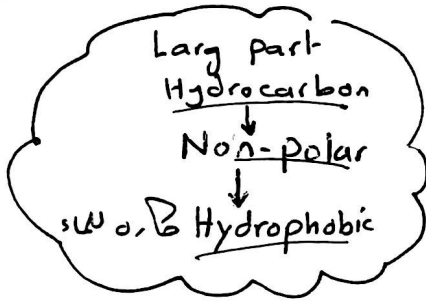


-chapter 8
Part 1

lipids

↳ Large group of compounds
all of them are insoluble in water
But, Soluble in organic solvents
Such as chloroform and acetone

why?



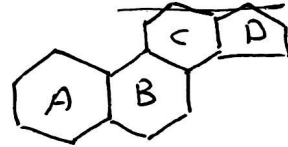
lipids

سلسلة مفتوحة
Open chain lipids

- Fatty acids (F.A)
- Tri-acyl-glyceride (TAG)
- Phospholipids (Phosphoacyl glyceride)
- Wax
- sphingolipids
- Glycolipids " Sugar + lipid "

حلقات متحدة
Fused rings lipids

• Steroids

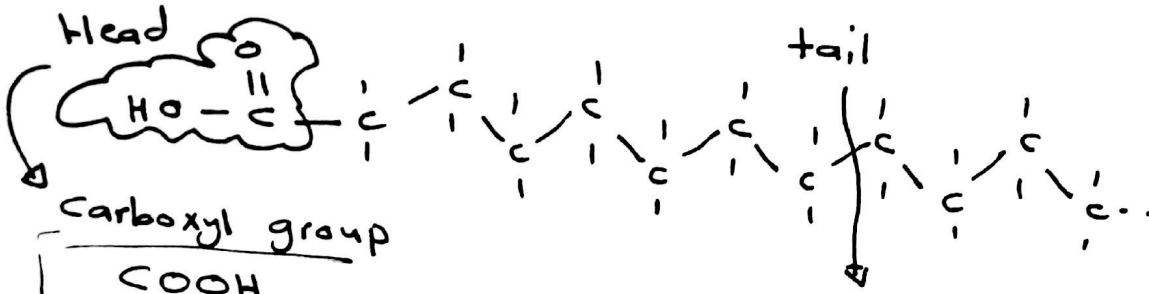


Ex:- cholesterol
Sex hormones

Q:- What characteristic is most used to define lipids?

- ionic charge
- melting point
- Solubility
- ability to bind metal ions.

Fatty acids الأحماض الدهنية



Carboxyl group



- ionized at pH: 7

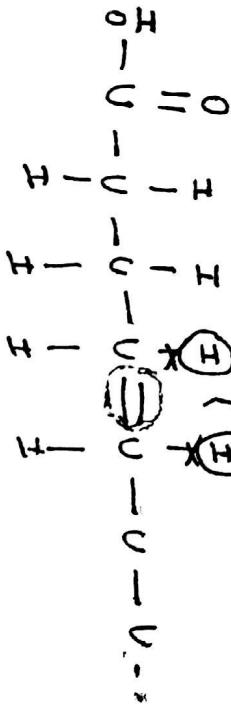


→ polar → Hydrophilic

Hydrocarbon

Nonpolar → Hydrophobic

Amphipathic



Unsaturated

غير مشبع



* if No = (double bond)
→ Saturated

F.A

Saturated
series

No =

Unsaturated

has = (double bond)

