MED437
KING SAUD UNIVERSITY

BIO TEAM

Lipids

Objectives ;

1-Define and classify lipids

2- Understand the physiological importance of lipids

3-List the examples of simple and complex lipids

4- Correlate implications of lipids in clinical conditions

فريق المراجعة
غيداء آل مصمم
و
عبدالرحمن الحبيسوني

– Color Index:

- Important.
- Extra Information.
- Doctors slides
- Notes and explanations

Lipids

What are the lipids ?

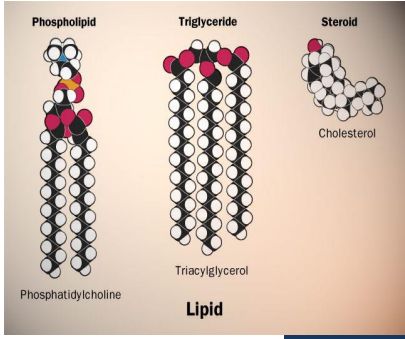
- Heterogeneous group of hydrophobic (water–insoluble) organic molecules that are soluble in organic solvents .
- Body lipids are compartmentalized (packed) in cell membranes, tissue and plasma.**

The functions of lipids

- Essential components of cell membranes
- Lipids+hydrocarbon chains = major energy stores
- Cell signaling involves lipid molecules e.g : inositol triphosphate
- Fat-soluble vitamins , steroid hormones and prostaglandins are formed of lipids

Fat soluble vitamins: vit A,D,M,E,K

اللبيد تعطينا طاقة ضعف الكربوهيدرات



**In plasma, they cant present on their own. They are either carried by plasma proteins or found as lipoproteins "complex molecules"

مقتبس من 1436

Lipids and disease

Disease that are strongly associated with abnormal in lipids metabolism:

- Metabolic syndrome
- Obesity
- Hypertension
- Heart disease
  - Coronary artery disease
  - Atherosclerosis

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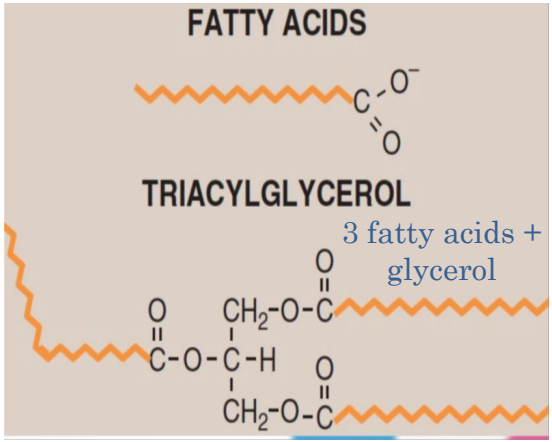
Classification of lipids

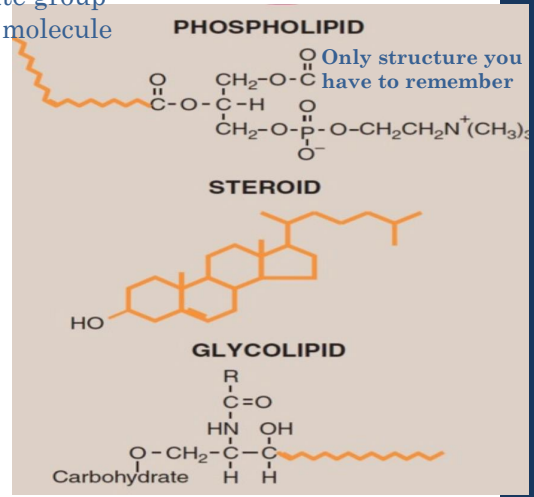
- **Simple lipids**
  - Fatty acids
  - Triacylglycerol
  - Steroids (cholesterol)
- **Complex lipids**
  - Phospholipids
  - Sphingolipids
  - Glycolipids

