# Biochemistry team


MEDICAL STUDENTS 432

# Lipid Compounds Of Physiological Significance

اللون الاحمر = مهم

Just to know

غير مهم او فقط للاستزاده.

ملاحظة: الدهون (lipids) غالبا لاتذوب في الماء. تذوب في المذيبات العضوية مثل البنزين. (( فقط الـ ketone bodies «نوع من الدهون» تذوب في الماء )).

# Functions of lipid compounds:

## 1-Major energy source for the body

مصدر رئيسي لطاقة الجسم

## 2-Structural component of cell membranes(lipid bilayer)

أحد مكونات غشاء الخلية

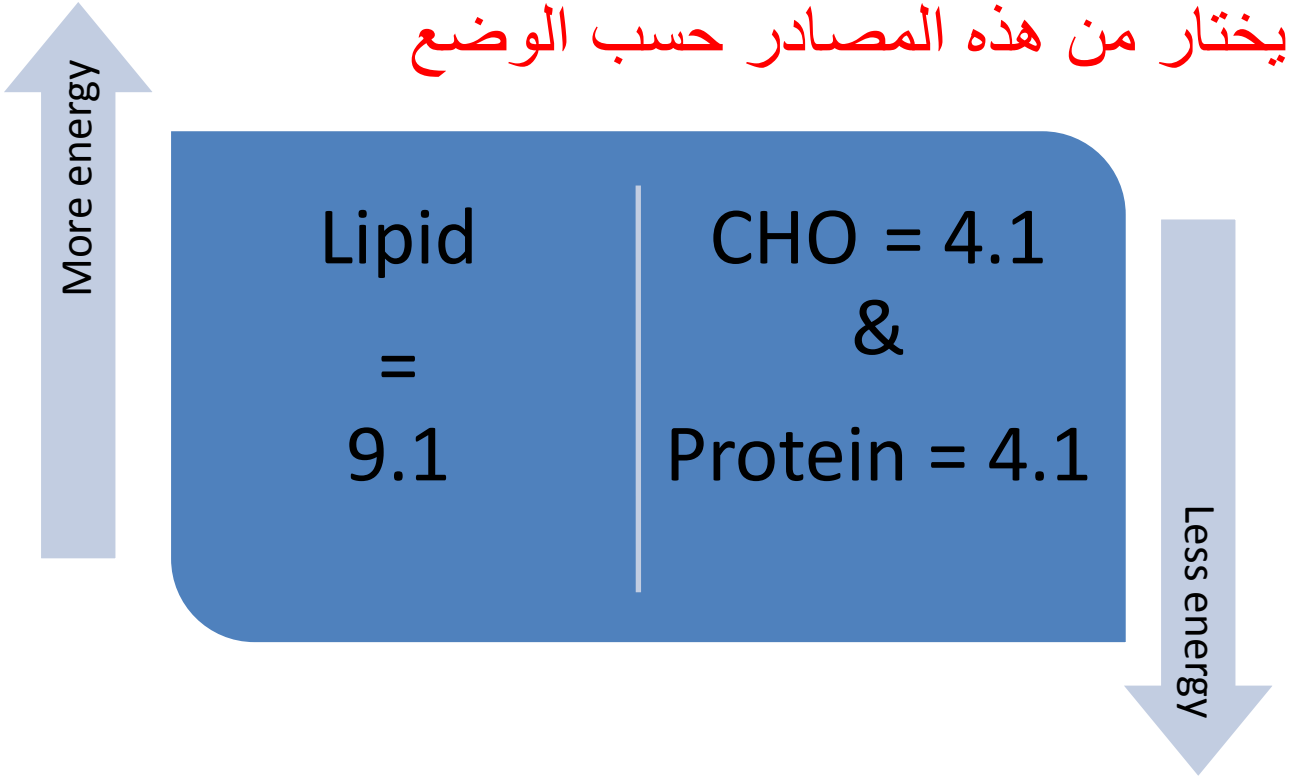
## 3-Important regulatory molecules:

جزئيات تنظيمية مهمة

**e.g., Fat-soluble vitamins A,D,E,K**
**Steroid hormones**
**Prostaglandins** (Secrete in every cell in human body)
**Signaling molecules: Inositol triphosphate (IP3)**

# ❑Major energy source for the body:

الجسم له اختيارات يختار من هذه المصادر حسب الوضع




*fatty acid: is the Top Energy هو الاعلى طاقةً

## ❑ Signaling molecules

يتصل وهو خارج الخلية عن طريق
"second massenger"

Just to know

❑ **A prostaglandin : is any member of a group of lipid compounds that are derived enzymatically from fatty acids(Arachidonic acid)and have important functions in the body.**

**Storge form of this energy : are many>>> subcninous tissue an adipose tissue**

# Lipids and Related Clinical Problems:

- **Obesity.**
  «السمنة»
- **Atherosclerosis and hypertension.**
  «تصلب الشرايين»
- **Coronary heart diseases.**
  «أمراض القلب التاجي»

# Lipid Compounds:

- Heterogeneous group. «مجموعات غير متجانسة»
- Relatively water-insoluble. «مجموعات غير ذائبة في الماء»
- (? Exception)

هناك استثناء وهو

keton bodies

- Soluble in non-polar solvents.