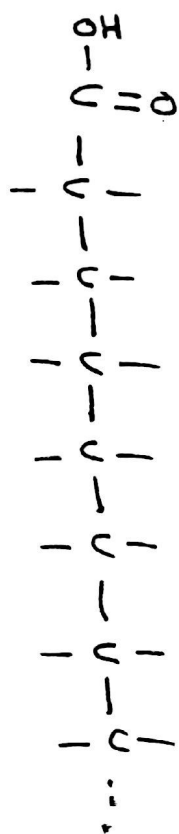
Mono-Unsaturated

واحدة =

Poly

أكثر من واحدة

Saturated F.A



- No =

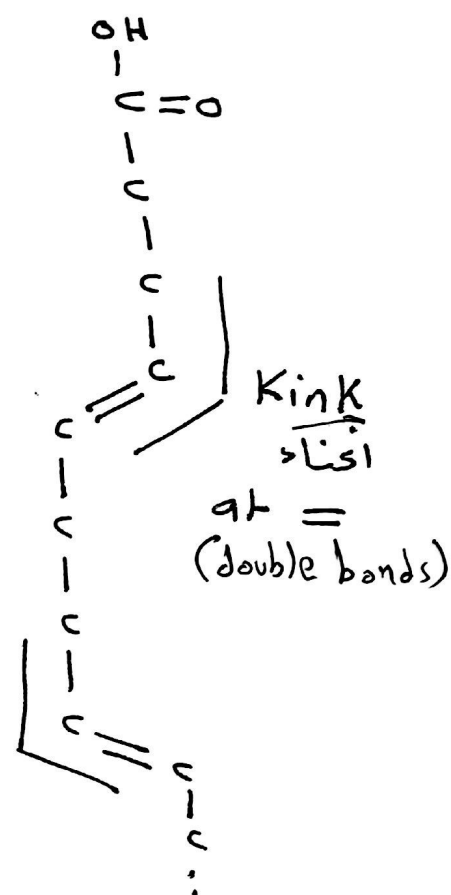
- No Kinks

↓
Ordered

↓
Solid at room Temp

↓
Animal Fat

Unsaturated F.A



- has =

- has Kinks

↓
Disordered

↓
Fluid / liquid at room Temp

↓
Plant Fat
(oils)

ny acids in Nature

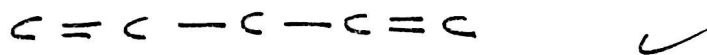
1 mostly have Even number of Carbons
and Not Branched

2 if Unsaturated, the = is



(skip) \rightarrow if trans \rightarrow No Kink as saturated (ordered)

3 The double Bonds are NOT conjugated



at least 2 single Bonds

Between them



Notation of F.A

معلومات عن

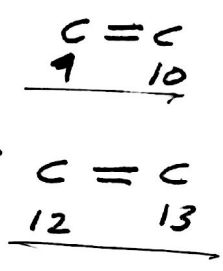
- ① # of C
- ② # of =
- ③ Location of =

Ex: F.A

18:2 Δ (9) (12)

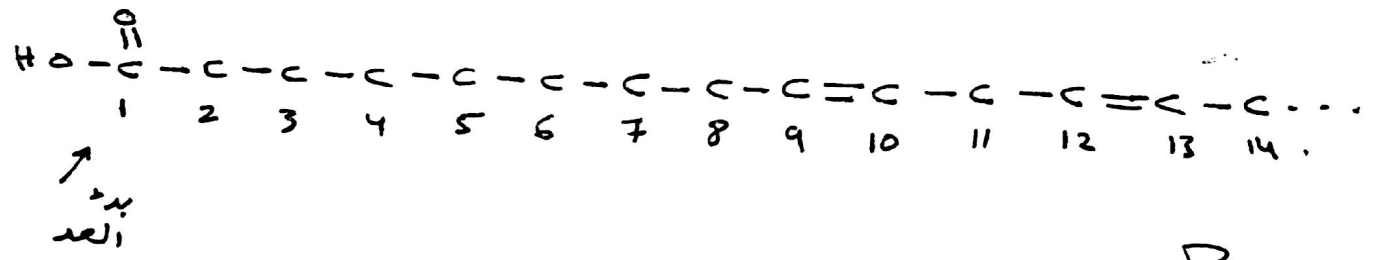
عدد الكربون
لازم زوجي

عدد =



مواقع =

لازم ما يكون
conjugated.



* ليدجانت
 $18:2 \Delta 9,11$
 \rightarrow conjugated
غير موجود في الطبيعة

Ex: 2

12:0

No =
 \downarrow
 saturated.

عدد الكربون

Q: which of the followings is/are not a common Fatty acid ?

a. 18: 2^Δ2, 9

b. 20: 2^Δ5, 7

c. 16: 0

d. 15: 1^Δ9

e. b + c

f. b + d

Q: which of the following is true?

a. All Fatty acids have an even number of carbons

b. Most Fatty acids have an odd number of carbons

c. Fatty acids are equally likely to have an even number of carbon as they are an odd number

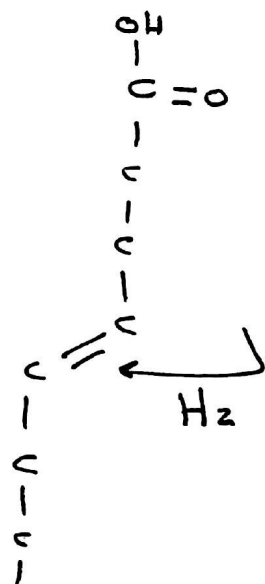
d. Fatty acids with an odd number of carbons

are more rare than those with an even number

Hydrogenation الهيدروجنة

↳ Commercially important
مهم تجارياً

Unsaturated Fat
(oils)



