



Lipid Compounds of Physiological Significance

Lecture 6

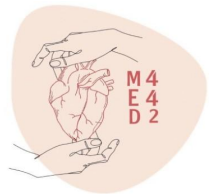
Color Index

- Girls' slides
- Boys' slides
- Doctors' notes
- Important
- Extra info

Editing File

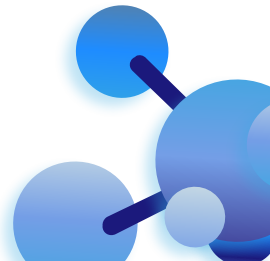


Biochemistry
442





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.
- 

What Are 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, tissue 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:

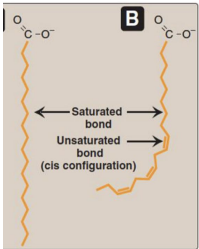
Diseases that are strongly associated with **abnormality** in **lipid metabolism**:

1. **Atherosclerosis** (fat accumulation in artery)
2. **Coronary artery disease** (fat accumulation in coronary artery)
3. **Obesity**
4. **Metabolic syndrome**
5. **Hypertension**

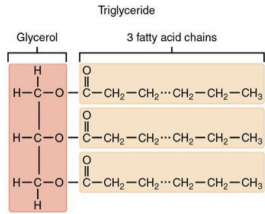
Lipid Classification

Simple lipids

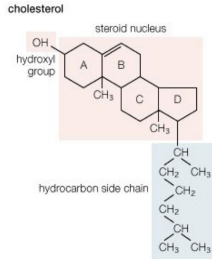
Fatty acids



Triacylglycerol



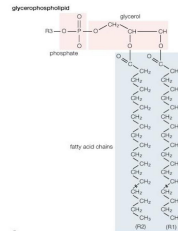
Steroids
(cholesterol)



Complex lipids

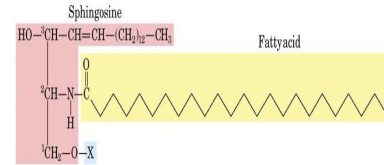
Phospholipids

Glycerophospholipids



Sphingolipids

Sphingophospholipids



Glycolipids

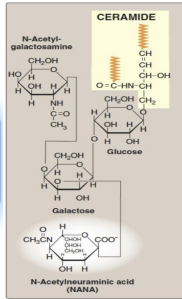
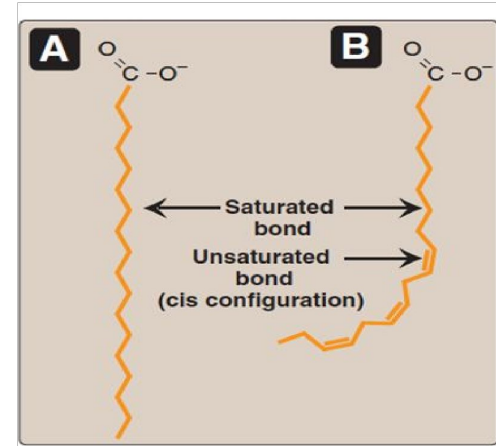


Figure 17.15 Structure of the ganglioside GM₂.

1- Fatty Acids (FAs): Simple Lipids

- 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**.

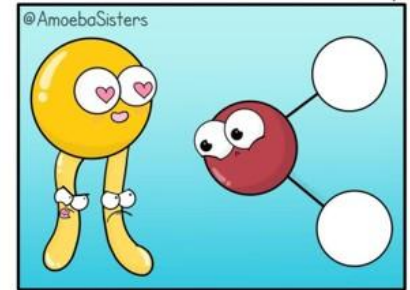


$\text{CH}_3(\text{CH}_2)_n$	COO^-
Hydrophobic hydrocarbon chain	Hydrophilic carboxyl group (ionized at pH 7)

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 Ultimate Love/Hate Relationship



Phospholipids are amphiphilic - they have polar heads and nonpolar tails.