«مجموعات تذوب في المركبات الغير قطبية كالبنزين ومشتاقته»

## 1 -Lipids and Related Clinical Problems

- Obesity
- Atherosclerosis and hypertension
- Coronary heart diseases

## 2-Lipids compounds

- Heterogeneous group
- Relatively water-insoluble (? Exception)
- Soluble in non-polar solvents

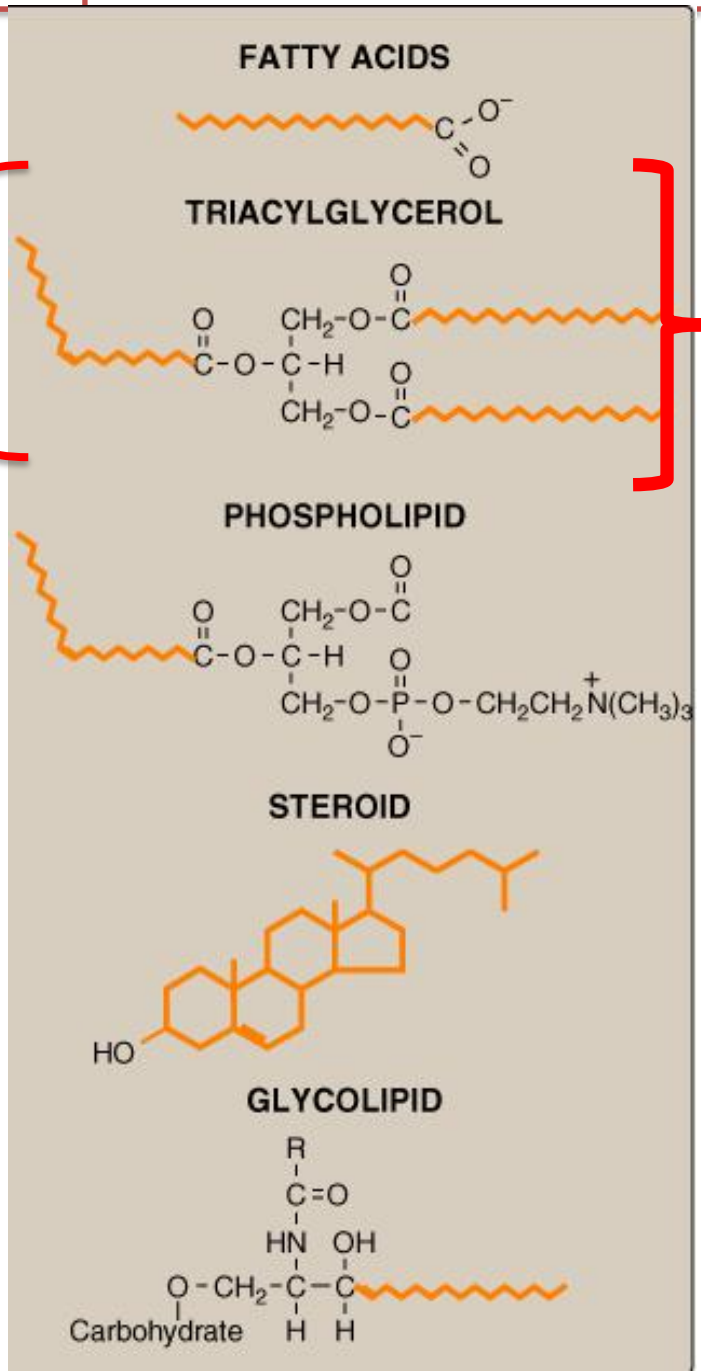
# Lipid Compounds: Heterogeneous Group

## A. Simple Lipids:
تتكون من
Lipid
فقط

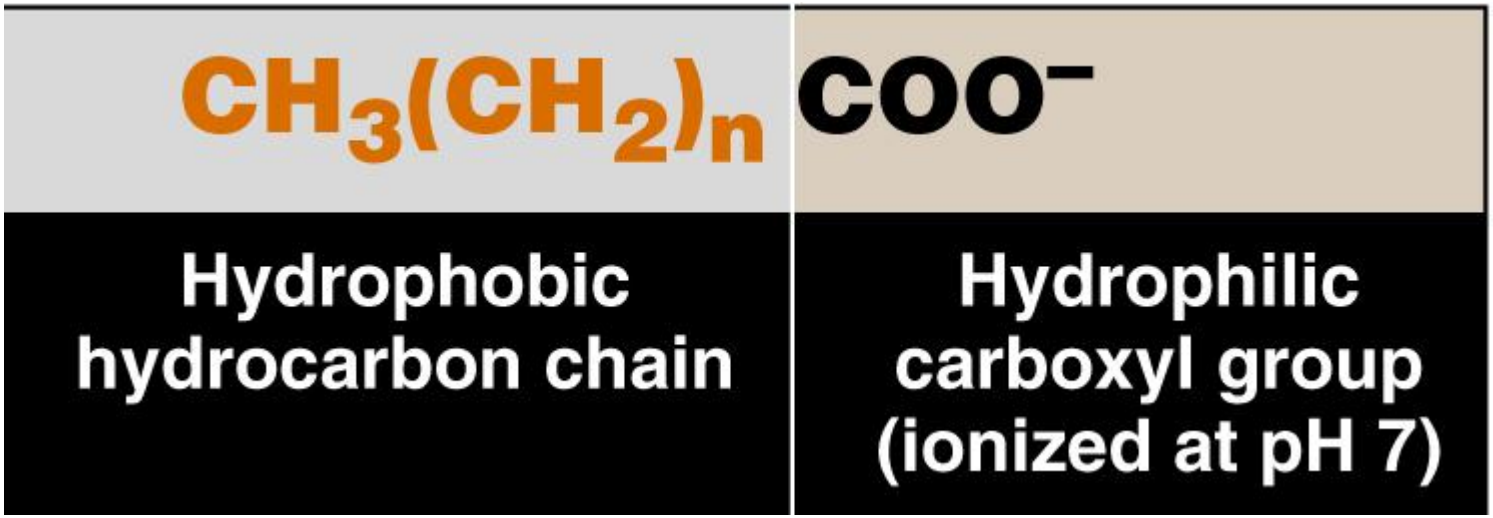
- Fatty acids
- Ketone bodies
- *Triacylglycerol*
- Cholesterol