يتحد الـ H₂
→

Saturated Fat
(Solid)



Liquid

Solid

Ex: Oligomargarine
Trans Fat

الزبدة / peanut Butter

↳ Unsaturated Fat with trans double bond
produced during hydrogenation

* Saturated Fat and Trans Fat ↑ LDL (Bad cholesterol)
increase the risk of cardiovascular diseases
تزيد خطر الإصابة بأمراض القلب والأوعية الدموية

* Unsaturated Fat ↑ HDL (Good cholesterol)
Reduce the risk of cardiovascular diseases

Melting Point of F.A
درجة انصهار الاحماض الدهنية

[A] Saturated $\xrightarrow{\text{مشبع}}$ Unsaturated لا مشبع

Sat M.P. أعلى Un-sat M.P.

18:0 Higher M.P. Δ^9 18:1

[B] \uparrow # of C \Rightarrow \uparrow M.P.

12:0
14:0
16:0
18:0 \rightarrow Higher M.P.

[C] \uparrow Number of = , \downarrow M.P.

18:1 Δ^9 Higher M.P.
18:2 $\Delta^9, 12$
18:3 $\Delta^9, 12, 15$ lower M.P.

* Trans = أعلى Cis = M.P.

Trans 18:1 $\Delta^9 \rightarrow$ higher M.P.
Cis 18:1 Δ^9 (8)

Cis = \downarrow Hydrophobic interaction Between F.A \downarrow Melting point

Saturated Fatty acid

Table 8.1

Typical Naturally Occurring Saturated Fatty Acids			
Acid	Number of Carbon Atoms	Formula	Melting Point (°C)
Lauric acid	12	$\text{CH}_3(\text{CH}_2)_{10}\text{CO}_2\text{H}$	44
Myristic	14	$\text{CH}_3(\text{CH}_2)_{12}\text{CO}_2\text{H}$	58
Palmitic	16	$\text{CH}_3(\text{CH}_2)_{14}\text{CO}_2\text{H}$	63
Stearic	18	$\text{CH}_3(\text{CH}_2)_{16}\text{CO}_2\text{H}$	71
Arachidic	20	$\text{CH}_3(\text{CH}_2)_{18}\text{CO}_2\text{H}$	77

Unsaturated Fatty acids

Table 8.2

Typical Naturally Occurring Unsaturated Fatty Acids				
Acid	Number of Carbon Atoms	Degree of Unsaturation	Formula	Melting Point (°C)
Palmitoleic	16	16:1- Δ^9	$\text{CH}_3(\text{CH}_2)_5\text{CH}=\text{CH}(\text{CH}_2)_7\text{CO}_2\text{H}$	-0.5
Oleic	18	18:1- Δ^9	$\text{CH}_3(\text{CH}_2)_7\text{CH}=\text{CH}(\text{CH}_2)_7\text{CO}_2\text{H}$	16
Linoleic	18	18:2- $\Delta^{9,12}$	$\text{CH}_3(\text{CH}_2)_4\text{CH}=\text{CH}(\text{CH}_2)\text{CH}=\text{CH}(\text{CH}_2)_7\text{CO}_2\text{H}$	-5
Linolenic	18	18:3- $\Delta^{9,12,15}$	$\text{CH}_3(\text{CH}_2\text{CH}=\text{CH})_3(\text{CH}_2)_7\text{CO}_2\text{H}$	-11
Arachidonic	20	20:4- $\Delta^{5,8,11,14}$	$\text{CH}_3(\text{CH}_2)_4\text{CH}=\text{CHCH}_2)_4(\text{CH}_2)_2\text{CO}_2\text{H}$	-50

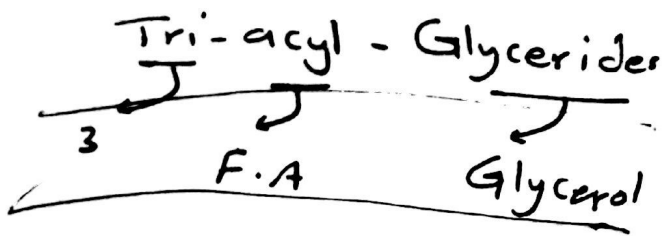
Degree of unsaturation refers to the number of double bonds. The superscript indicates the position of double bonds. For example, Δ^9 refers to a double bond at the ninth carbon atom from the carboxyl end of the molecule.

