

Lipids

Editing File

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- Main Text (black)
- Female Slides (Pink)
- Male Slides (Blue)
- Important (Red)
- Dr's Notes (Green)
- Extra Info (Grey)

Objectives

- Define and classify lipids
- Understand the physiological importance of lipids
- List the examples of simple and complex lipids
- Correlate implications of lipids in clinical conditions



[Helpful video](#)

What are Lipids ?

Lipids

A **heterogeneous** group of **hydrophobic (water-insoluble)** organic molecules that are soluble only in **organic solvents**.

Body lipids are compartmentalized (**packed**) in cell membranes, tissues and plasma
(because the environment is mainly water)

Functions:

- Lipids are **essential components** of biological membranes. (cell membranes)
- Lipids with hydrocarbon chains serve as **major energy stores**.
- **Cell signaling** involves lipid molecules e.g. Inositol triphosphate.
- Fat-soluble vitamins (Vit: A,D,E,K), steroid hormones (**sex hormones**) and prostaglandins (**inflammation process**) are formed of lipids.

Lipids and Diseases



Diseases that are strongly associated with (abnormality) in lipid (Metabolism):

- Atherosclerosis (fat accumulation in artery, heart disease)
- Coronary artery disease (fat accumulation in coronary artery)
- Obesity
- Metabolic syndrome (cluster of conditions that occur together, increasing your risk of heart disease)
- Hypertension



Lipids classification



Simple lipids

Fatty acids

Triacylglycerol

Steroids
(cholesterol)

Complex lipids

Glycolipid

Phospholipid

Sphingolipid



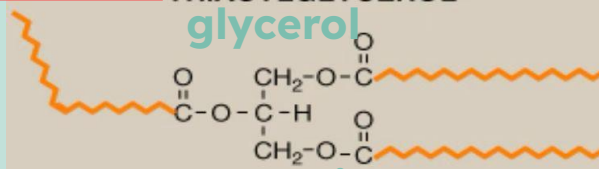
3 fatty acid

FATTY ACIDS



Carboxyl group

TRIACYLGLYCEROL glycerol

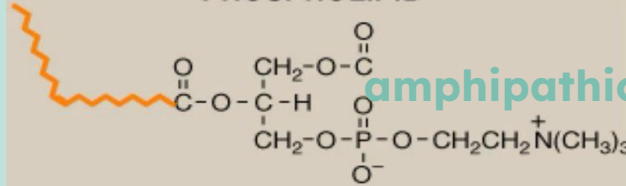


Not amphipathic

Between 3 FA + glycerol

Ester linkage

PHOSPHOLIPID

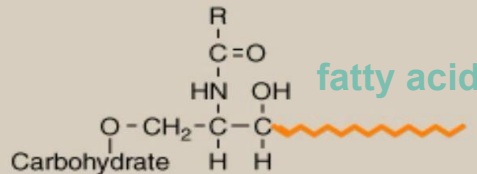


amphipathic

STEROID



GLYCOLIPID



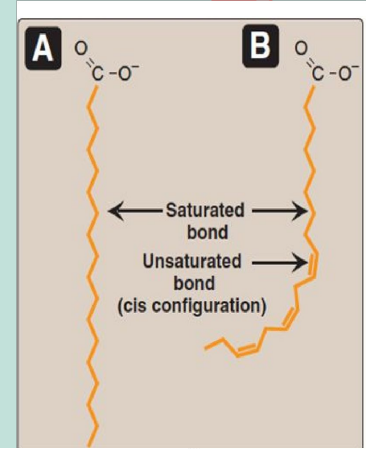
fatty acid

Don't memorize the structure
Just the linkage type
and other notes

1- Fatty acids (simple lipids) FAs

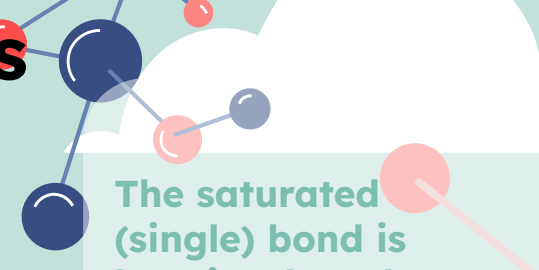
- FAs are **carboxylic acids** with long-chain hydrocarbon side groups.
- They are **amphipathic** in nature (have both hydrophilic and hydrophobic).
- The carboxylic group (**COOH**) is hydrophilic & the hydrocarbon **chain** is hydrophobic

(trans) move
stable than (cis)



1- Fatty Acids (FAs): Simple Lipids

- FAs are highly **insoluble** in water. (because they're lipids and they're non-polar)
- Must be transported in plasma with proteins.
- **Majority of plasma FAs are esters** of: Triacylglycerol, Cholesterol, Phospholipids.