Chain Length:

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

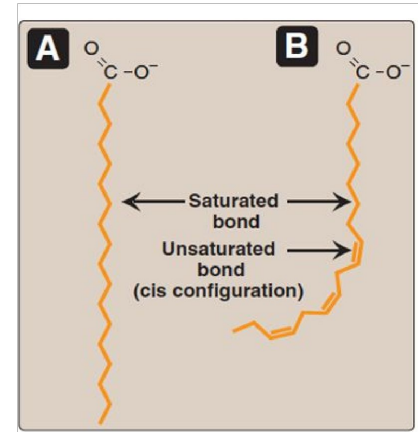
The saturated (single) bond is heavier than the unsaturated (double) bond because the carbon in saturated bond attached to 4 atoms.

Fatty Acids (FAs) Simple Lipids, Contd..

Degree of saturation:

FAs may contain:

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



439 Notes:

- Trans fatty acid " seen in unsaturated ", trans = straight , as you see in the pic .
- Cis kink fatty acids " seen in unsaturated ", kink = bending , as you see in the pic.
- Kinks means bends, they're sites where cholesterol is found. Important for membrane fluidity.

Fatty 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

16:0

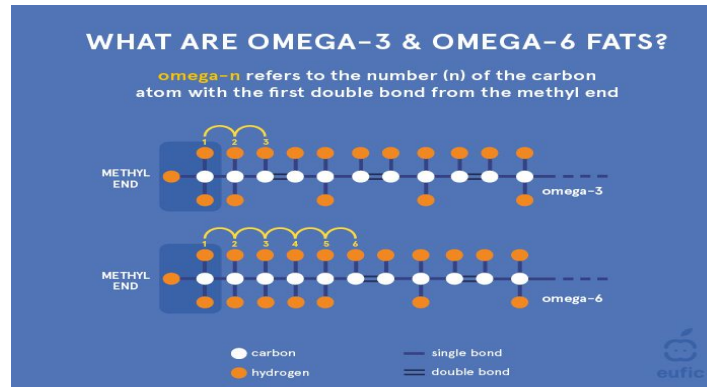
NO.of carbon atom

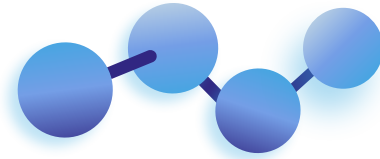
No. of double bond

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**).





Essential Fatty Acids:

ω -3 fatty acids

Long-chain **polyunsaturated** FAs with **first double bond at the 3rd carbon** from the methyl end

Reducing **serum triglycerides**, blood pressure and risk for heart disease

Major source: **fish**

α -Linolenic acid,
EPA (Eicosapentaenoic acid),
DHA (Docosahexaenoic acid).

Definition

Function

Sources

Examples

ω -6 fatty acids

Long-chain **polyunsaturated** FAs with **first double bond at the 6th carbon** from the methyl end