You can NOT synthesize any Fatty acid

have = beyond C9

So any F.A have = beyond C9, you
should take it from diet (food)

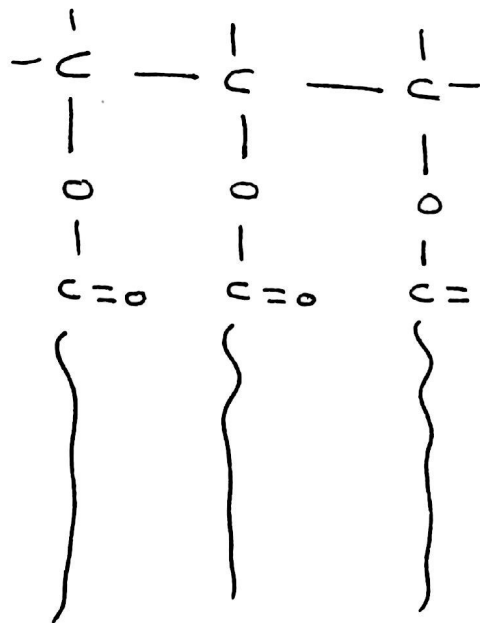
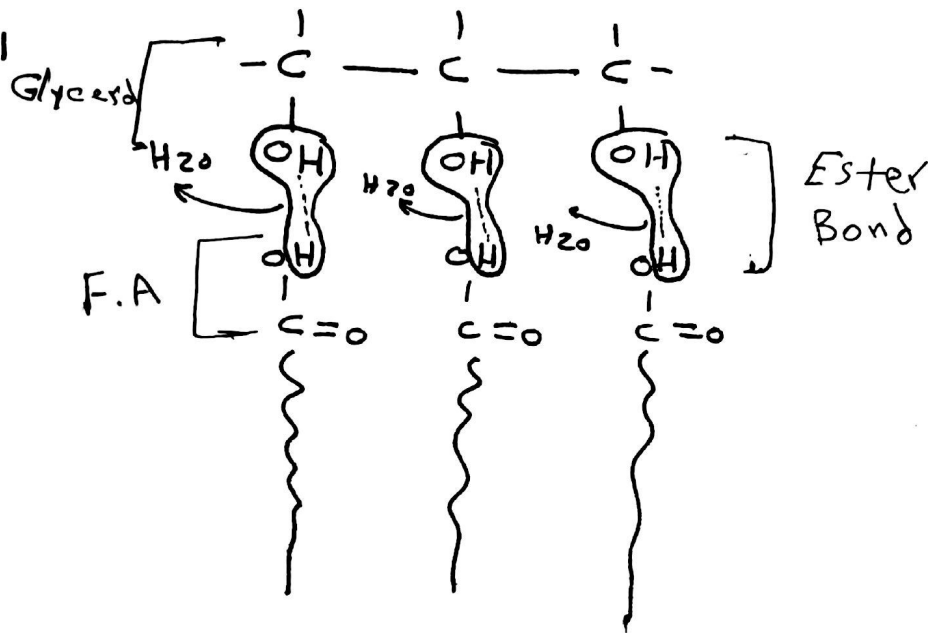
these called Essential Fatty acids.



* Most lipid
in diet

Glycerol \rightarrow Alcohol

Alcohol
+
acid
 \downarrow
Ester



Ester "polar part"
but not very polar

Not Amphipathic
it's hydrophobic

Function of TAG

→ Storing F.A in Adipose tissue.

* Never found in Cell membrane

↓ Glucose → Hydrolysis of TAG → 3 F.A (source of energy)

Fat 9 Kcal/g

CHO 4 Kcal/g
* Proteins

Hydrolysis of TAG

In vivo
Inside Body

TAG

In vitro
outside Body

↓ H₂O / Lipase
انزيم

↓ H₂O + Strong acid
HCl

Glycerol

+ 3 ionized F.A (because of PH of the body)
CC(=O)O

or + Strong Base

NaOH, KOH

with Base ⇒ Glycerol

+ 3 Na⁺ or K⁺ Salts

of F.A (Soap)
الصابون

* Glycerol used in creams
and to produce Nitroglycerine
درا

* Soap + Hard water with (Ca²⁺, Mg²⁺) → ppt
عاب

(الكالسيوم)