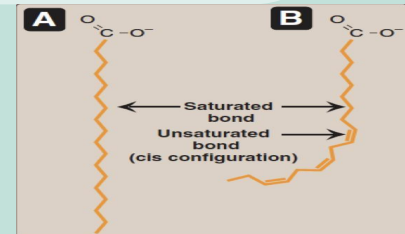
The saturated (single) bond is heavier than the unsaturated (double) bond because the carbon in saturated bond attached to 4 atoms

Degree of saturation:
FAs may contain:

- **No** double bonds (Saturated/transform)
- **One or more** double bonds (**Mono or Polyunsaturated/cis form**)

Chain length:

- In mammals it varies from **C16–C18**.
- Examples: palmitic, oleic, linoleic, stearic acids.



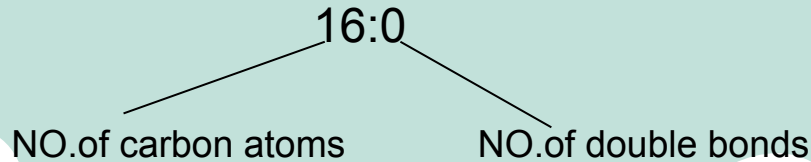
(FAs) Simple Lipids Contd..

Saturated FAs

- 12:0 Lauric acid
- 16:0 Palmitic acid
- 18:0 Stearic acid

Unsaturated FAs


- 18:1 Oleic acid
- 18:2 Linoleic acid
- 20:4 Arachidonic acid




Note443: You need to memorize examples from the table, no need for numbers

Essential Fatty Acids:

- Body cannot synthesize (like essential amino acids).
- Must be supplied in the diet.
- Deficiency can cause **dermatitis** التهاب الجلد membrane function loss.
- Examples of essential fatty acids:
 - **Linoleic acid** (precursor of arachidonic acid) (Arachidonic is derived from Linoleic)
 - **α -Linolenic acid**.
 - **Arachidonic acid** is essential when linoleic acid is deficient in the diet (**conditional**). (Linoleic acid في حال نقص ال)

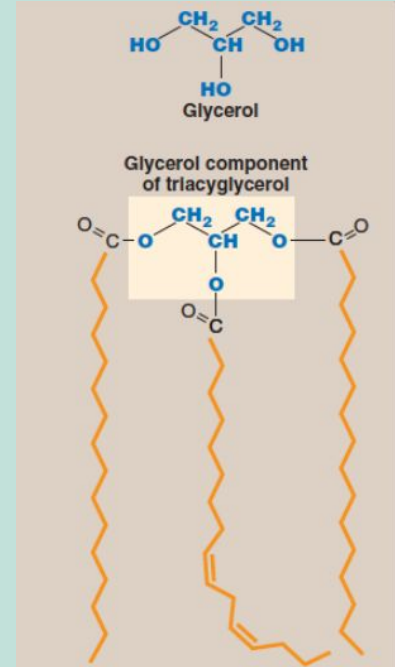


Name	ω -3 fatty acids	ω -6 fatty acids
Definition	Long - chain polyunsaturated FAs with First double bond at the 3rd carbon from the methyl end	Long-chain polyunsaturated FAs with first double bond at the 6th carbon from the methyl end
Function	Reducing serum triglycerides , blood pressure and risk for heart disease	Reducing serum cholesterol
Z Sources	Major source: fish	major source: vegetable oils, nuts
Examples	α-Linolenic acid. EPA (Eicosapentaenoic acid). DHA (Docosahexaenoic acid).	Linoleic acid 18:2 Arachidonic acid 20:4



Triacylglycerols (TGs)

- TGs are **tri-esters of fatty acids** also called **fats**.
- Three fatty acids are bonded to a glycerol molecule.
- Constitutes majority of dietary lipids.
- Stored in adipocytes (fat cells) as energy reservoir.
- Not a component of cell membranes.
- Subcutaneous layer of fats provides thermal insulation.