## B. Complex Lipids:
تتكون من
Lipid
+
مجموعه مرتبطه به

- *Phospholipids*
- Lipoproteins
- Glycolipids



# Free Fatty Acids




**Amphipathic: Both hydrophobic & hydrophilic parts**

تعني ان هناك جزء محب للماء وجزء كاره للماء

**كلما زادت السلسة كلما قلت الذائبية (Hydrocarbon chain)**

# Free Fatty Acids (FFA)

## 1. Chain length:

**Short-chain and Medium-Chain**

**Long-Chain ⩾16** "No double bonds" **e.g.,Palmitic acid 16:0**

**Very long-chain ⩾20** "No double bonds" **e.g.,Nervonic acid 24:1**

١٦:٠ تعني ١٦ كربون لايوجد بها رابطة ثنائية و ٢٤:١ تعني ٢٤ كربون يوجد بها رابطه ثنائية واحده

## 2. Degree of saturation:

**Saturated: No double bonds**

**Unsaturated: Mono- or poly-unsaturated**

**Cis- or trans-form**

## 3. Branched Vs straight-chain

أغلبها في داخل الجسم

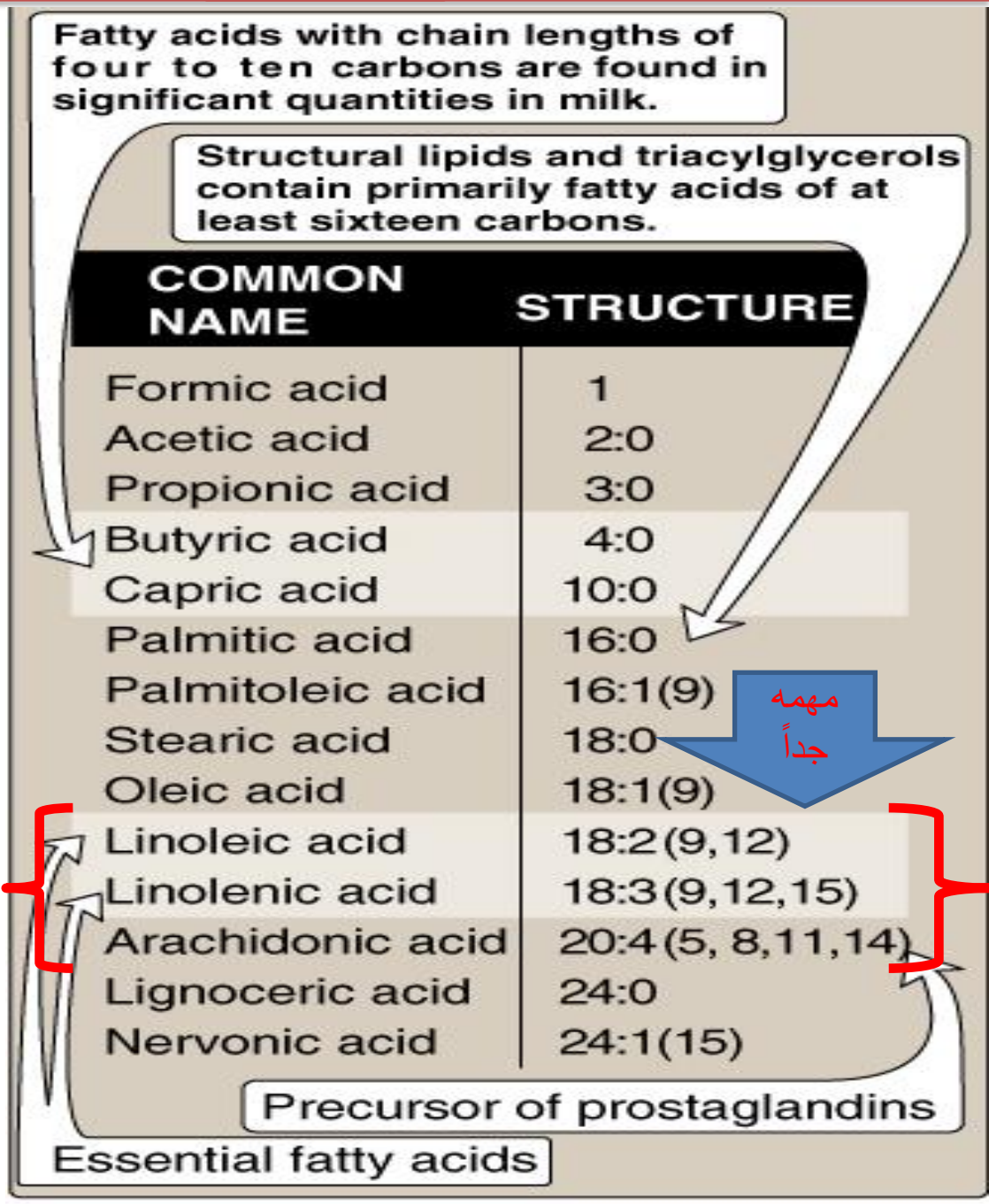
## 4. Essential fatty acids

تعني ان الجسم لايكون قادر على تكوينها او يكونها بكميات ضئيلة وأي نقص فيها يؤدي لأعراض مرضية