2 fatty acids
A phosphate group
A glycerol molecule



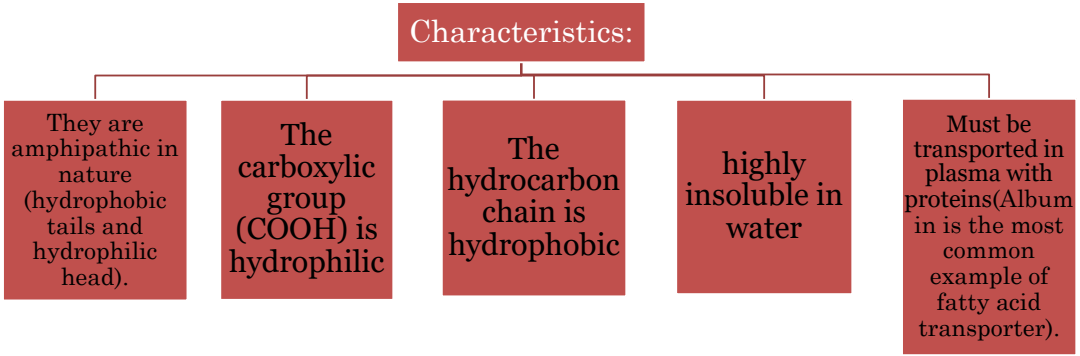
The lipids compound is heterogeneous group

Glycolipids are lipids with a carbohydrate attached by a glycosidic bond.



Fatty Acids (FAs)

Definition: FAs are carboxylic acids with long-chain hydrocarbon side groups



Majority of plasma FAs are esters of:

- Triacylglycerol
- Cholesterol
- Phospholipids

Chain length:

- In mammals it varies from C_{16}–C_{18} Eg milk
- Examples: palmitic, oleic, linoleic, stearic acids

Degree of Saturation (مدى التشبع)

Saturated fats are difficult to **digest and **break down**.

FAs may contain:

No double bonds (saturated – trans form, rigid chain).

One or more double bonds (mono or poly unsaturated – cis form, fluid chain, because it creates a bend "kink" in the structure).

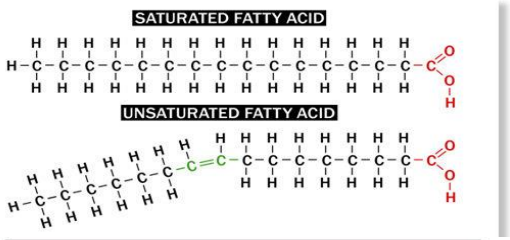
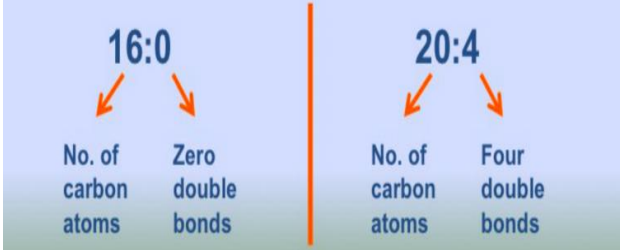


Figure 16.3
A saturated (A) and an unsaturated (B) fatty acid. Orange denotes hydrophobic portions of the molecules. [Note: Cis double bonds cause a fatty acid to "kink."]

لو كان عندي أكثر من رابطة ثنائية بالليبيد راح يكون بين كل وحدة واللي بعدها ثلاث كربونات بمعني إذا كانت أول رابطة ثنائية عند كربونة 3 اللي بعدها تكون عند 6 وهكذا

Saturated FAs	Unsaturated FAs
12:0 Lauric acid	18:1 Oleic acid
16:0 Palmitic acid	18:2 Linoleic acid
18:0 Stearic acid	20:4 Arachidonic acid



Also, Cholesterol causes a deformity in the structure of the chain making it more fluid.

Essential Fatty Acids

- There are two essential fatty acids that our bodies can not synthesize so they must be supplied in diets which are Linoleic acid and Alpha-Linolenic acid

- Deficiency can cause dermatitis **(dry scaly sking)**, membrane function loss .