Saponification

spholipids

Phospho-acyl - Glycerol or (Phospho glyceride)

↓
phosphate
Group

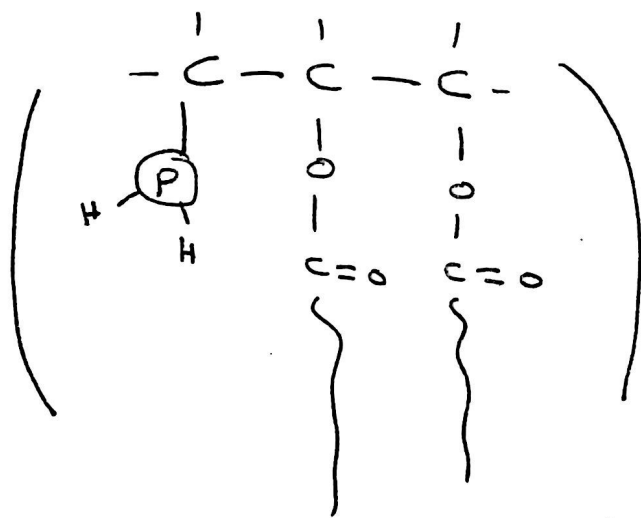
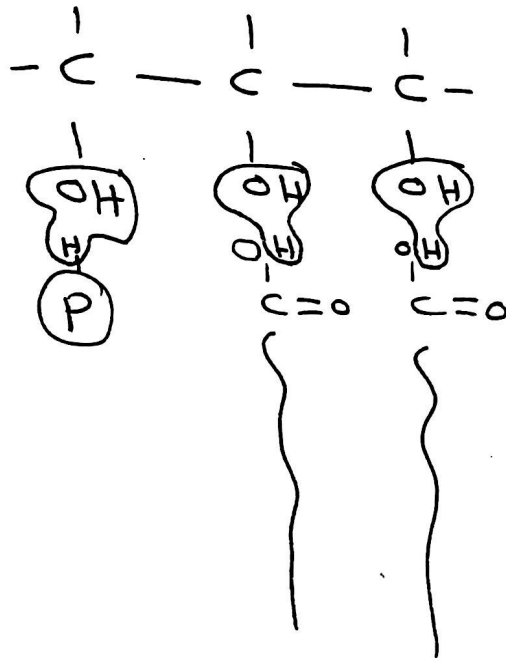
↓
Phosphoric
Acid



