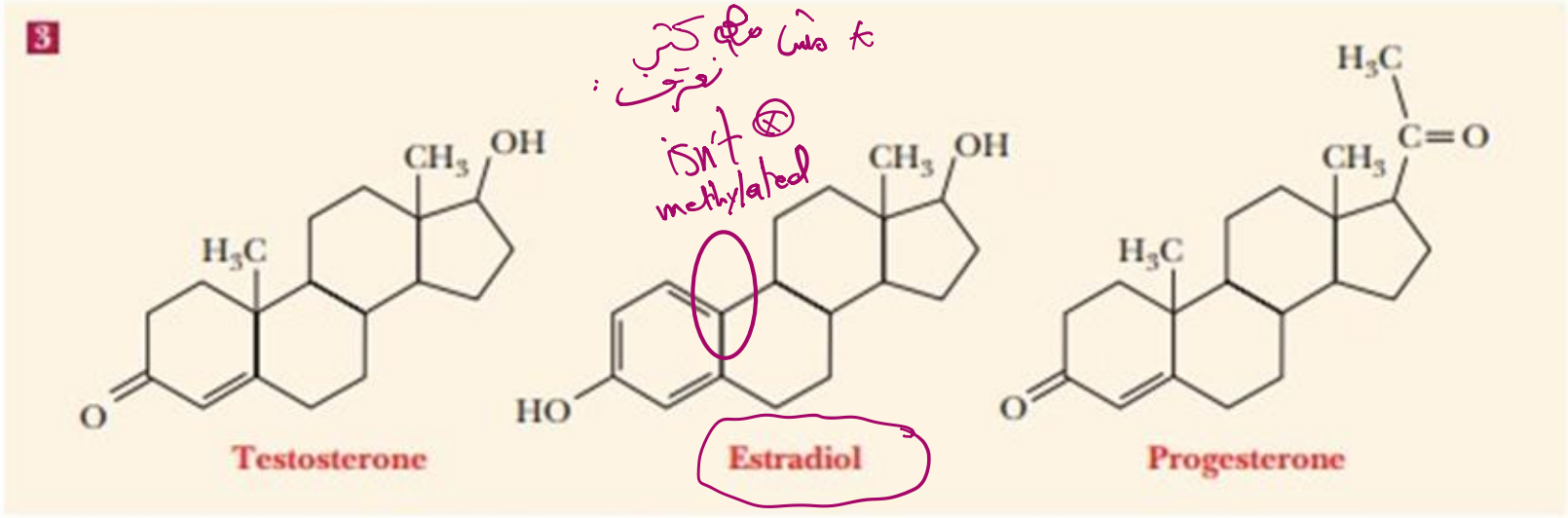
عند الكربون

C 10

+ C 13



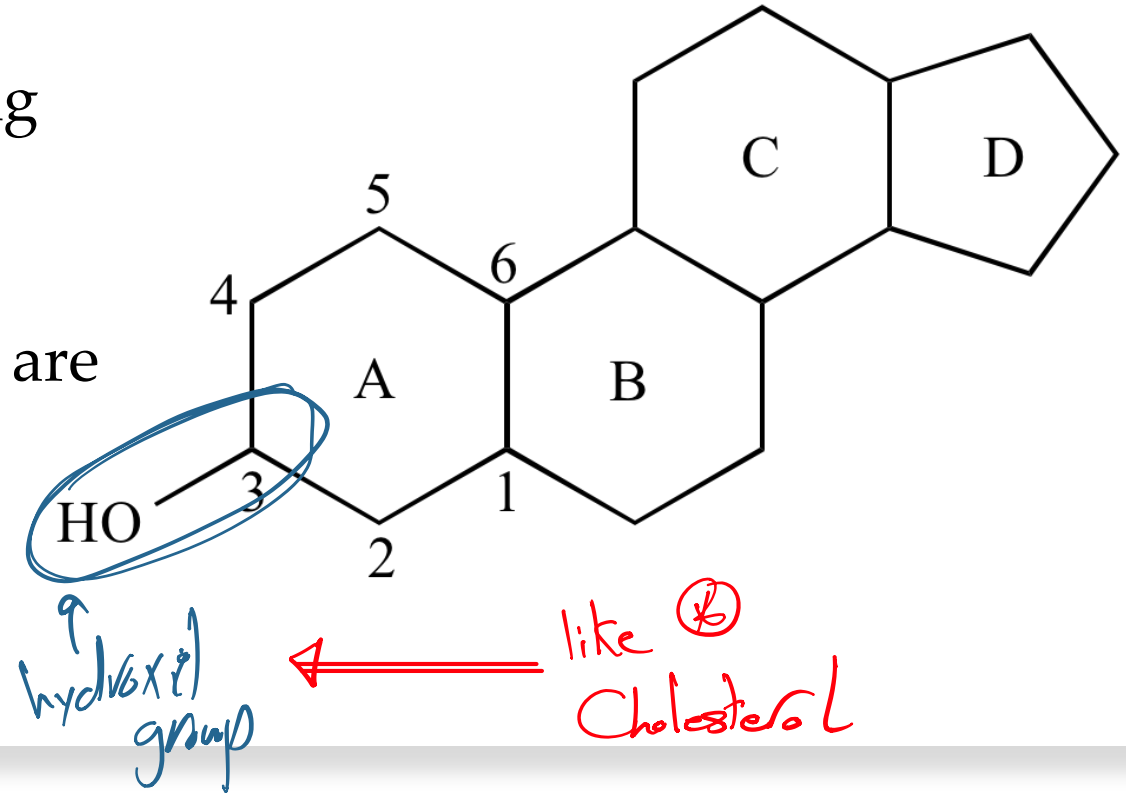




Sterols

These are steroid alcohols containing **OH at C3**

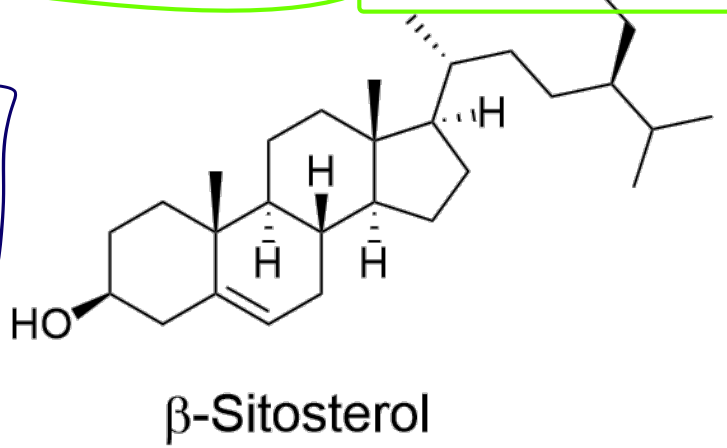
- There are 3 types of sterols which are phytosterol, mycosterols and zoosterols



Phytosterols

- Are of plant origin
- Sitosterol is an example phytosterol
- It is present in plant oil
- Sitosterol can inhibit the absorption of cholesterol

are poorly absorbed by humans (5% absorbed as compared to 40% for cholesterol)