Structure of
(TGs)



Steroids

Derivatives of
cyclopentano-perhydro-phenanthrene ring

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

- Steroids with a hydroxyl group are called **sterols**.
 - **Cholesterol** is a **major** sterol in humans and animals.
 - Cholesterol in plasma is bound to fatty acids called cholesteryl esters.
- 
- 

Functions of cholesterol

1-Component of cell membranes

2-Precursor for:



Bile acids /
Bile salts



Vitamin D



Steroid
hormones

(Aldosterone, cortisol,
testosterone,
estrogen,
progesterone)

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

Phospholipids

The background is a light teal color. It features several decorative elements: a white circle in the top left, a red molecular structure in the top right, a white circle in the middle right, and various blue and red molecular structures and lines scattered throughout.

Glycerophospholipids

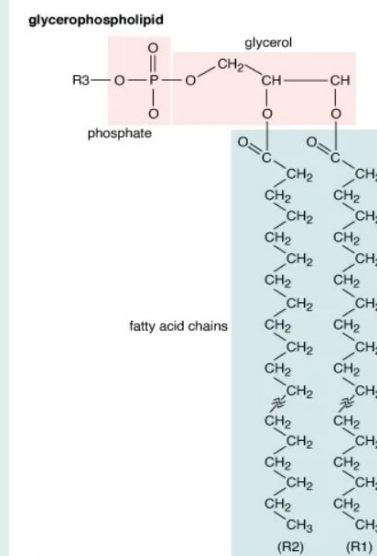
(contain **glycerol** backbone)

Sphingophospholipids

(**contain** sphingosine)

Glycerophospholipids

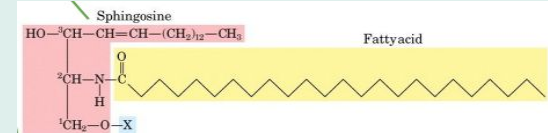
- Glycerol-3-PO₄ is bonded to **two fatty acid chains**.
- The PO₄ group is linked to a **hydrophilic** group (from glycerol)
- Amphiphilic in nature:
 - Hydrophobic tail
 - Hydrophilic phosphoryl heads



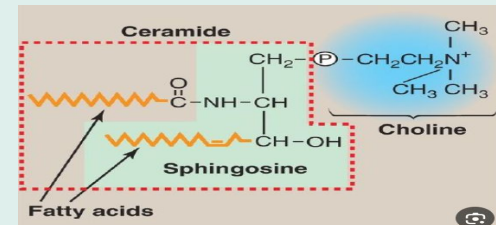
structure

Sphingophospholipids

- Long-chain fatty acids attached to sphingosine.



- Notice the FA chain in sphingosine itself
- FA+Sphingosine =Ceramide



function

Major components of biological membranes

An important component of myelin that protects and insulates nerve fibers

Examples

phosphatidic acid, phosphatidylcholine and serine

Sphingomyelin

Glycolipids

- ★ Contain both carbohydrate and lipid components.
- ★ Derivatives of ceramide.
- ★ Ceramide + Carbohydrate = Glycolipid.
- ★ A long chain fatty acid is attached to sphingosine.
- ★ Also called glycosphingolipids.
- ★ e.g. Ganglioside & Galactocerebroside.
- ★ Acts as: Blood group antigens (A,B,AB,O), cell surface receptors for bacteria/viruses.



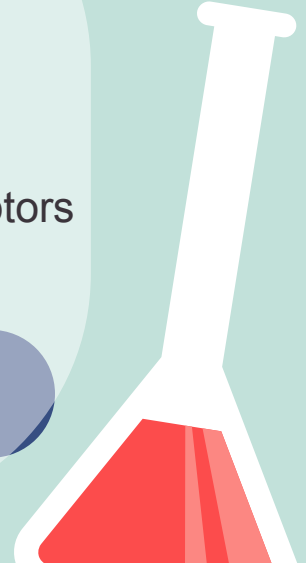
Transport of plasma lipids:

Plasma lipids are transported as lipoprotein particles (lipids + protein) (it presents in blood plasma) .