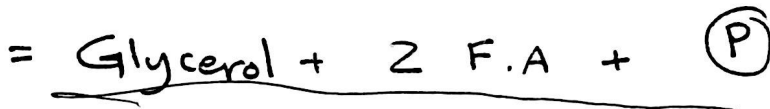
↓
Tri-prtic acid

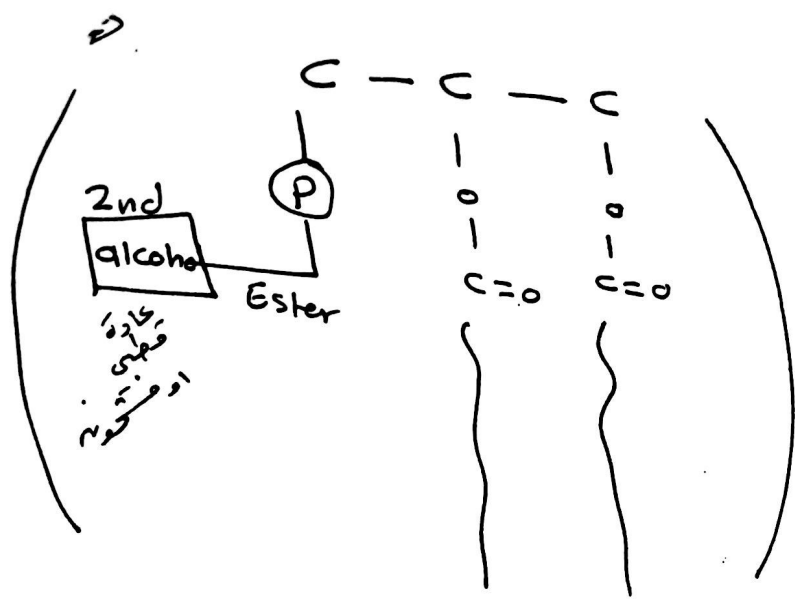
3H⁺ 3OH⁻

↳ can form more
than one ester
with alcohol

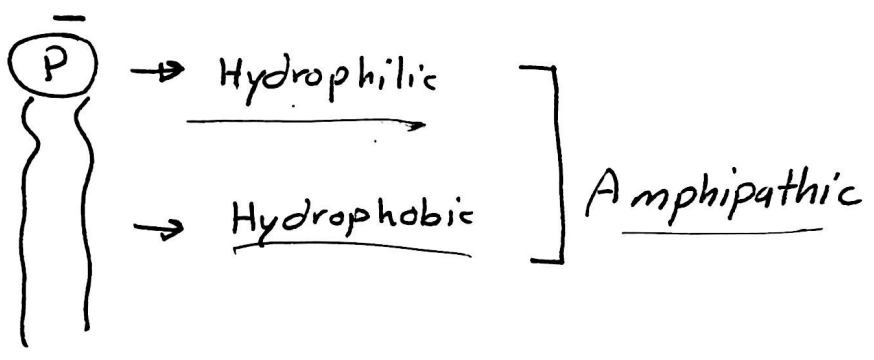


Phosphatidic Acid

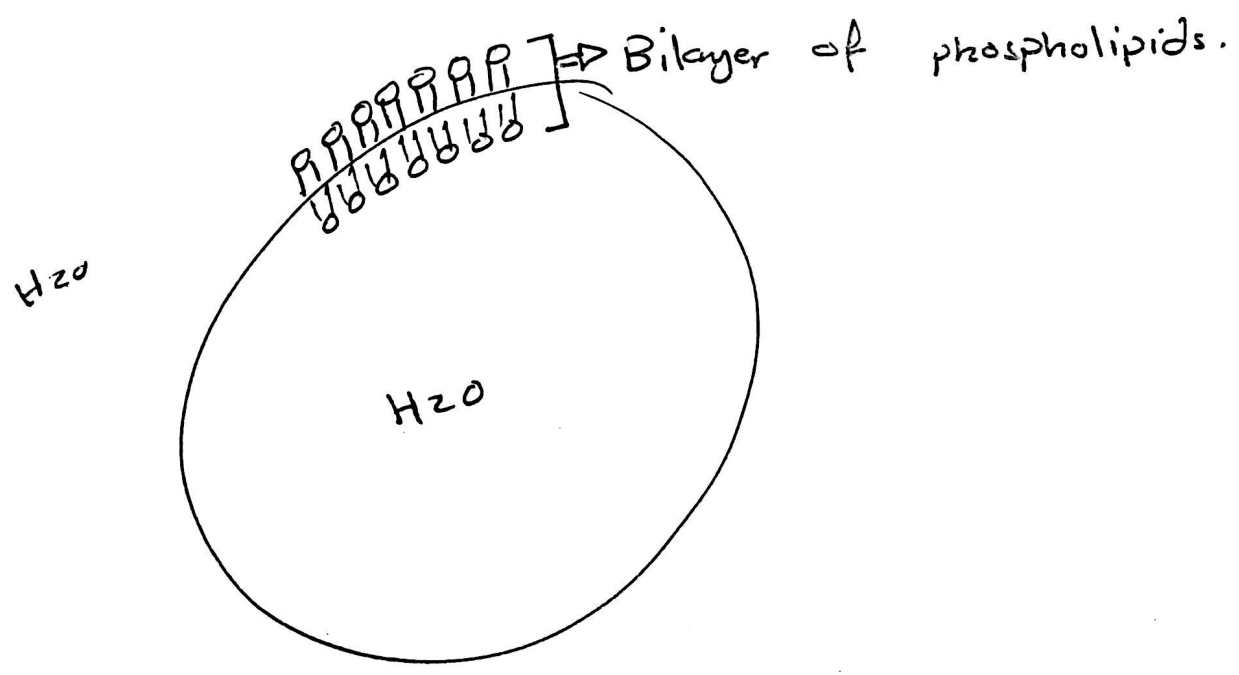




Phospholipid
Phospho-acyl Glycerol
Phosphotidyl Ester
↓
يسمى عن الكحول
الساى



Function of phospholipids ⇒ main component of Cell membrane



The name of phospholipids depends on the second alcohol bonded to phosphoric acid

Ex:-

Phosphatidyl Serine

Phosphatidyl Ethanol-amine (cephaline)

Phosphatidyl Inositol

Phosphatidyl Glycerol, [Cardiolipin: Diphosphatidyl]
Glycerol

Phosphatidyl Choline [Lecithine]

Phosphatidyl Sugars,

* Note: usually different types of Fatty acids bind to glycerol in TAG or phospholipids

Q: How many hydroxyl groups does a molecule of glycerol have? 3

Q: Which of the following is true?