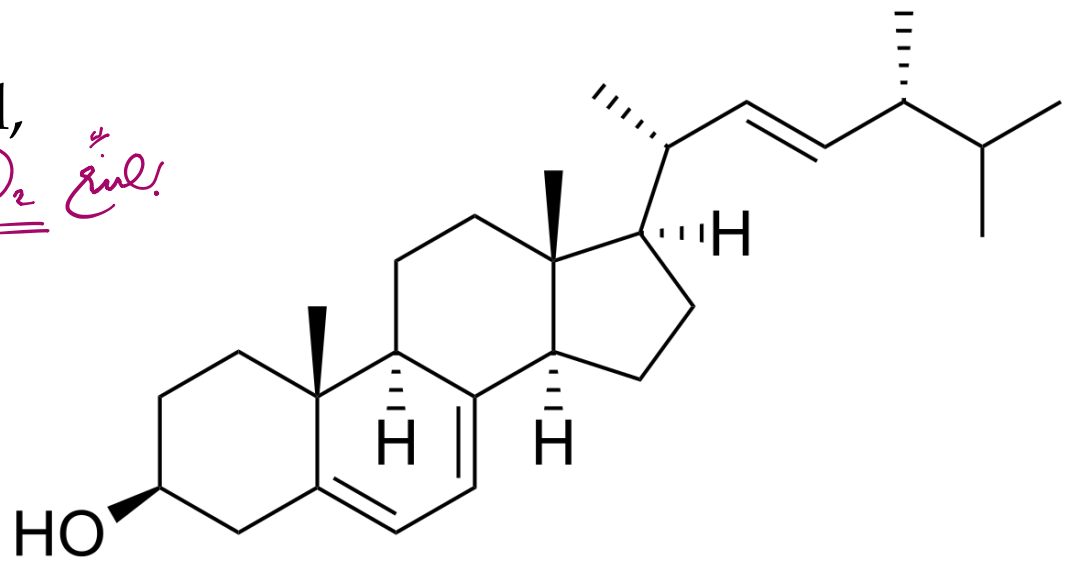
β-Sitosterol

Mycosterols

ex: Ergosterol.

- Are of mycotic origin
- Ergosterol is an example of mycosterol, it is the precursor of vitamin D2
- It is present in yeast

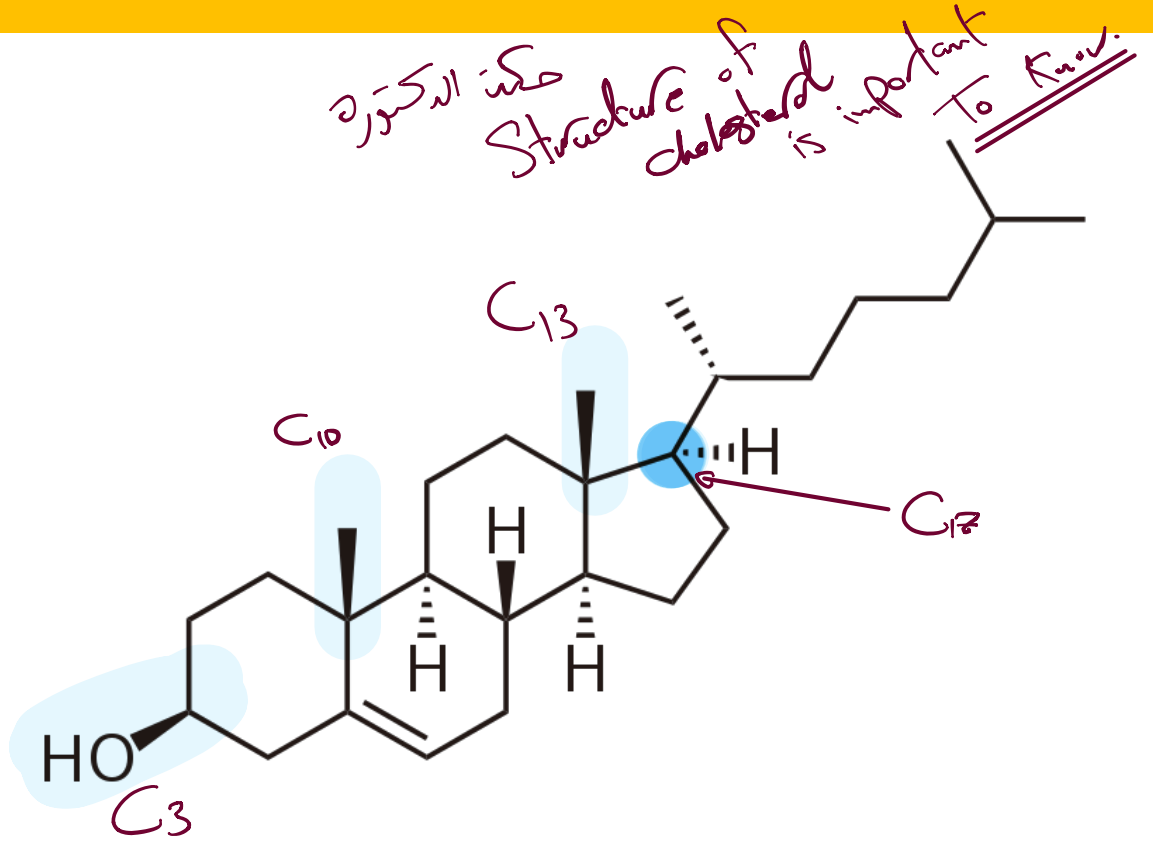
(Extra double bond between C7-8, unsaturated side chain, extra methyl group)