# Fatty Acids

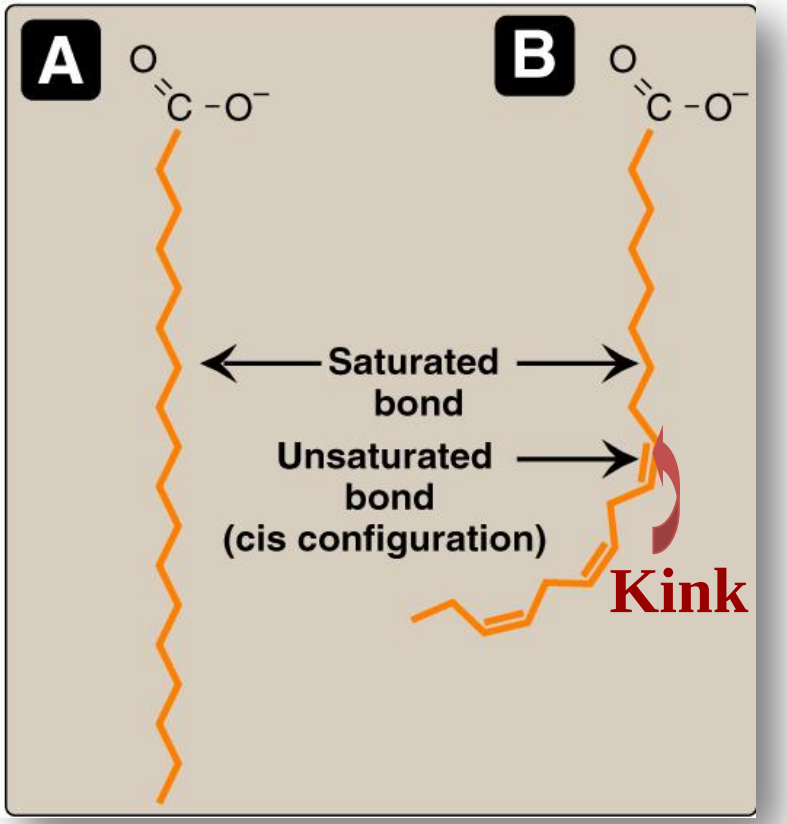
**essential fatty acids:**
**linol(e)ic acid**
**linol(en)ic acid**
***linoleic acid يحتوي على**
رابطتين ثنائية عند الذرتين رقم ٩ورقم ١٢
***linolenic acid يحتوي**
على ثلاث روابط ثنائية عند الذرات رقم ٩و ١٢ و ١٥

**Prostaglands:**
يتم تكوينها عن طريق
**((Arachidonic acid))**
**arachidonic acid 20:4**, is also considered **essential fatty acid** if linoleic acid is deficient from diet



# Fatty Acids

## Saturated Vs Unsaturated




## Melting temperature ($T_m$):

### Addition of double bonds:

↓ $T_m$

### Increase chain length:

↑ $T_m$

**Unsaturated (not straight) = have kink & usually cis conf.\unlike the saturated (straight)**

**unsaturated fatty acids have lower melting points than the saturated fatty acids**

الدهون الغير مشبعه أقل في درجة الإذابة من المشبعه.

(أي كلما كانت الدهون مشبعه أكثر كلما زادت درجة الإذابه)

يعني: ١- كلما كانت السلسلة طويلة كلما زادت درجة الإذابة(علاقة طردية)

٢- كلما كانت الروابط (الثنائية)أكثر قلت درجة الذوبان (علاقة عكسية)

# Free Fatty Acids (FFA)

## Chain length:

- Short-chain & Medium-Chain
- Long-Chain e.g., Palmitic acid 16:0
- Very long-chain e.g., Nervonic acid 24:1

## Degree of saturation:

### Unsaturated

- Mono- or poly-unsaturated
- Cis- or trans-form of double bond

### Saturated: No double bonds

## Branched vs. straight-chain

Melting temperature ($T_m$):

- Addition of double bonds: → $T_m$ decrease
- Increase chain length: → $T_m$ increase

## Essential fatty acids

- Linoleic acid, 18:2
- Linolenic acid, 18:3
- The precursor of prostaglandins, Arachidonic acid 20:4, is also considered essential fatty acid *if (linoleic acid) is deficient from diet*

# Plasma Fatty Acids:

Thy are present in the circulation

## Esterified form (~90%): «تكون روابط استر»

**In triacylglycerol, cholesterol ester, phospholipids (as part of lipoproteins)**

Thy can't be in the circulation with out lipoprotein (water insoluble)

## Free-form (unesterified):

**Transported in association with albumin**

* اللي مايذوب يتم نقله عن طريق "Carrier"