- a. all triglyceride and all phospholipids have the same fatty acids in them
- b. all triglyceride have the same fatty acids, but the fatty acids in phospholipids vary
- c. the fatty acids in triglyceride vary, but all phospholipid have the same fatty acids in them
- d. The fatty acids in both triglyceride and phospholipid vary

Q: What kind of bonds do lipase break in order to release fatty acid from triglycerides?

- a. ester
- b. Carbon - Carbon single bond
- c. Carbon - Carbon Double bond
- d. There are no fatty acids in triglycerides to release

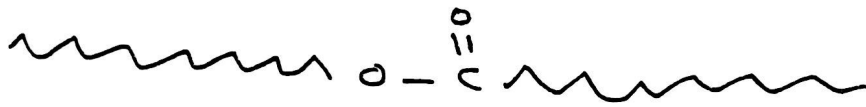
Q: Saponification is the hydrolysis of a(n) :-

- a. peptide Bond
- b. ester Bond
- c. anhydride Bond
- d. glycosidic Bond.

(in)

Wax \rightarrow protective coat for animal and plants
Ester, consist of

Long chain alcohol + long chain carboxyl (Fatty acid)



Not Amphipathic

Ex:- ① Mericyl - Cerotate \rightarrow Carnauba wax
used for floor and automobile

② Cetyl - palmitate \rightarrow from whales
 \hookrightarrow Component of Spermaceti
and cosmetics.

Q: Biological waxes are composed of :-

- glycerol and only one fatty acid
- glycerol and two fatty acids
- a fatty acid and long chain alcohol
- cholesterol and Fatty acid.

lipids

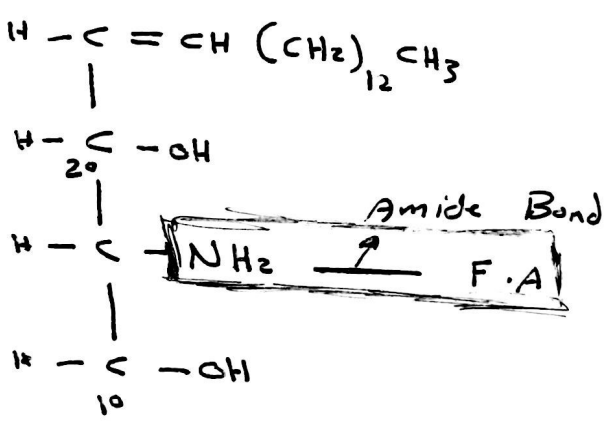
Amphipathic, similar to phospholipids
found in Nervous System Cell membrane

Myelin Sheath

found in plants too.