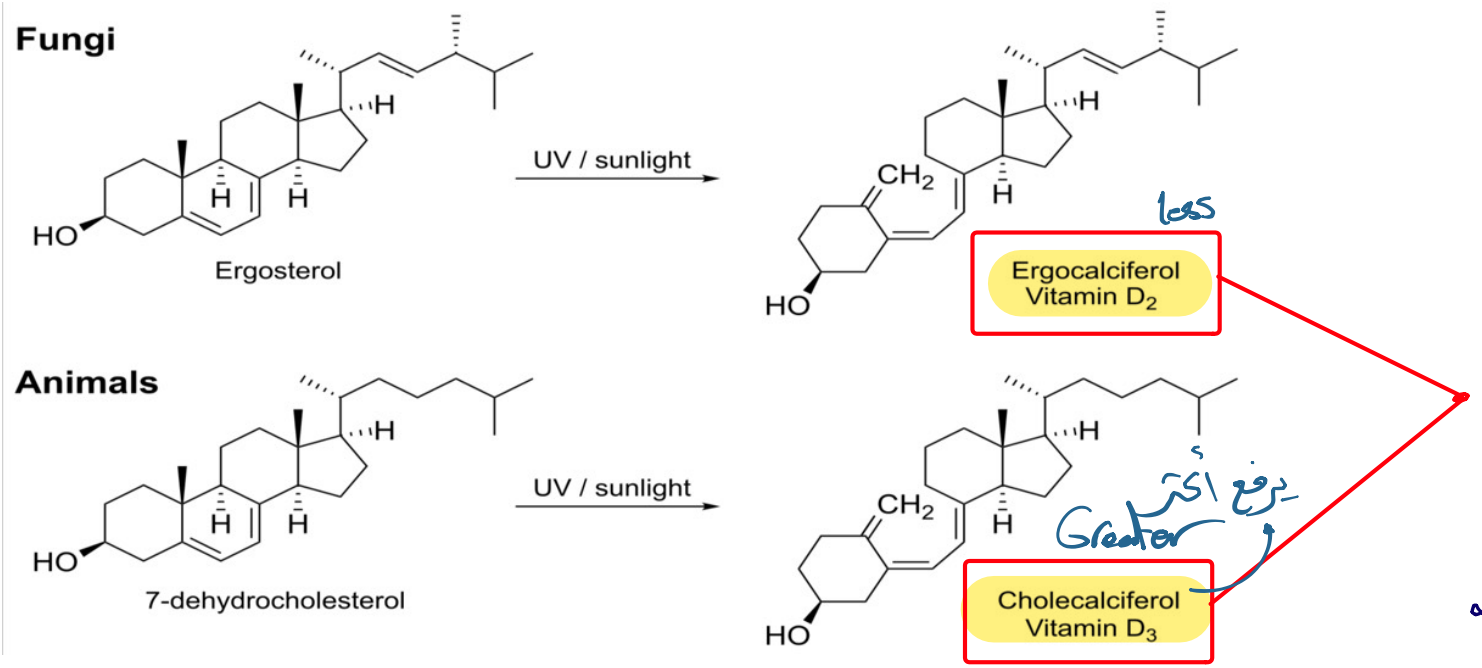


Zoosterols

ex: Cholesterol

- Of animal origin
- Cholesterol is an example of zoosterol





الاثنين الهم
نفس الفائدة
عند استخراجهم

كلهم نفس الفايدة ⊛

(ما بنحكي لو أخذنا لـ D_2 أفضل
ولا الـ D_3 أحسن

* عنانقص بال Vit. D بالأردن
→ Deficiency in Vitamin D

Types of steroids and sterols

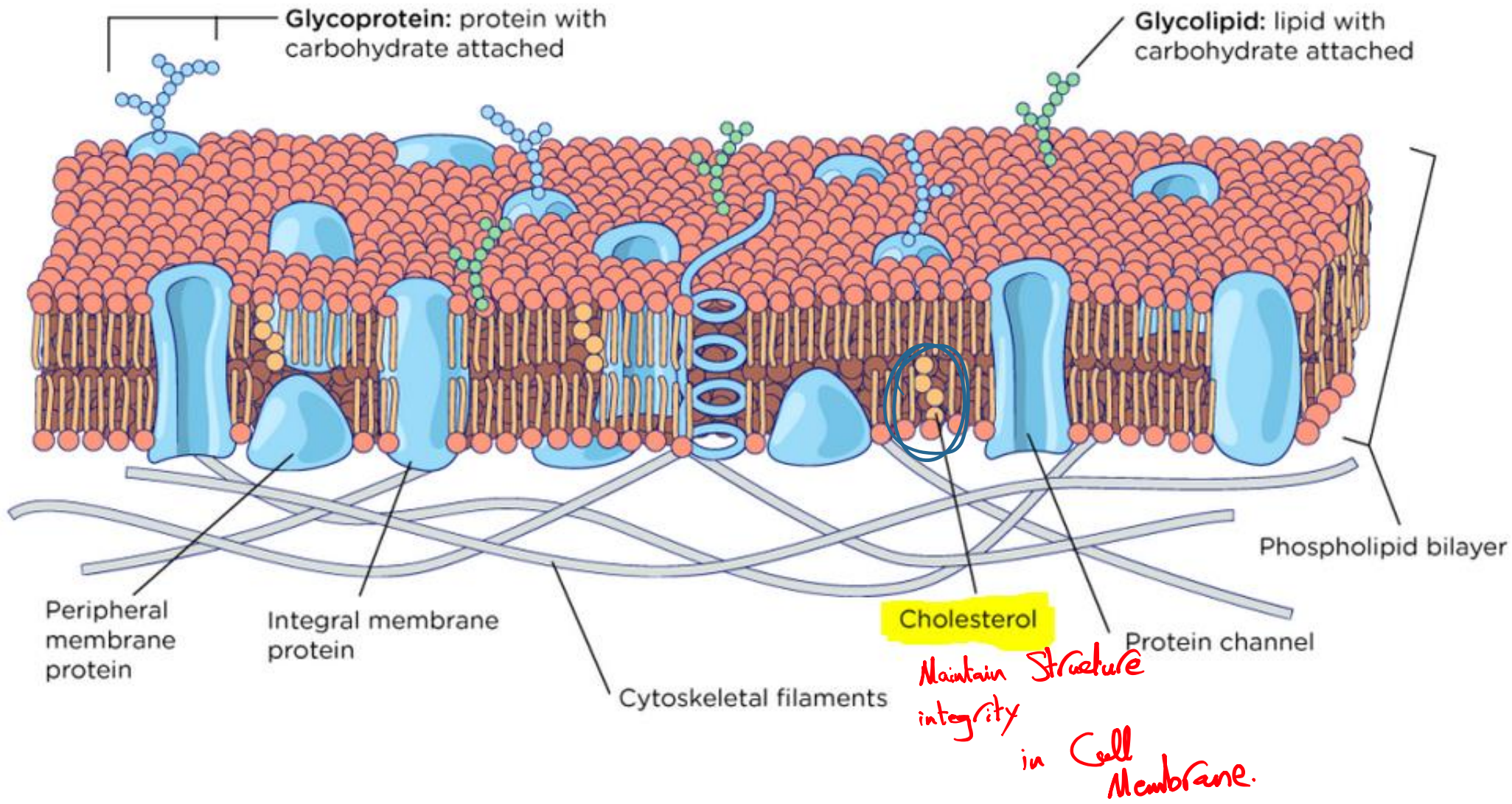
- Cholesterol (animal origin)
- Ergosterol (plant origin)
- Vitamin D group (D2 and D3)
- Bile acids and salts
- Steroid hormones
- Digitalis

Digitalis

- A cardiac stimulant, composed of galactose and a steroid alcohol
- Digitalis is used in treatment of heart failure ← متى بنستخدمها :
  (stimulate cardiac muscle contraction)

Cholesterol

- It is the main steroid in humans (present in all cells especially nervous system & plasma)
- It is a precursor that forms all other steroids
- Egg yolk, red meat, liver, kidney, butter and brain are rich in cholesterol


Glycoprotein: protein with carbohydrate attached
Glycolipid: lipid with carbohydrate attached
Phospholipid bilayer
Peripheral membrane protein
Integral membrane protein
Cytoskeletal filaments
Cholesterol
Protein channel
Maintain Structure integrity in Cell Membrane.

Cholesterol

- Contains unsaturated double bond between C5 and C6
- It can accept two hydrogen atoms
- It can be esterified into cholesteryl esters

cholesterol has – OH at C3, so it can form esters with any fatty acid

عند ال cholesterol ــــ ذرة الكربون 3 عندها OH ← بقدر اعمل عليها

Esterification. → واحولها استر (مع FA)