- Linoleic acid (precursor of arachidonic acid).

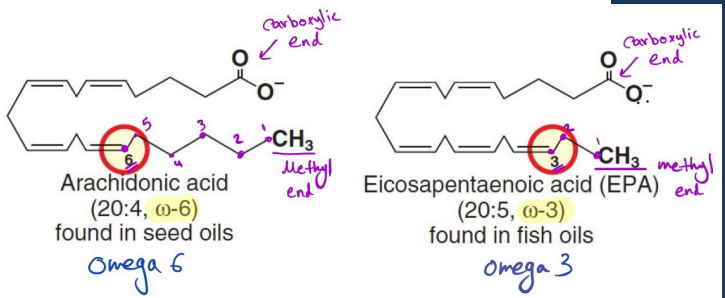
- Arachidonic acid is essential where Linoleic acid is deficient in the diet

-We can synthesize Arachidonic acid as long as we have linoleic acid in our body, if we don't have linoleic acid , we cant make arachidonic acid, this is why arachidonic acid is considered a conditionally essential fatty acid.
-for this reason, people with linoleic acid deficiency experience symptoms of both linoleic and arachidonic acid deficiency.

General reminders:
*please Be careful not to confuse linolenic acid and linoleic acid
** arachidonic acid is conditionally essential not essential.

W-3 and W-6 Fatty Acids (W=omega)

w-3	w-6
Long chain poly-unsaturated fatty acid's. first double bond starting with third carbon from the methyl end	Long chain poly-unsaturated fatty acid's. first double bond starting with sixth carbon from the methyl end
Reduce serum triglycerides (Fat), which lead to reduce of blood pressure and risk for heart disease (Reduce fat in blood)	Reduce serum cholesterol
Major source: fish	Major source: vegetable oil – nuts
Examples: ▯ Alpha-linolenic acid ▯ EPA (eicosapentaenoic acid) ▯ DHA (Docosahexaenoic acid)	Example: ▯ Linoleic acid 18:2



نبحث عن أول ذرة كربون تحمل رابطة ثنائية من الجهة القريبة للـmethyl (للجهة البعيدة عن C=O).
W-3 < الذرة الثالثة
W-6 < الذرة السادسة

Triacylglycerols (TGs)

-Three fatty acids with a glycerol bonded are called triglyceride* (TGs) also known as fat.

-A triglyceride (TGs) Are tri-ester** of fatty acid With a glycerol molecule bounded to them.

-Constitutes majority of dietary: يعني معظم الدهون في غذائنا من هذا النوع

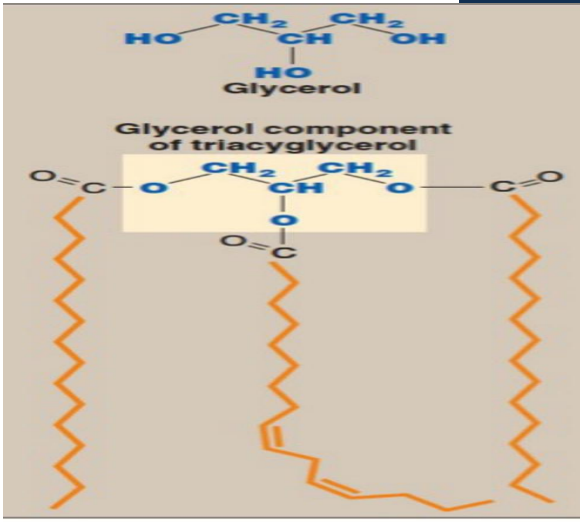
-stored in adipocyte (fat cells) as energy reservoir***

"in case of starvation- or fasting- TG are converted into fatty acids and then sent to the blood"

-not a component of cell membrane: ليس من احد مكونات الغشاء الخلوي

-subcutaneous layer of fats provides thermal insulation****

*also called triacylglycerol
**tri-ester means 3 ester, ester is a fatty acid with alcohol (in this case the alcohol is glycerol)
***reservoir: مخزن
**** تشكل طبقة تحت الجلد تعمل كعازل حراري تحمي الجسم من البرودة



Steroids

steroids

- Steroids with a hydroxyl group (OH) are called sterols

.