# Triacylglycerols

Storage form in adipose tissue

~ 90% of dietary lipids

Glyscerol plus 3 fatty acids

Blood transport: **Chylomicrons and VLDL**

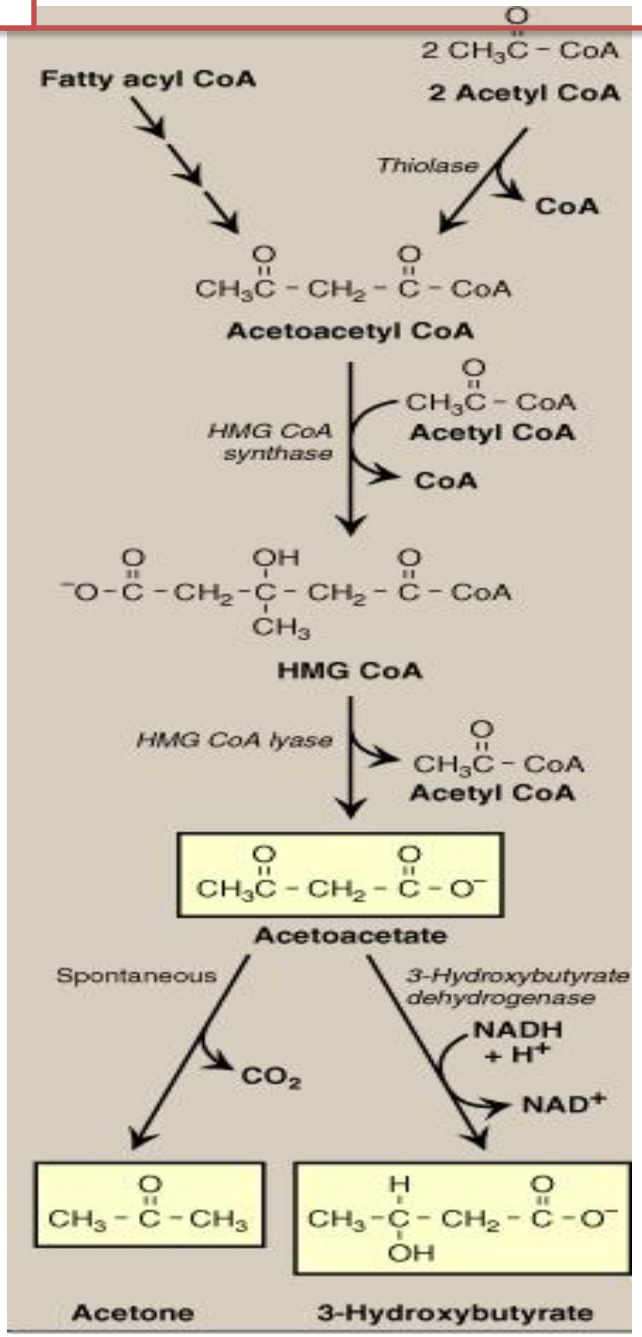
# Ketone Bodies

**Totally soluble in water does not need carrier**

1. Water-soluble
2. Diabetic Ketoacidosis

**increase in case of Diabetic Ketoacidosis**

1. Acetone
2. Acetoacetate
3. β-Hydroxybutyrate



# Phospholipids

## A. Glycerophospholipids:

Glycerol-containing phospholipids

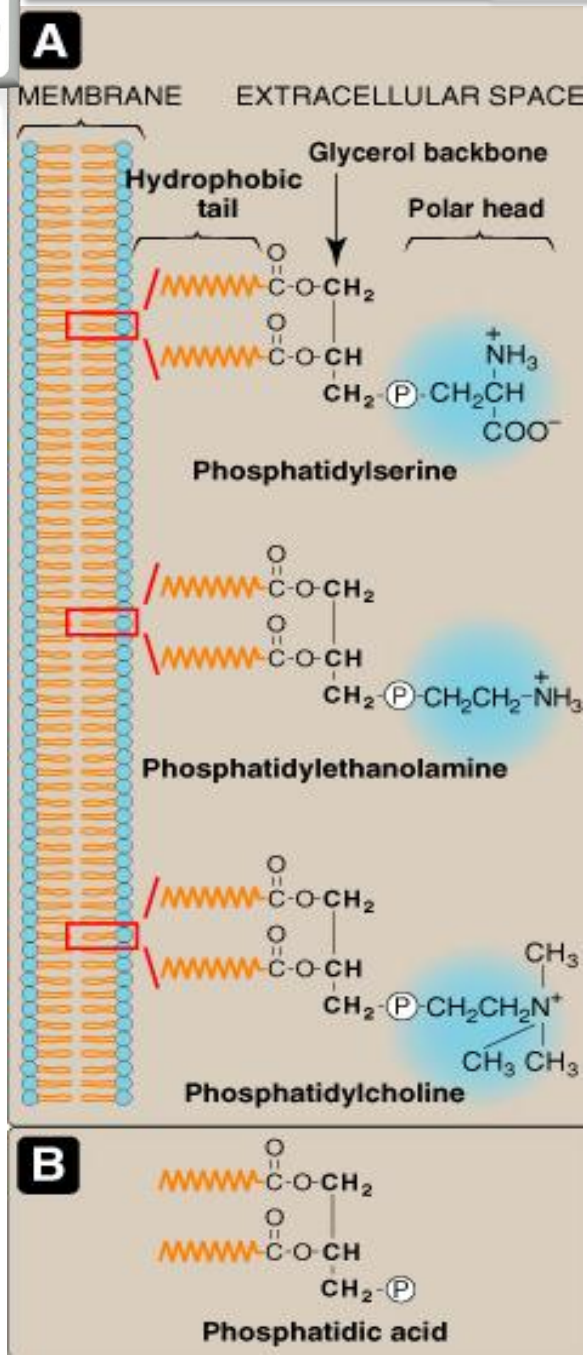
1. Phosphatidylcholine (Lecithin)
   - e.g., **Surfactant (Dipalmitoylecithin)**
2. Phosphatidyl inositol **(signaling molecule)**