هذا يدل
على
وجود
مركب
كبير

Sphingosine



Ceramide = Sphingosine

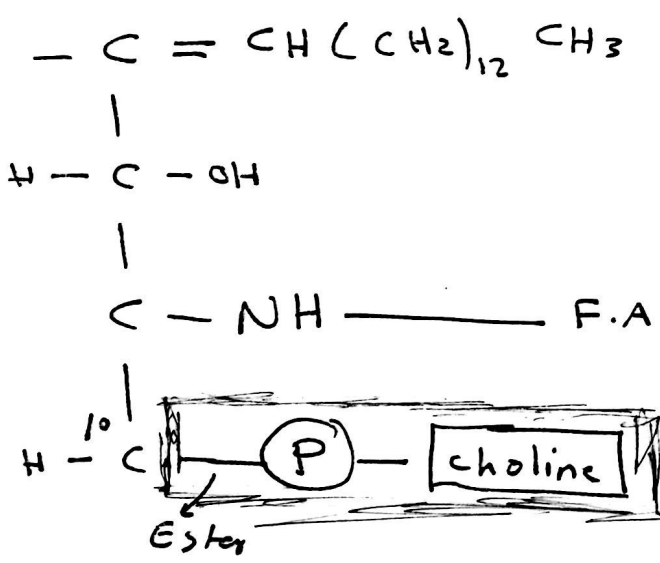


الربط
مركب
كيميائي
الجليكوسيد

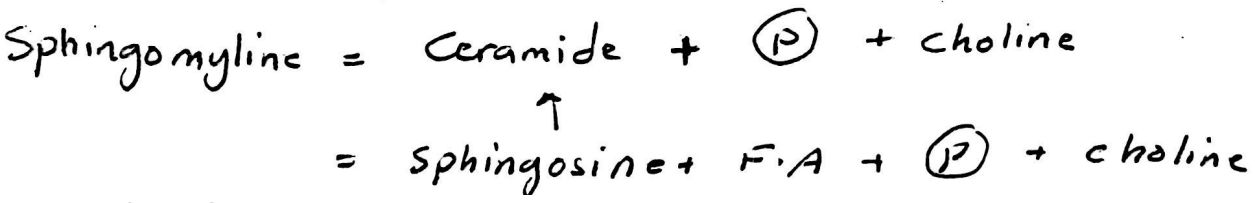
Amino-alcohol

N-acetylsphingosine

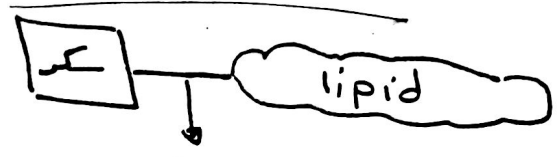
F.A ⇒ amino acid
منه alcohol



Sphingomyline



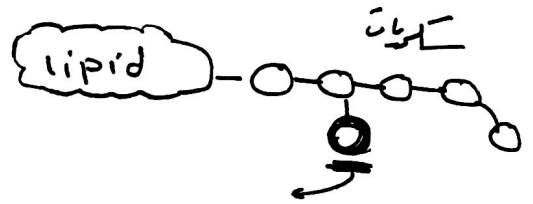
glyco-lipids = Sugar + lipid



Glycosidic linkage

* Sugar

- mono saccharide (Glucose, Galactose, ...)
 "w k"
- Oligo saccharide
 more than 3



one of them
must be
Sialic acid
-ve at pH=7
(amino-sugar)

* lipid (الدهون)

Ex:- Ceramide

Ceramide +
 {
 monosaccharide → Cerebroside
 oligosaccharide → Ganglioside
 }

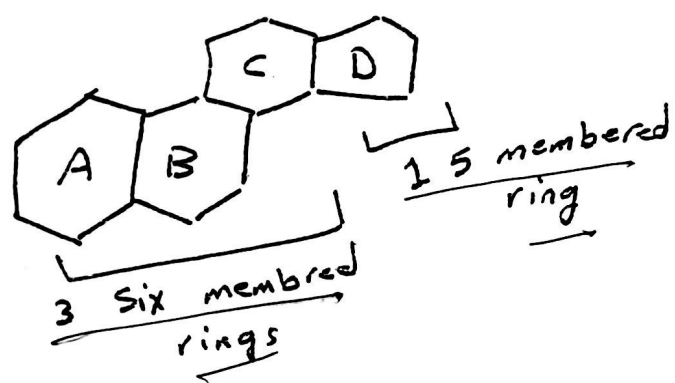
Function of Glycolipids

→ Markers & For tissue specificity

Glycolipids
found in
Nervous System
Cell membrane

Steroids ⇒ large family of compounds

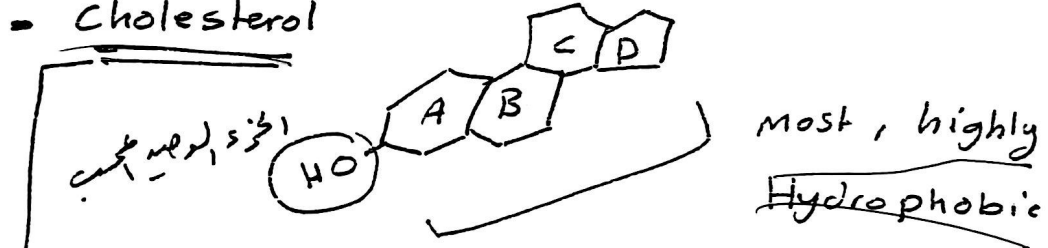
General Structure →



Ex:- Sex hormones : Testosterone, Estradiol, progesterone

• Adrenal Gland hormones : Aldosterone, Cortisone

• Cholesterol



- precursor for other steroids
- precursor for Vit D₃
- found in Animal Cell membrane

Not found in