- Consists of four fused rings called steroid nucleus with 8-carbon chain

.

- are a derivatives of Cyclopentanoperhydrophenenthrene ring Or simply called steroid nucleus

Functions of cholesterol

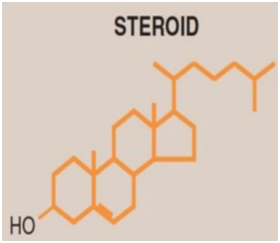
- Component of cell membranes "maintain the fluidity of the membrane"

- Precursor for: Precursor: a substance from which another is formed
  - Bile acids / Bile salts
  - Vitamin D
  - Steroid hormones (Aldosterone, cortisol, testosterone, estrogen, progesterone)

Bile is secreted from the liver and helps to absorb fat

- High levels of plasma cholesterol is strongly associated with coronary artery disease and atherosclerosis

- Cholesterol is a major sterol in humans and animal
- Cholesterol in plasma is bound to fatty acids called cholesteryl esters
- Cholesterol in cell membrane and bile is free (not bound to fatty acid)



Phospholipids

∗Major components of biological-membranes

- There are two classes of phospholipids :

Phospholipids

Glycerophospholipids (contains glycerol back bone)

1 Phosphate + 1 Glycerol + 2 Fatty acids = Glycerophospholipid

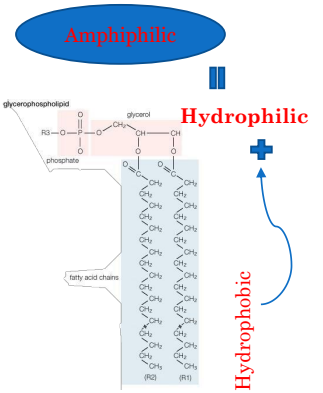
-Glycerol-3-PO_4 is bonded to two fatty acid chains

-The PO_4 group is linked to a hydrophilic group

Sphingophospholipids (contains sphingosine backbone)