## B. Sphingo-phospholipids:

**Sphingosine-containing phospholipids:**

**e.g., sphingomyelin** (Myelin sheath)

***(To be discussed with CNS Block)***




# Phospholipids:

## A. Glycerophospholipids

**Parent Compound**

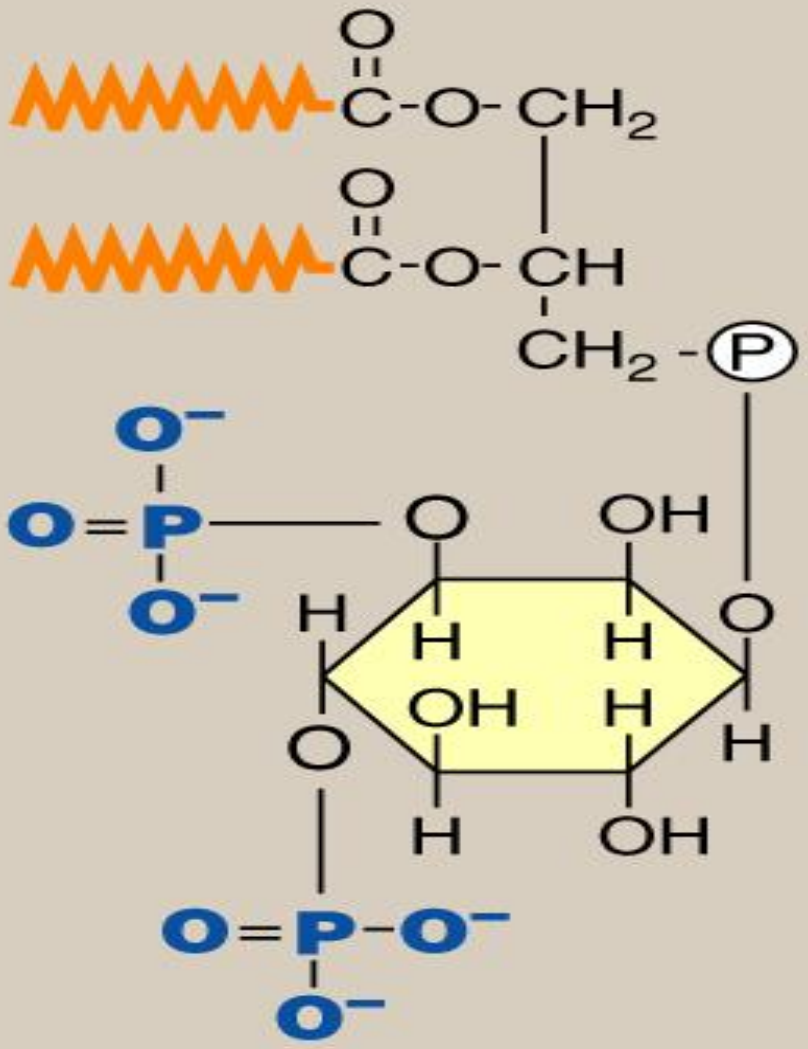
Phosphatidic acid

*All other **Glycerophospholipids derives from it**

**Members:**

1. Phosphatidylcholine (Lecithin)

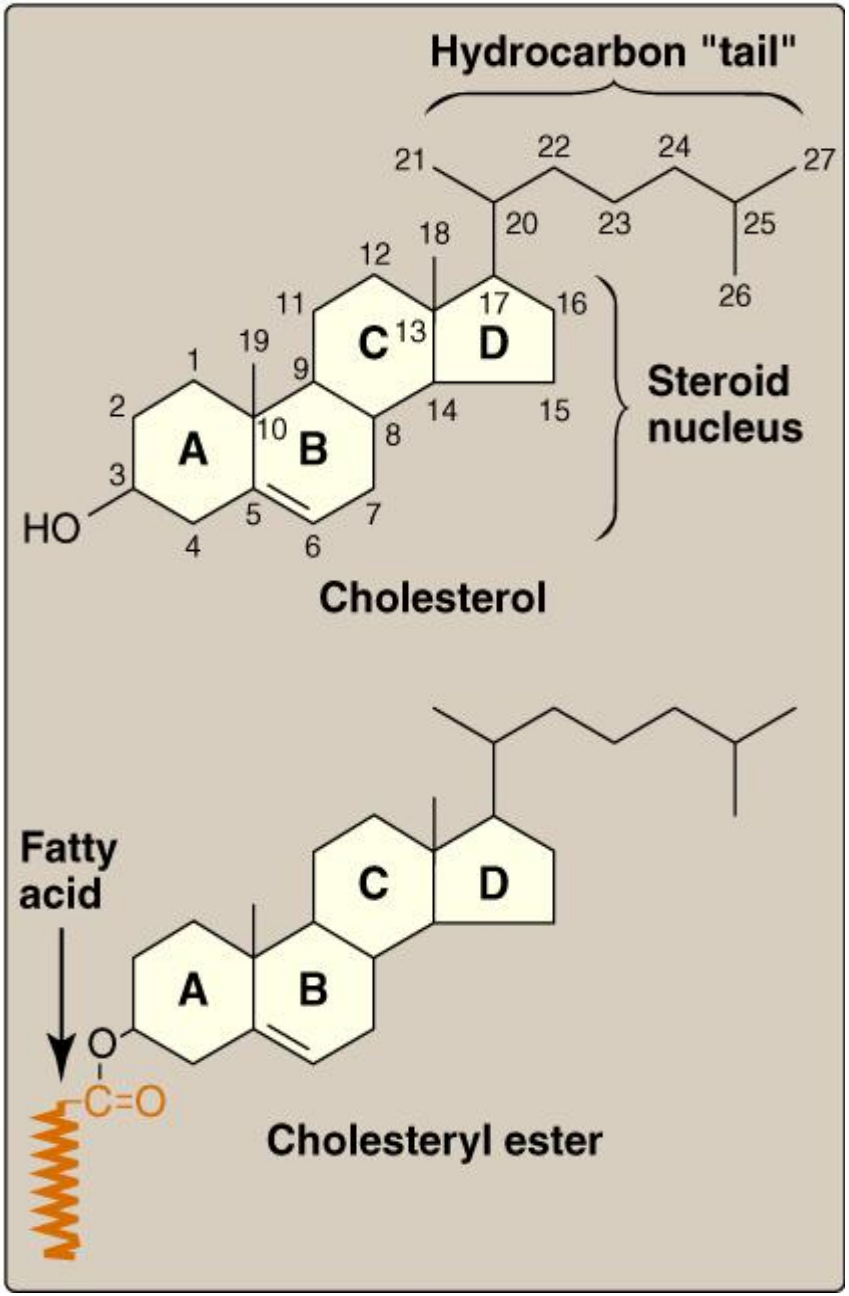
e.g., Surfactant (Dipalmitoyl lecithin)



Phosphatidylinositol 4,5-bisphosphate

# Cholesterol: Structure:

## Parent of steroid compound



# Overview and Functions

- Major Sterol of animal tissues
- Component of cell membranes
- Precursor for:
  - Bile acids & salts
  - Vitamin D
  - Steroid hormones:
    - Mineralocorticoids e.g., Aldosterone
    - Glucocorticoids, e.g., Cortisol
    - Sex hormones, e.g., Testosterone
      Estrogen & progesterone
- Hypercholesterolemia: Atherosclerosis & CAD