* احفظ زي الـعلـ ء

هون حكيت اهم المميزات

عند

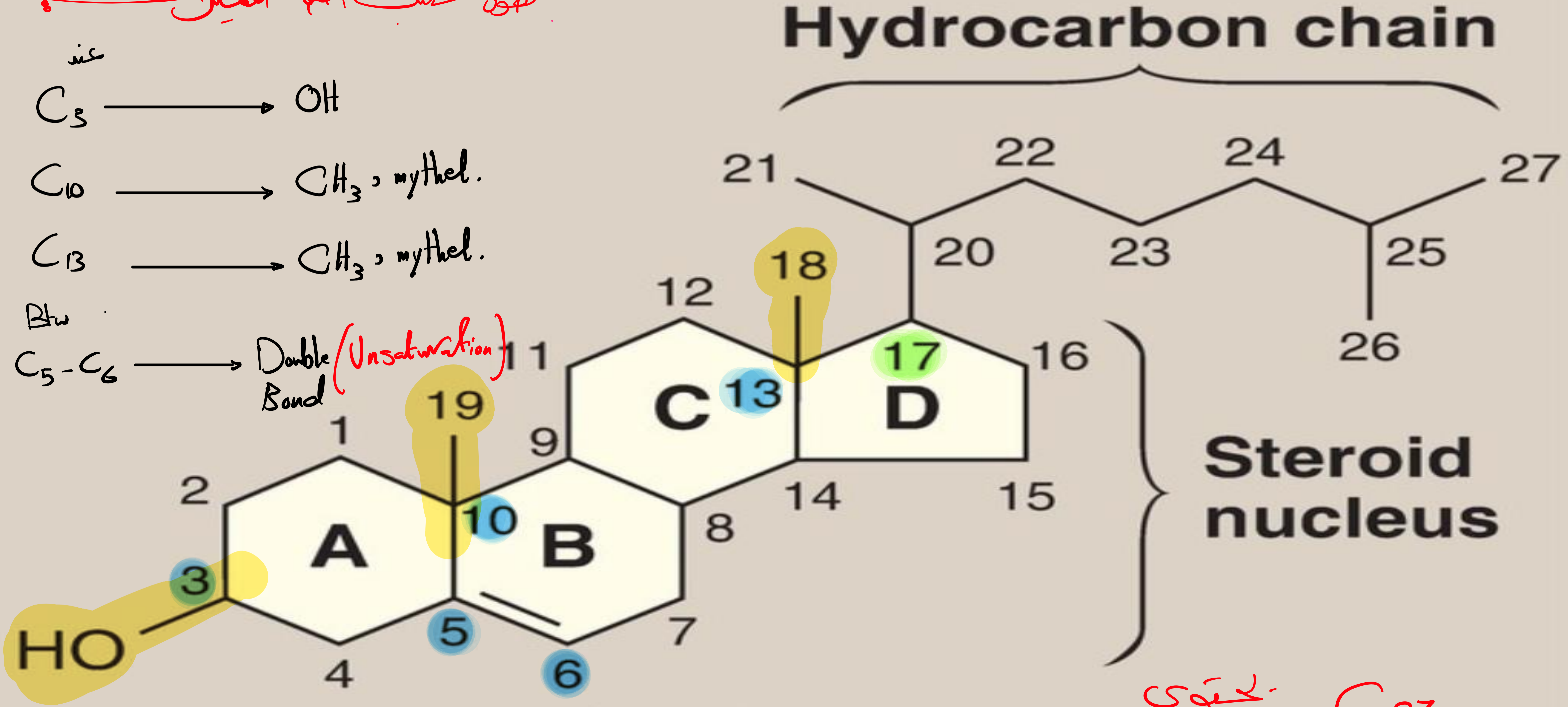
C_3 → OH

C_{10} → CH_3 , mythel.

C_{13} → CH_3 , mythel.

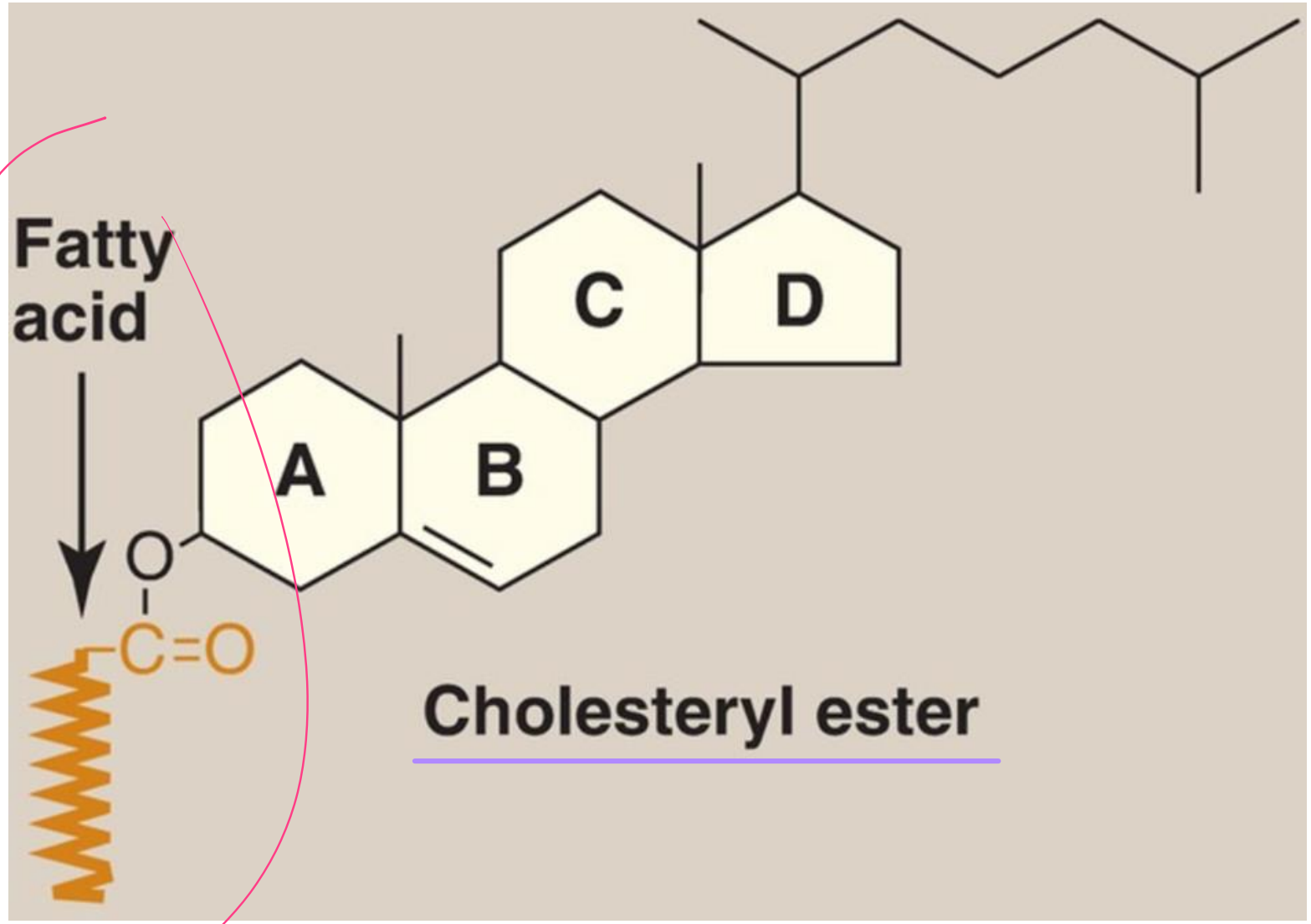
Btw

$C_5 - C_6$ → Double Bond (Unsaturation)



Cholesterol ⇒ يحتوي على C_{27}

27 كربون.