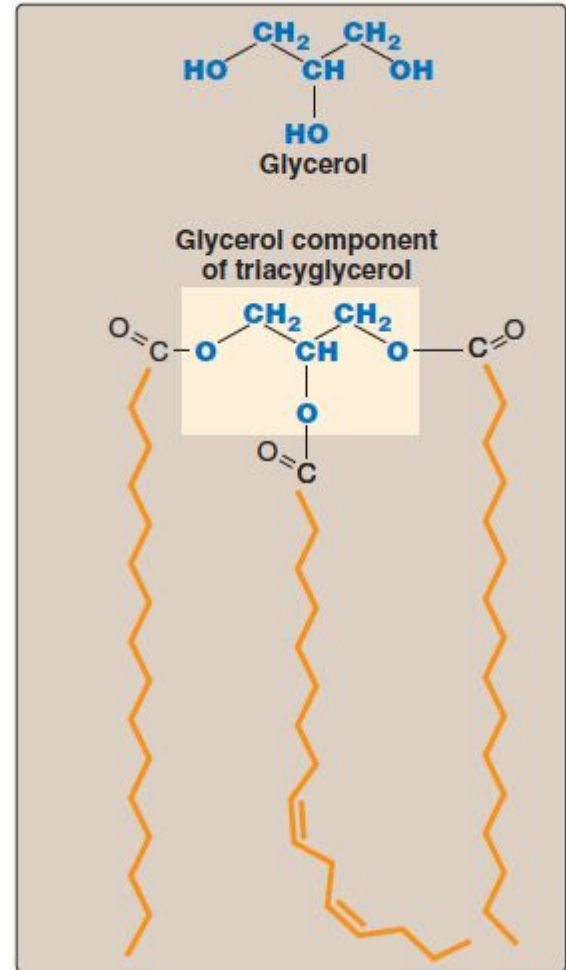
Reducing serum **cholesterol**

major source: **vegetable oils, nuts**

Linoleic acid 18:2
Arachidonic acid 20:4

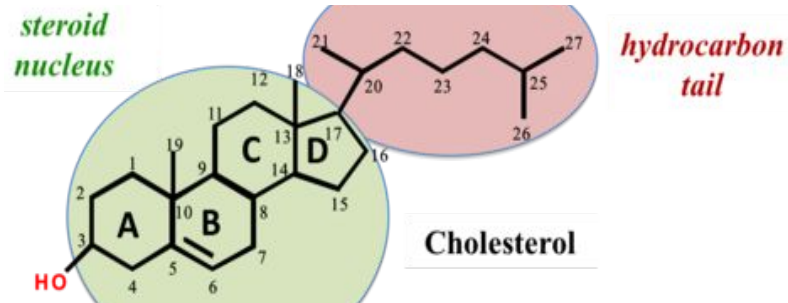
Triacylglycerols (TGs)

- **Tri-esters of fatty acids** (AKA fats)
- Composition: **3 fatty acids + 1 glycerol.**
- Constitutes majority of dietary lipids
- **Not a component** of cell membranes
- Stored in **adipocytes** (fat cells) as energy reservoir
- Subcutaneous layer of fats provides thermal insulation



Steroids

- Derivatives of cyclo-pentano-perhydro-phenanthrene
- Consists of **4 fused rings** called **steroid nucleus** with an **8-Carbon chain**.
- Steroids with -OH → Sterols.
- Steroids without -OH → Steroids.
- **Cholesterol** → major sterol in humans & animals.
- Cholesterol in plasma is bound to FAs called cholesteryl esters



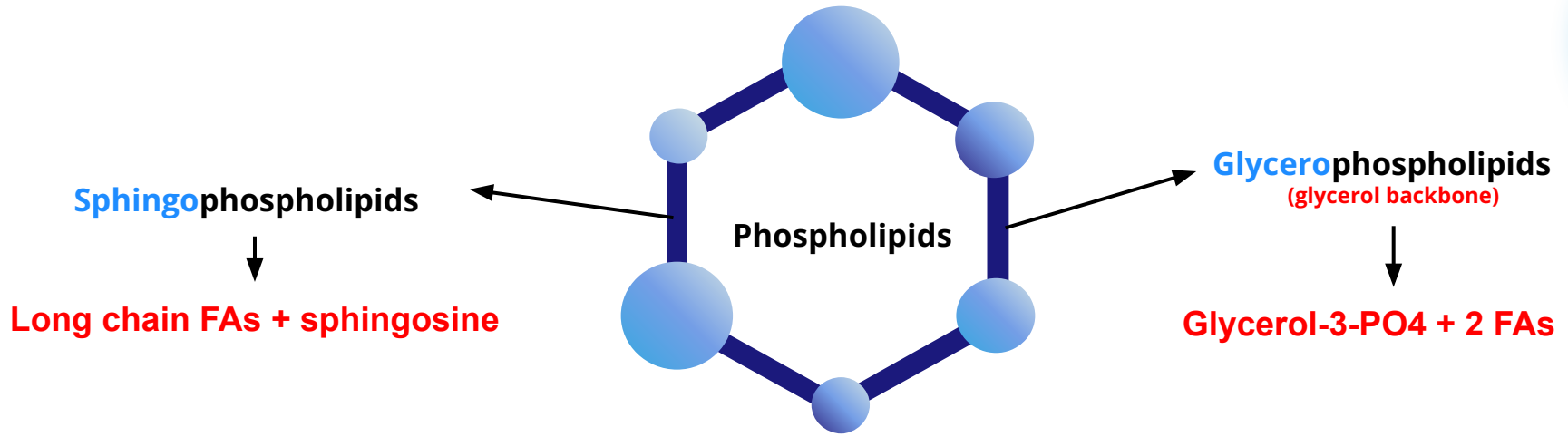
Functions of Cholesterol

Component of cell membrane
(increases its fluidity)