★ Protein part: Apoproteins or Apolipoproteins (outside)
e.g., Apolipoproteins A, B, C

Functions: lipid transport, enzymatic functions, ligands for receptors
Lipid part: contains lipids of various types.

(ligands are molecules which will bind to the receptors as a recognition molecule)



Types and functions of lipoproteins

Lipoprotein	Transports
Chylomicrons	Dietary TGs
Very low-density lipoprotein (VLDL)	Endogenous TGs
Low density lipoprotein (LDL) (Bad Cholesterol)	Free cholesterol
High density lipoprotein (HDL) (Good 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.

Question 1

The combination of ceramide + carbohydrate is ?

A

Phospholipid

C

Fatty acid

B

Glycolipid

D

Triacylglycerol

Question 1

The combination of ceramide + carbohydrate is ?

A

Phospholipid

C

Fatty acid

B

Glycolipid

D

Triacylglycerol

Question 2

Three fatty acids
are bonded to a
glycerol molecule

A

Phospholipid

B

Cholesterol

C

Triacylglycerol

D

Glycolipid

Question 2

Three fatty acids
are bonded to a
glycerol molecule

A

Phospholipid

B

Cholesterol

C

Triacylglycerol

D

Glycolipid

Question 3

Which of the following isn't a function of ω -3 fatty acids?

A

Reducing serum cholesterol

C

Reducing serum triglycerides

B

Reducing blood pressure

D

Reducing risk for heart disease

Question 3

Which of the following isn't a function of ω -3 fatty acids?