7GO

-Hydrophobic tails
-Hydrophilic phosphoryl heads

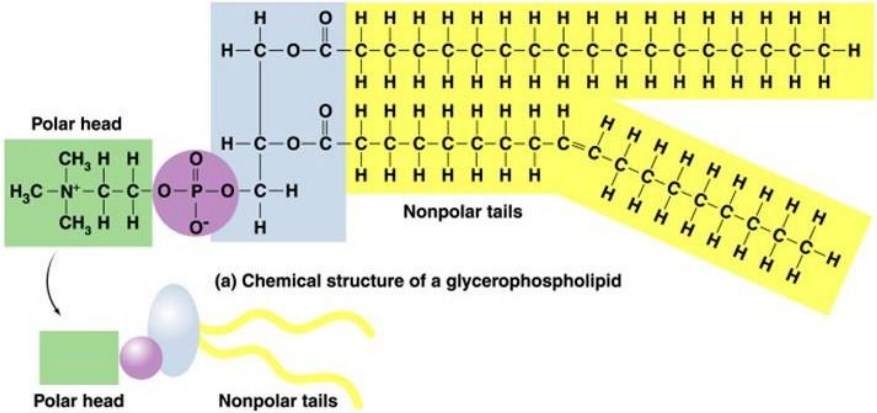


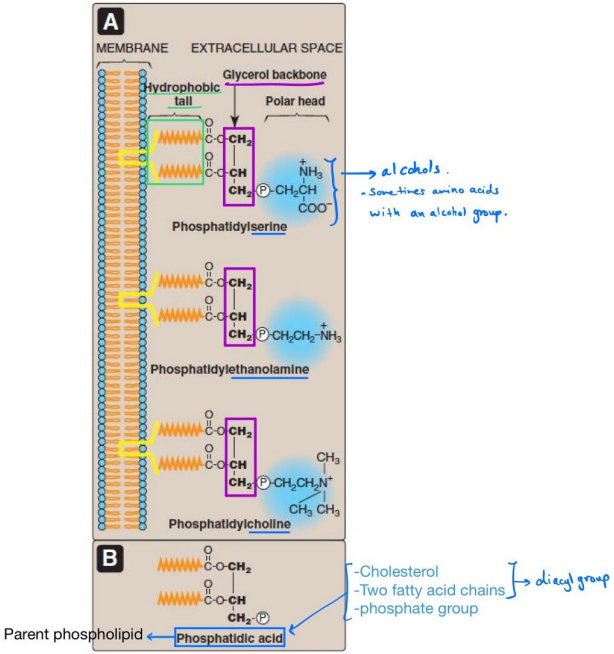
انصح بمشاهدة الفيديو
https://www.youtube.com/watch?v=oa-USLJZ0jY&t=228
الفرق انه مسمي
Glycophosphilipids الـ
Glycolipids

Glycerophospholipid chemical structure

**You don't have to memorize the structure, but you have to know the name and the components of each one.

- A glycerophospholipid has polar and nonpolar regions.





Phospholipids

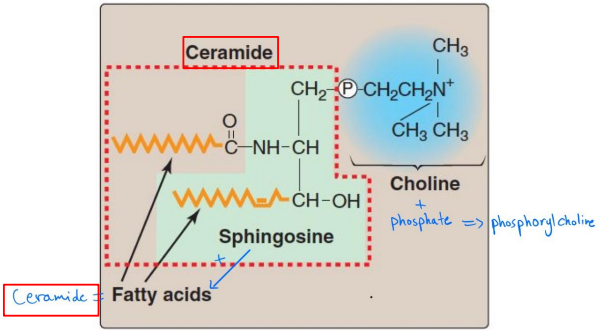
**You don't have to memorize the structure, but you have to know the name and the components of each one.

- Examples:
- phosphatidic acid, phosphatidyl –choline and serine , Sphinogophospholipids

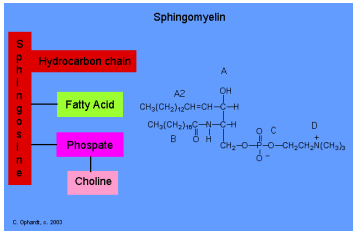
7GO

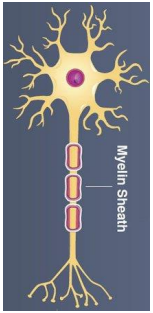
The only physiologically important sphyngophospholipid

Long-chain fatty acids attached to sphingosine



Example: Sphingomyelin
An important component of myelin that protects and insulates nerve fibers





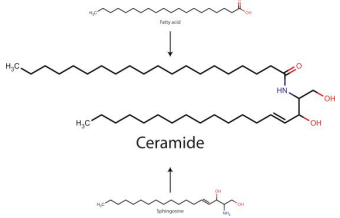
Names are enough here, don't go into details of structures

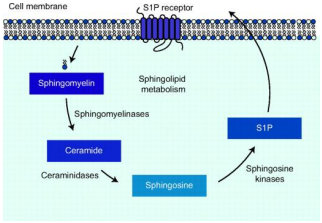
Glycolipids

Carbohydrates + Lipids = Glycolipds

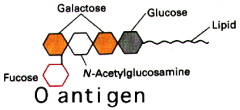
Cell Membrane بدرس الـ physiology اخذناه بالـ

- Contain both carbohydrate and lipid components
- Derivatives of ceramide
  - A long chain fatty acid is attached to sphingosine





- Also called glycoshpingolipids
- Examples: Ganglioside, glactocerebroside
- Act as: Blood group antigens, cell surface receptors for bacteria/viruses



Transport of plasma lipids

- Plasma lipids are transported as lipoprotein particles (lipids + protein)
- ***Protein part:*** Apoproteins or apolipoproteins
  - ***Examples:*** Apolipoproteins A, B, C
  - ***Functions:*** lipid transport, enzymatic functions, ligands for receptors
- ***Lipid part:*** Contains lipids of various types