Fatty acid
A
B
C
D
O
C=O
Cholesteryl ester

Cholesterol

- Blood cholesterol is either present in:

1. Free form (33%) or
2. Esterified form (67%) The most.

- Normal level of cholesterol in blood is less than 220 mg/dL
  if increased it is called hypercholesterolemia

It is oxidized in liver, intestine & skin to give **7-dehydrocholesterol** which is the precursor of vitamin D3 by exposure to UVR under the skin

(B) D_3 ثم تتحول لـ 7-dehydrocholesterol To cholesterol يتحول لـ. يعني اذا تعرض جسمنا لأشعة

(صح (B) Vit. D_3 تنتج تحت أشعة الشمس (يعني حقيقة الجلوس

Function of cholesterol

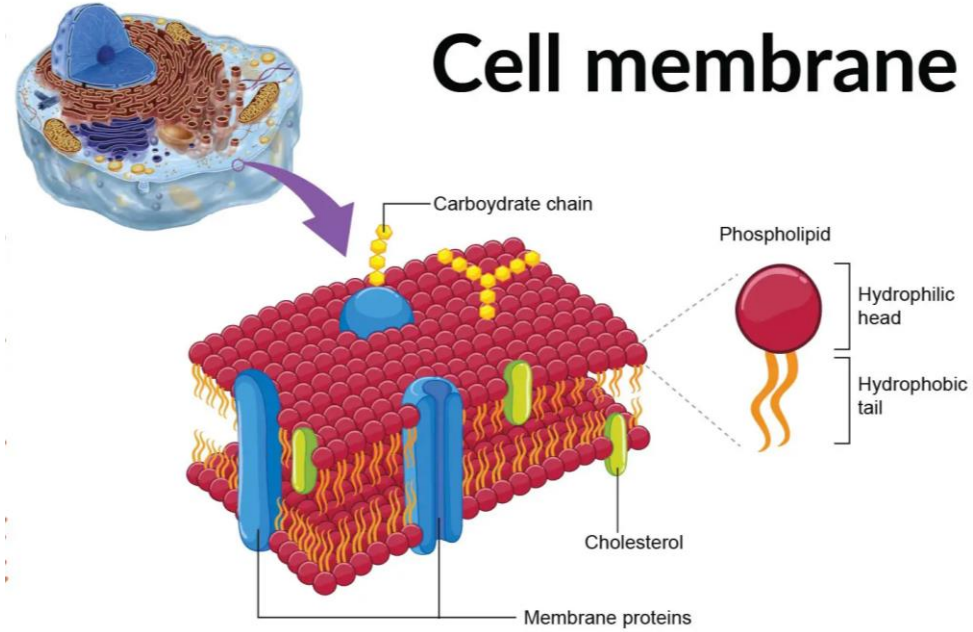
Enters in structure of every body cell especially nervous system + cell membranes

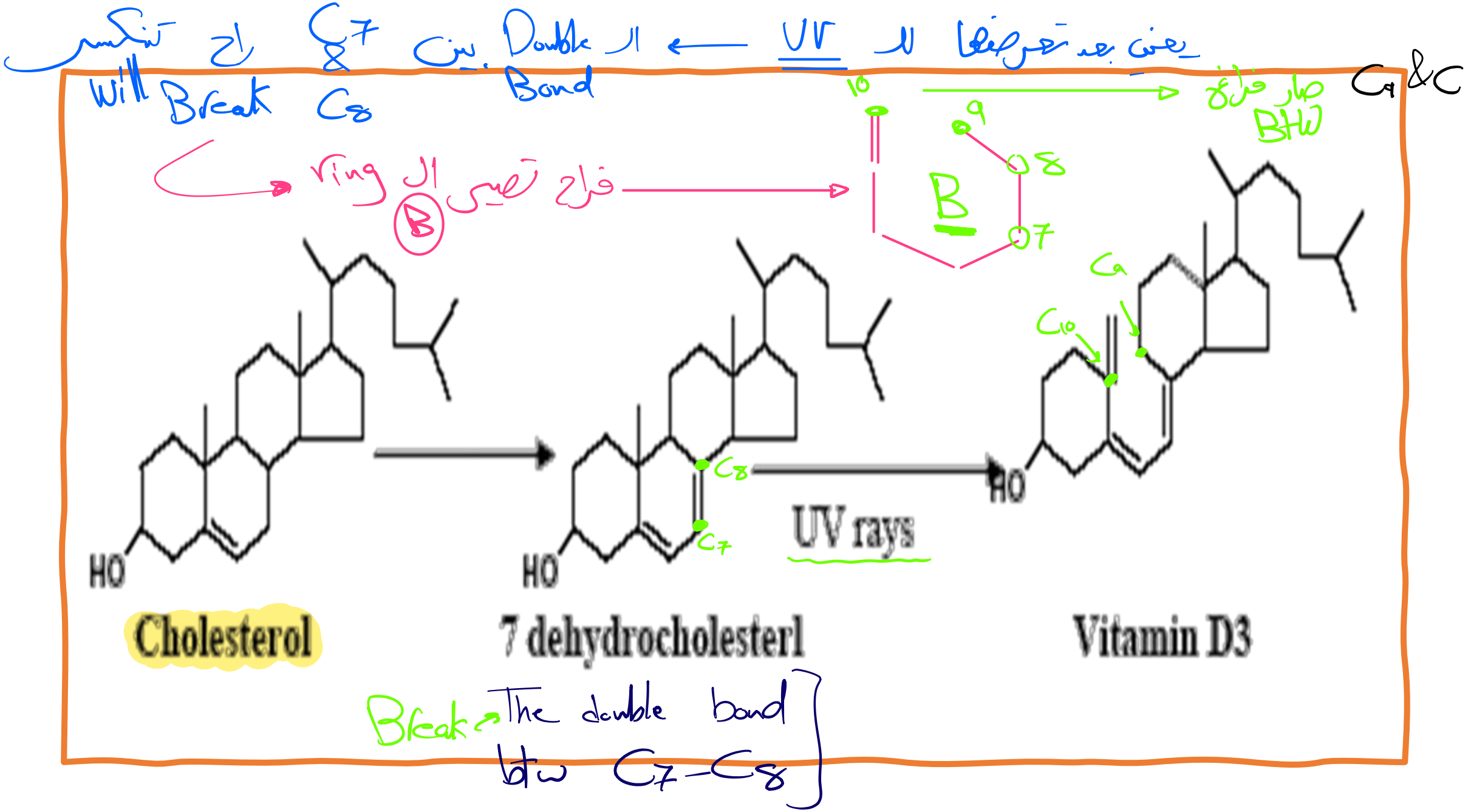
Synthesis of:

– Steroid hormones

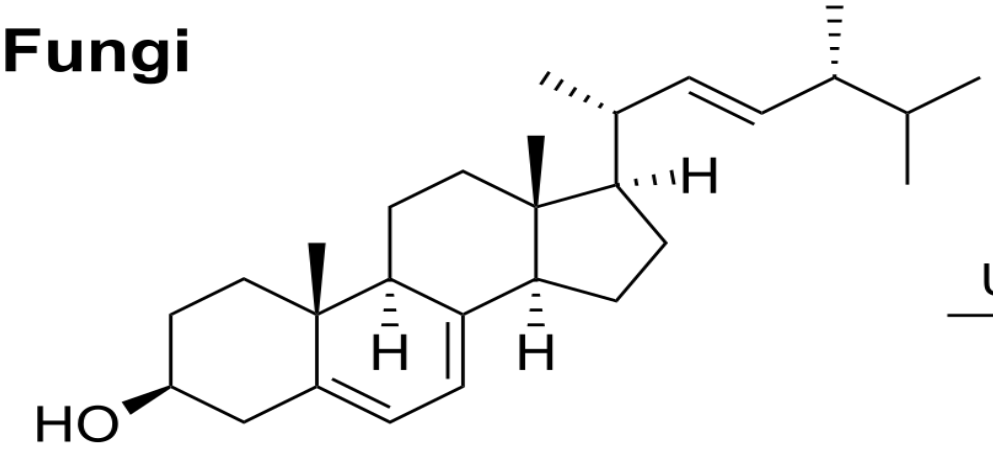
– Bile acids, salts

– Vit D3



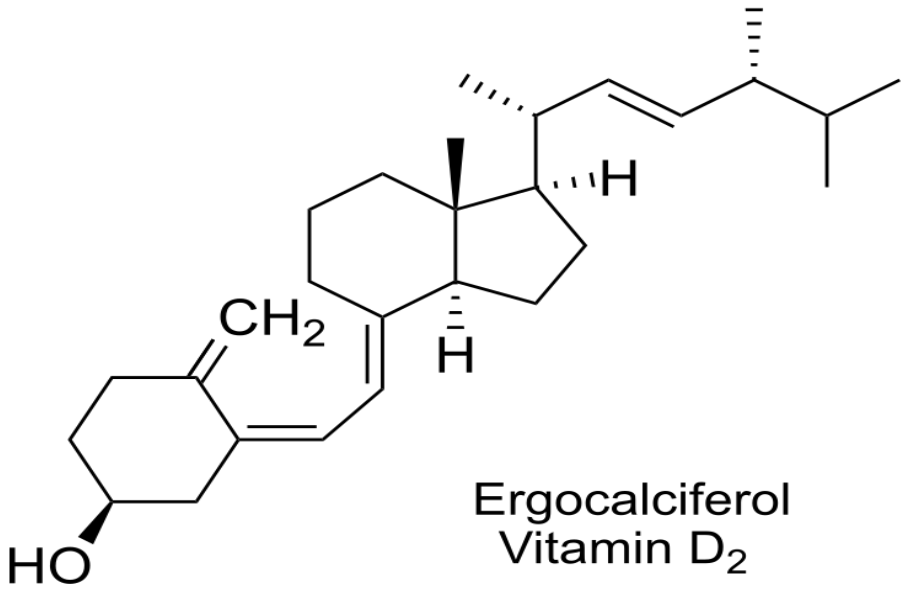

HO
HO
HO
C8
C7
UV rays
Cholesterol
7 dehydrocholesterl
Vitamin D3

Fungi



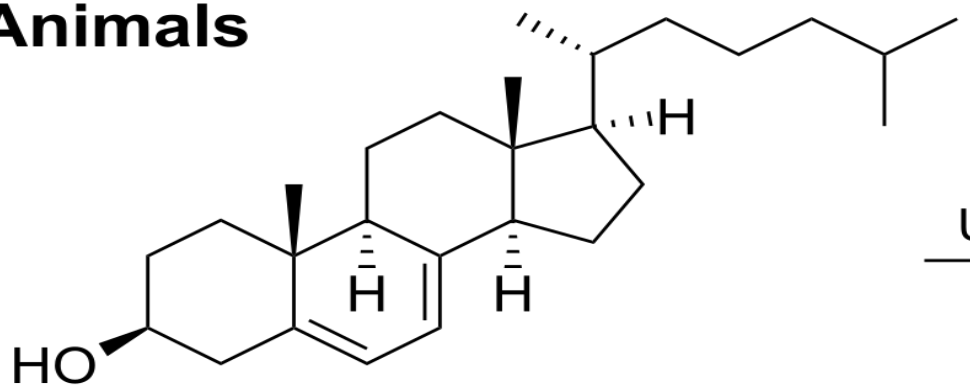
Ergosterol

UV / sunlight



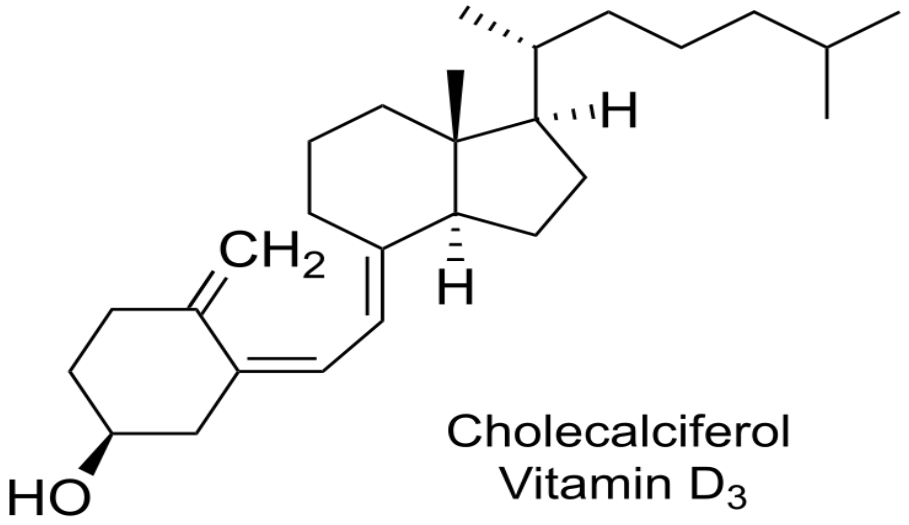
Ergocalciferol
Vitamin D_2

Animals



7-dehydrocholesterol

UV / sunlight



Cholecalciferol
Vitamin D_3

Eicosa = 20

= 20

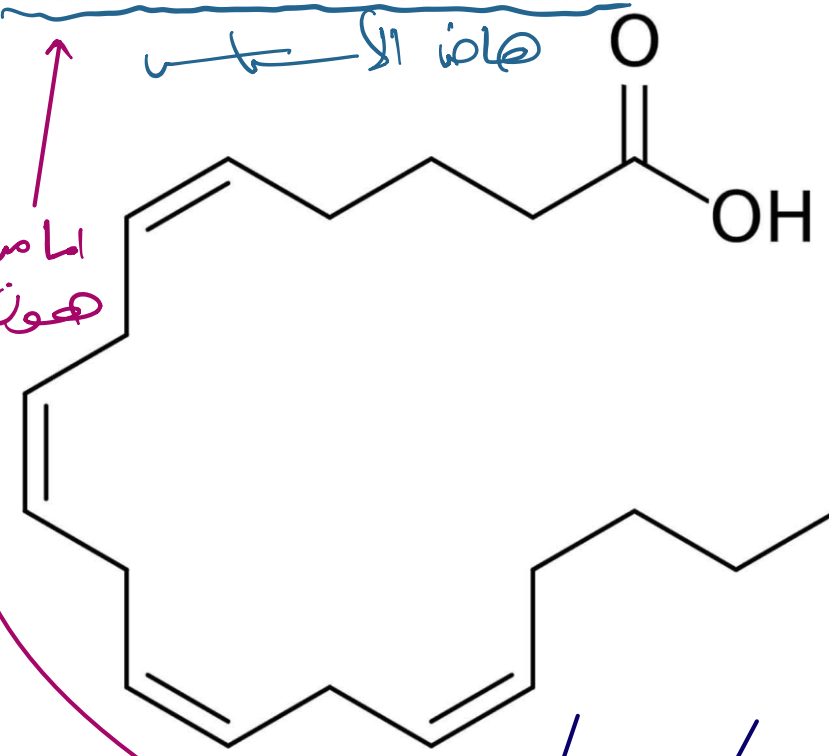
Eicosanoids

cell signalling molecule

- Eicosanoids are derived from arachidonate (arachidonic acid; 20:4) and eicosapentaenoic acid (EPA; 20:5)
- Derived from Eicosa (20 carbons) polyenoic FAs (arachidonic acid 20:4)
- The dietary precursor is the essential FA linoleic acid (18:2)

20 C & 4 double Bond

Arachidonic acid



Eicosa Pentaenoic

= 20 C

= 5 double Bond

Eicosanoids

Don't storge inside the cells.