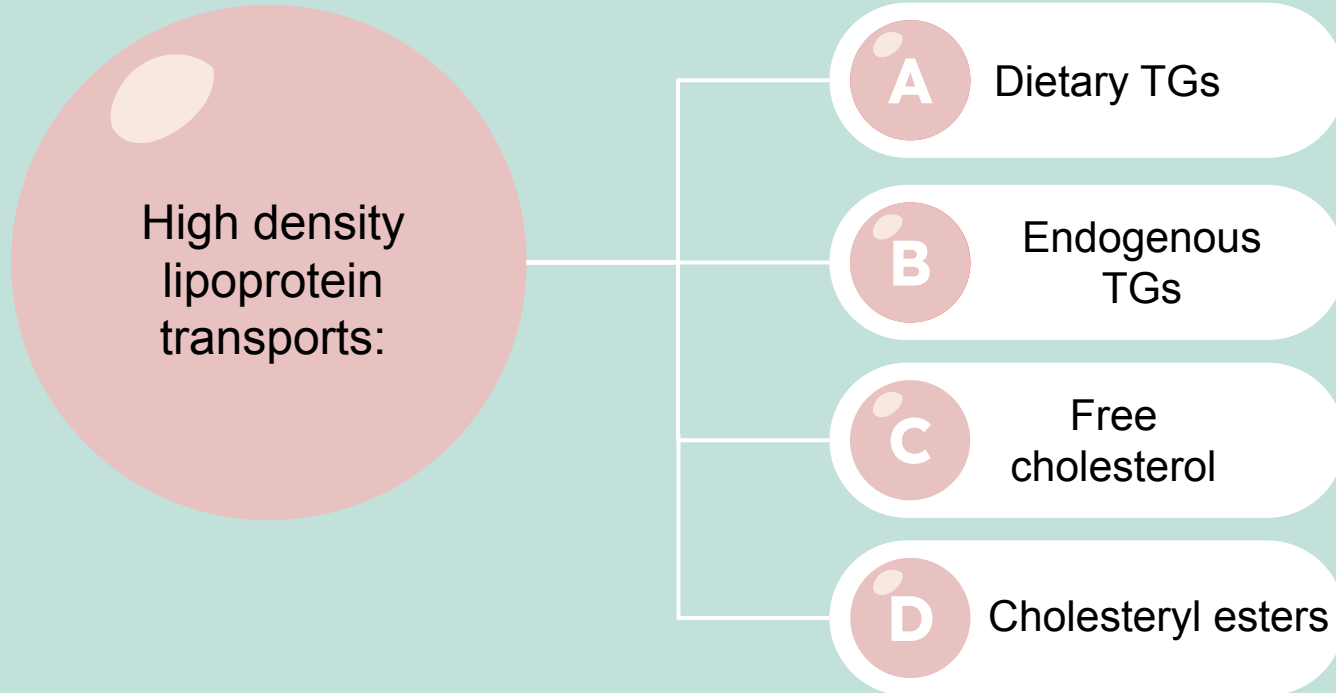
A Reducing serum cholesterol

C Reducing serum triglycerides

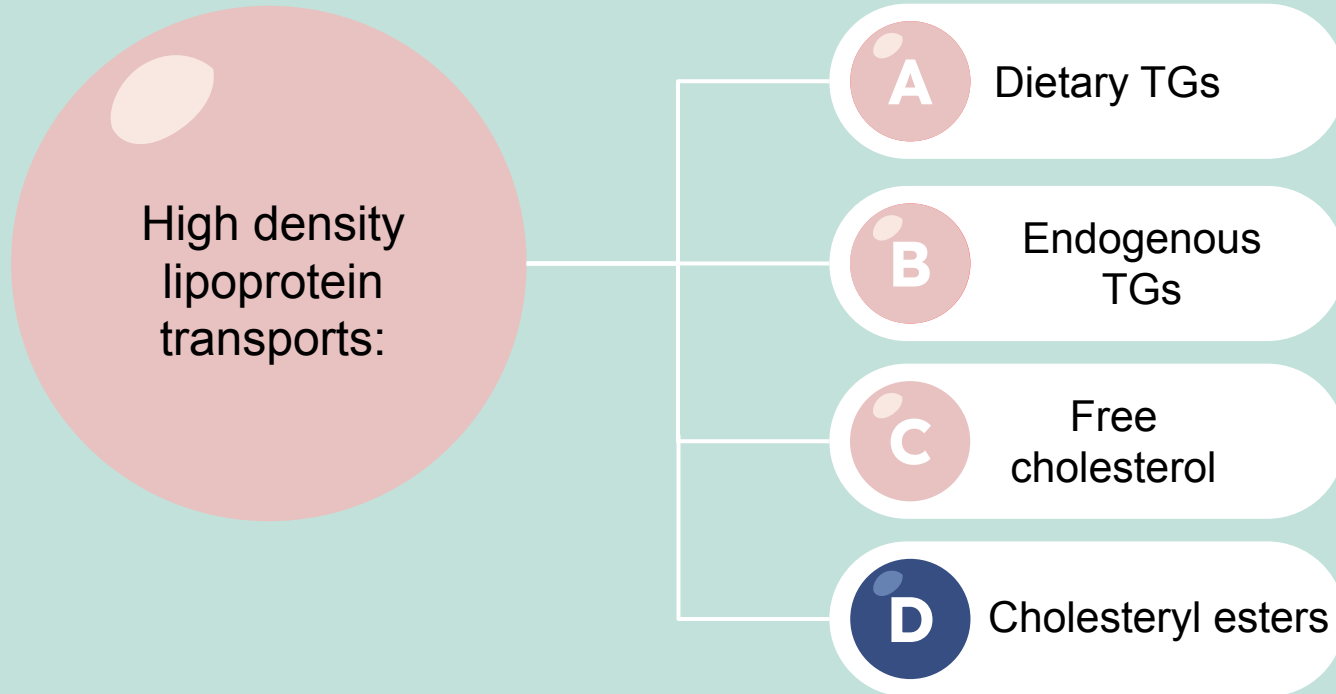
B Reducing blood pressure

D Reducing risk for heart disease

Question 4



Question 4



Question 5

Which of the following lipids isn't a component of cell membrane ?

A Cholesterol

C Both A & B

B Glycerophospholipids

D Triacylglycerol

Question 5

Which of the following lipids isn't a component of cell membrane ?

A

Cholesterol

C

Both A & B

B

Glycerophospholipids

D

Triacylglycerol

SAQ QUIZ

Q6:When do Arachidonic acid becomes essential?

when linoleic acid is deficient in the diet

Q7:What is a ceramide?

It is a fatty acid attached to sphingosine

Q8:Enumerate the types of saturated fatty acids

12:0 Lauric acid

16:0 Palmitic acid

18:0 Stearic acid

Q9:Enumerate the types of lipoproteins

Chylomicrons

VLDL

LDL

HDL

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