# Lipoprotein Structure

## Protein part: Apoproteins or apolipoproteins

**Abbreviations: Apo-A, B, C**

**Functions:**

**Structural and transport function**

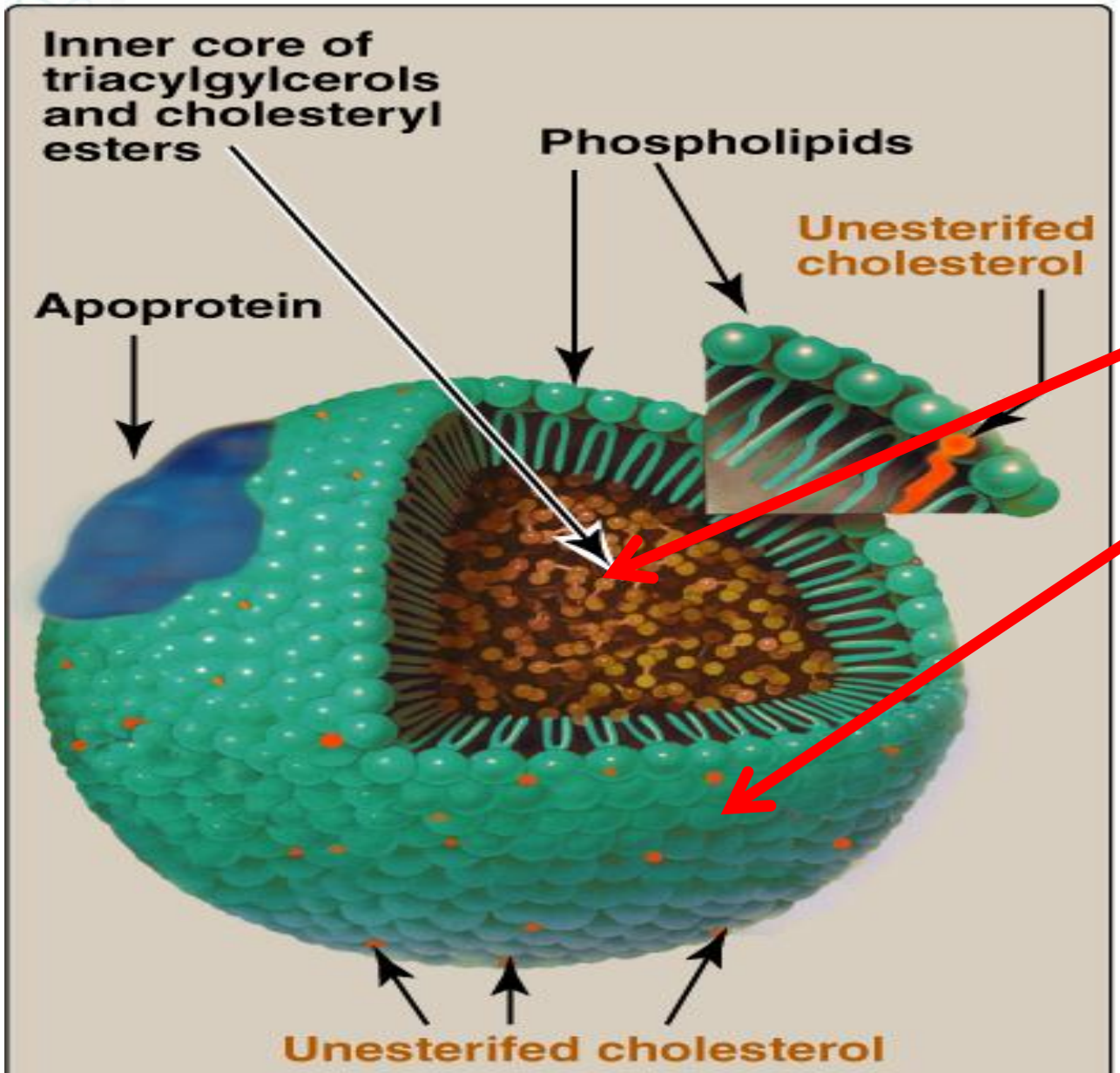
**Enzymatic function**

**Ligands for receptors**

## Lipid part:

- **According to the type of lipoproteins**
- **Different lipid components in various combinations**