- NOTE:
- OUTSIDE >HYDROPHILIC (PROTIEN)
- INSIDE > HYROPHOPIC (LIPIDS)

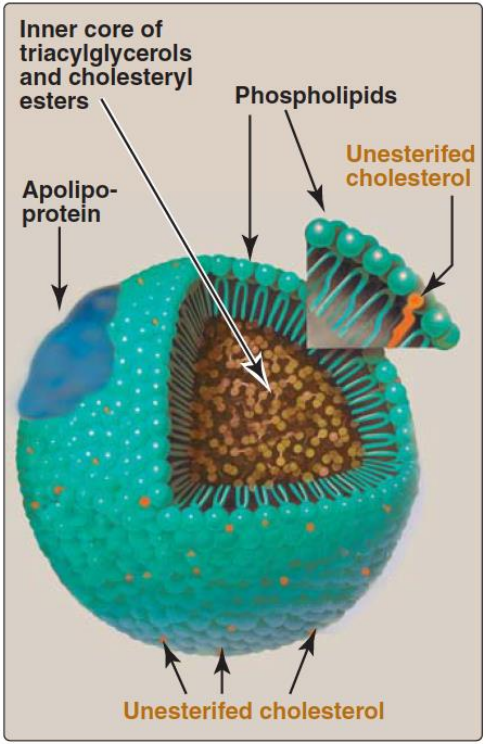
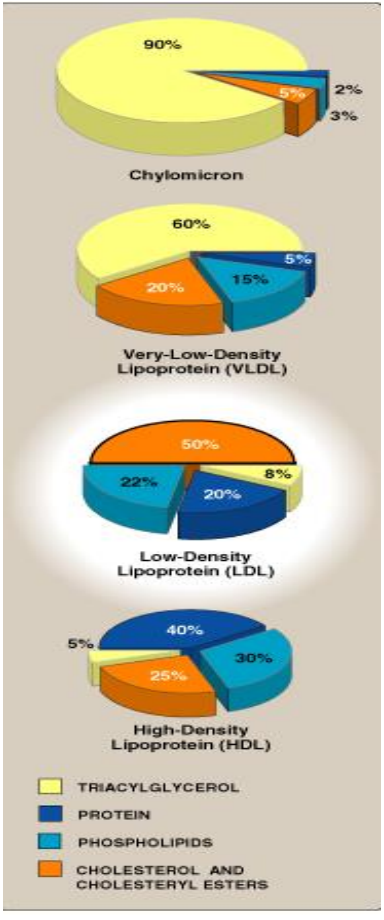


Figure 18.14
Structure of a typical lipoprotein particle.

Types and functions of lipoproteins

Lipoprotein	Transports
Chylomicrons Made after we eat food	Dietary TGs
Very low density lipoprotein (VLDL)	Endogenous TGs made by liver
Low density lipoprotein (LDL)	Free cholesterol
High density lipoprotein (HDL) The good one, because it helps removing the excess cholesterol	Cholesteryl esters



Take home message

- Lipids are a group of hydrophobic molecules
- Perform essential physiological functions in the body
- Simple lipids include: fatty acids, TGs and steroids
- Complex lipids include: phospholipids, sphingolipids and glycolipids
- A number of diseases are associated with abnormal lipid metabolism

Quiz

1-……is a major sterol in humans and animals
A- amino acid
B- Cholesterol
C-lipid
D- carbohedrates

2- glycolipids contain …..
A - carbohydrate
B – lipid
C- A&B
D- none

3- prostaglandins are formed of :
A- protein
B- lipids
C- carbohydrate
D- none

4- which of the following is true about linoleic acid :
A- 18:1
B- 18:0
C- 20:4
D- 18-2

Answers :
B
C
B
D

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15- نواف عبدالعزيز

Team leaders:

١-محمد حسن حكيم
٢- رهام الحلبي

Contact us:
teambiochem437@gmail.com

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