* اهم معلومة ← ما بتخزن داخل الخلايا ال Eicosanoids

* طيب كيف بتنشأ:-
* أول ما يصير عندي حاجة ↑ Arachidonic بتحول ال 20:4
  ↳ Eicosanoid.
  when injury happened OR trauma

- Produced by most mammalian cells
- Paracrine hormones + Auto crine (بنفس ال cell) + Endo crine (الخلايا المجاورة) ← تعمل كعدة وظائف
- Have physiological and pharmacological actions
- Subscript number in an eicosanoid denotes n of double bond (e.g. PGE_2)

Classification of eicosanoids

1. **Cyclic compounds (prostanoids)**

   Prostaglandins (PG) - via cyclooxygenase pathway

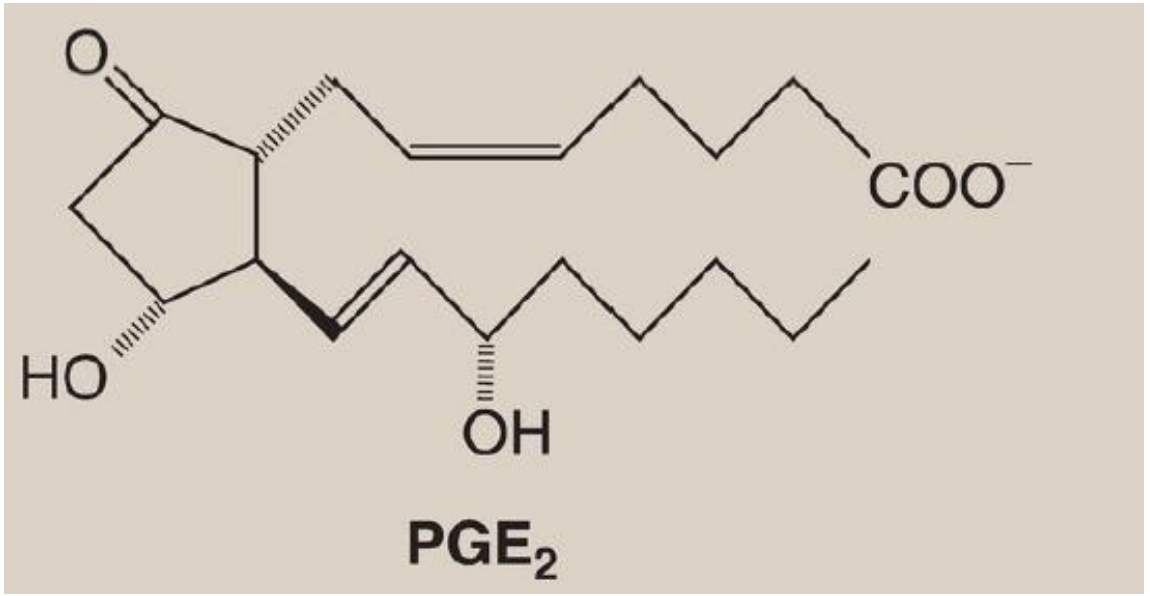
   Prostacyclins (PGI) - via cyclooxygenase pathway

   Thromboxane (TX) - via thromboxane synthase

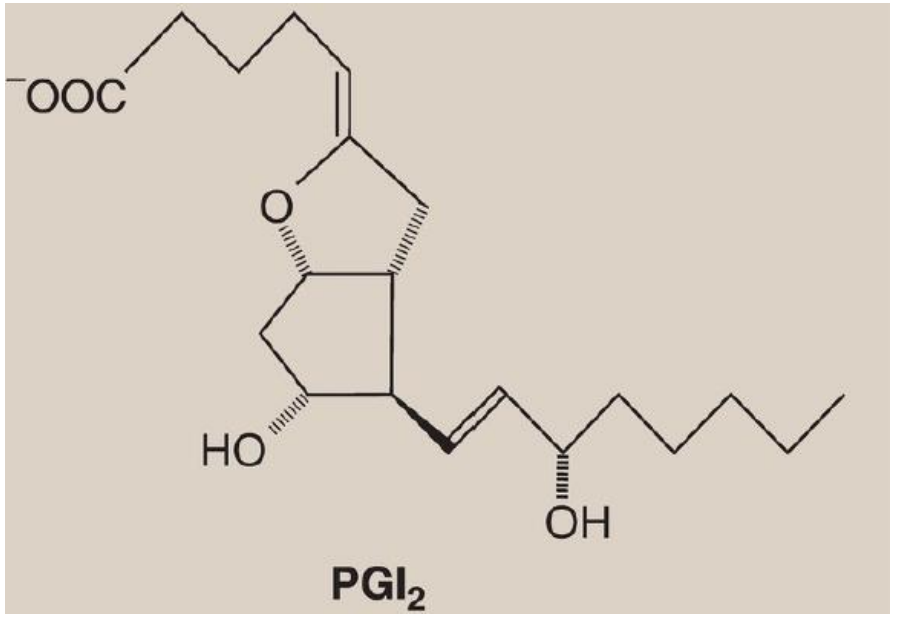
2. **Acyclic compounds (via lipoxygenase pathway)**

   Leukotrines (LT) 3 conjugated double bonds

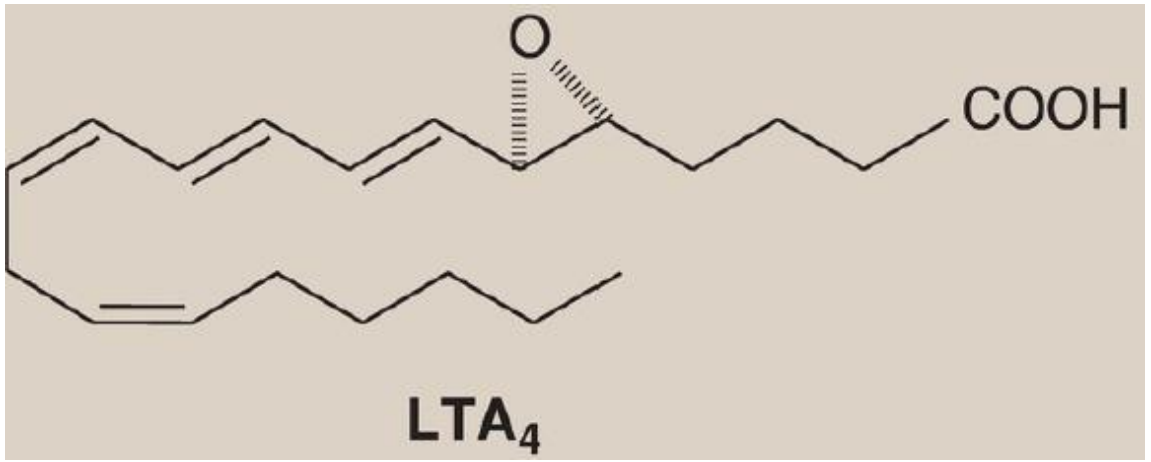
   Lipoxins (LX) 4 conjugated double bonds, contains more oxygen