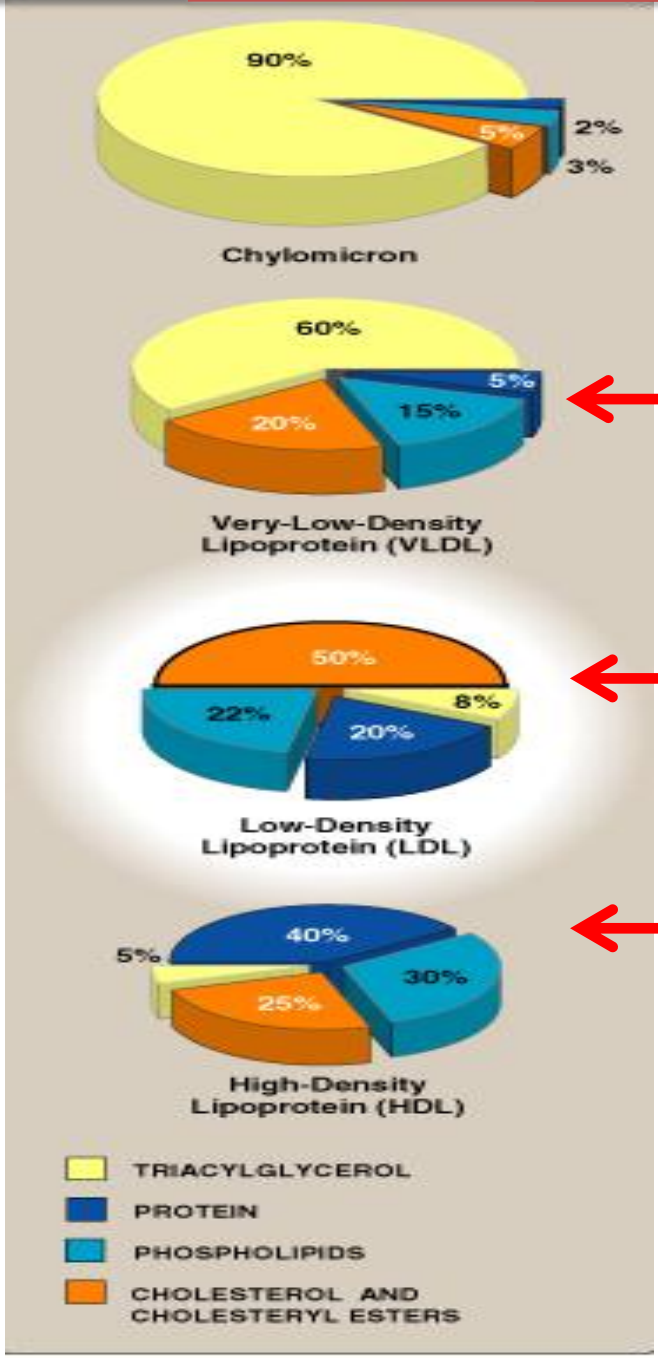
# Lipoprotein Structure




The core insolub

The cote soluble

# Composition of Lipoproteins

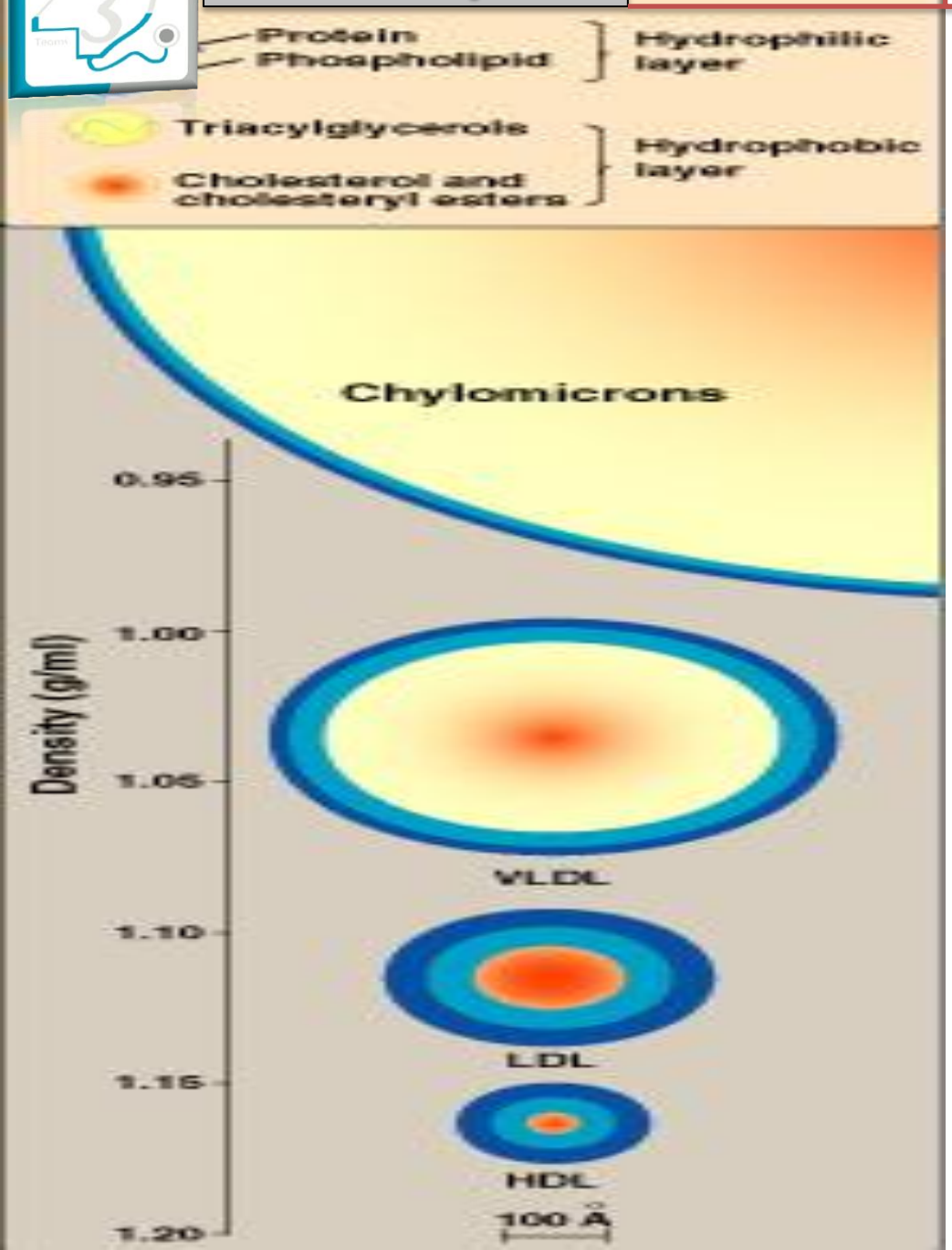



## Chylomicrons:

## Types of Lipoproteins:

- ❑ Very low density Lipoprotein (VLDL)
- ❑ Low density Lipoprotein (LDL)
- ❑ High density Lipoprotein (HDL)

# Ultracentrifugation of Lipoproteins




نفس الصورة الماضية ولكن باستخدام جهاز اخر

# Plasma Lipoproteins

## Triacylglycerol transport:

**Chylomicrons:** TG of dietary origin

**VLDL:** TG of endogenous synthesis

## Cholesterol transport:

**LDL:** هو الكولسترول السيئ — Mainly free cholesterol

**HDL:** هو الكولسترول الجيد — Mainly esterified cholesterol

# Take Home Message

- Lipids are heterogeneous group of compounds
- Lipids are relatively water-insoluble
- Simple lipids:

  **FFA, TG, Ketone bodies, Cholesterol**
- Complex lipids:

  **e.g., Phospholipids, Lipoproteins**
- Lipids have important physiological functions
- Lipid disorders are the basis for common human diseases, namely **obesity** and **atherosclerosis**

# Done by

# Biochemistry team


MEDICAL STUDENTS 432