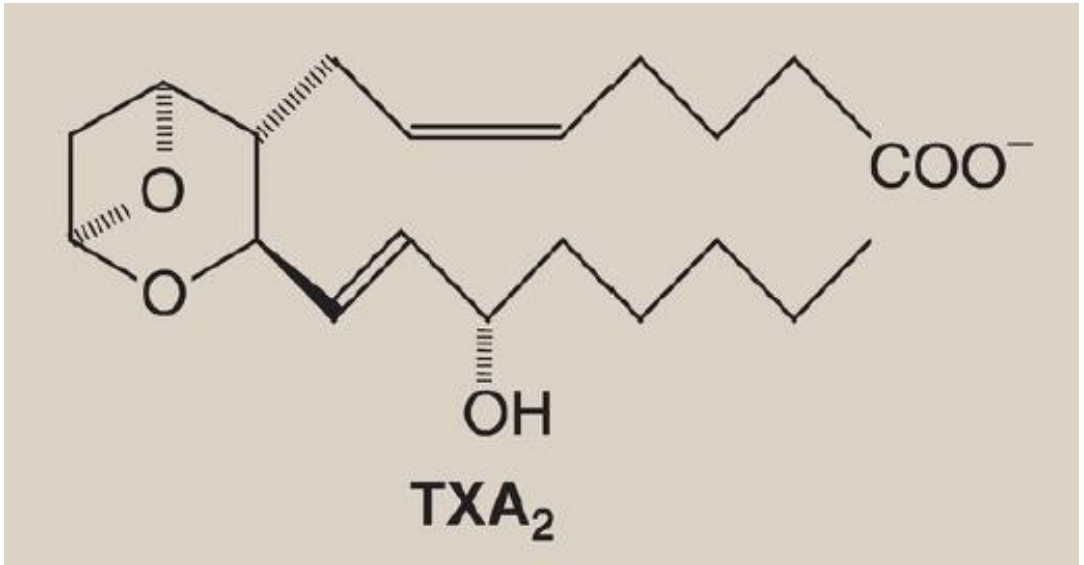
PGE_2



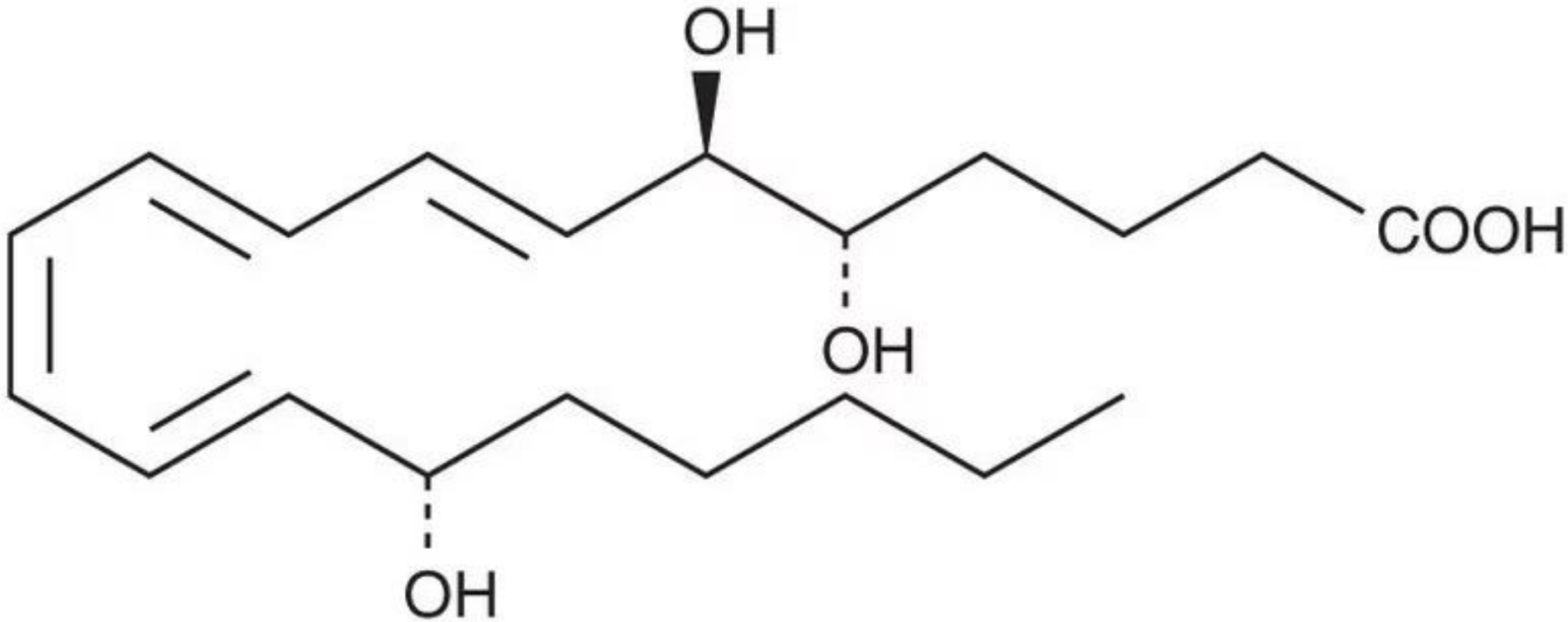
PGI_2



LTA_4

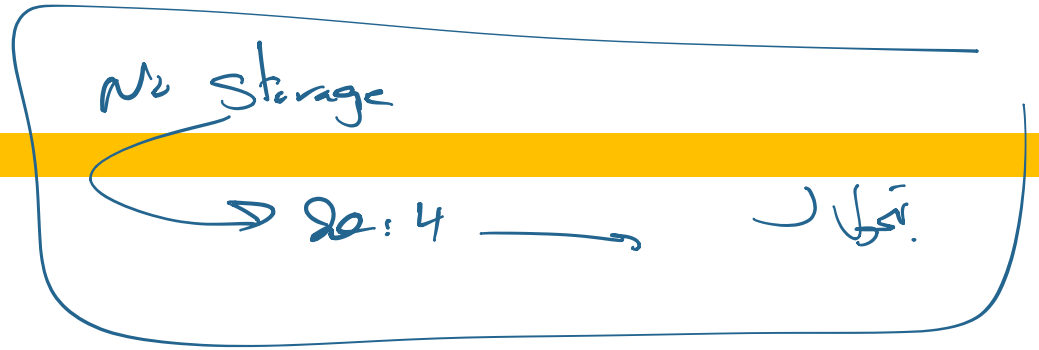


TXA_2



Lipoxin A_4

Prostaglandins



First discovered in prostate

- Present in most human tissues (males & females)
- All have a cyclopentane ring in the middle (C8-12)
- Many types: PGA, PGB, PGE, PGF, PGG, PGH

Effects of eicosanoids

* عند الأفراز قبل حدوث Pain .

PGE2 - vasodilation, relaxation of uterus & intestines

PGF2 - vasoconstriction, contraction of uterus & intestines

PGI2 - vasodilation + inhibits platelet aggregation

TXA2 - vasoconstriction + stimulates platelet aggregation

Leukotrienes - allergic mediators

Lipoxins - inflammatory functions

Thank you