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

Precursor (means what it was initially) for:

- Bile acids & salts (responsible for digestion & absorption of fat)
 - Vitamin D (fat-soluble molecule)
- Steroid hormones (aldosterone, cortisol, testosterone, estrogen, progesterone)



Sphingophospholipids contains **sphingosine**

Example:

- Spingomyelin

Sphingophospholipids are important components of **myelin** that **protects and insulates nerve fibers**

The **PO4** group is linked to a **hydrophilic** group **Amphiphilic** nature:

- **Hydrophobic** tail
- **Hydrophilic** phosphoryl heads

Major components of **biological membranes**

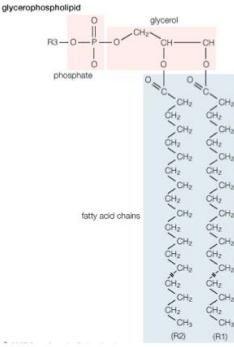
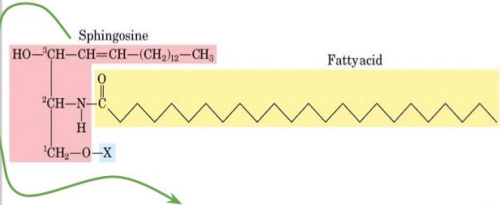
Examples:

- phosphatidic acid
- phosphatidylcholine
- phosphatidylserine

Quick Comparison

441

 **Phospholipids**
complex lipid:

	Glycerophospholipids (contain glycerol backbone)	Sphingophospholipids (contain sphingosine backbone)
Structure	<ul style="list-style-type: none"> - Glycerol - phosphate is bonded to two FAs chains - The PO₄ group is linked to a hydrophilic group (from glyc) - Amphiphilic in nature 1- Hydrophobic tail 2- Hydrophilic phosphoryl heads 	<ul style="list-style-type: none"> • Long-chain fatty acids attached to sphingosine  <p>-Notice the FA chain in sphingosine itself -FA+Sphingosine=Ceramide</p>
Function	Major components of biological membranes	An important component of myelin that protects and insulates nerve fibers
Examples	Phosphatidic acid Phosphatidyl- choline and Serine	Sphingomyelin

Glycolipids (glycosphingolipids)

- Derived from: ceramide (**long chain fatty acid** + **sphingosine**)
- Components: **Carbohydrates** + **Lipids**
- **Examples:** Ganglioside & Galactocerebroside
- **Act as:** blood group **antigens**, cell surface **receptors** for **bacteria/viruses**

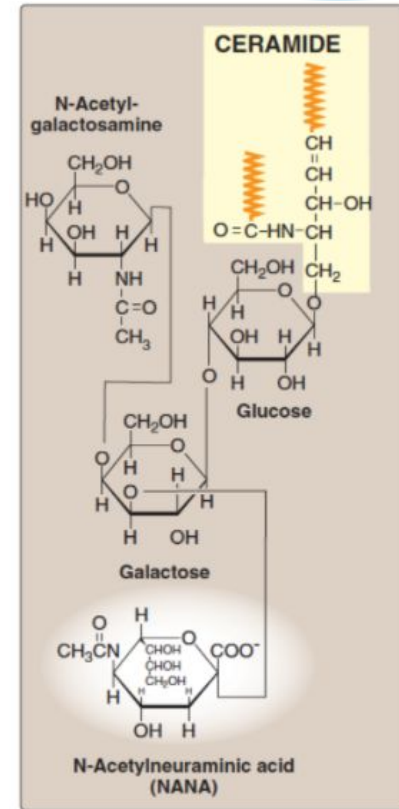
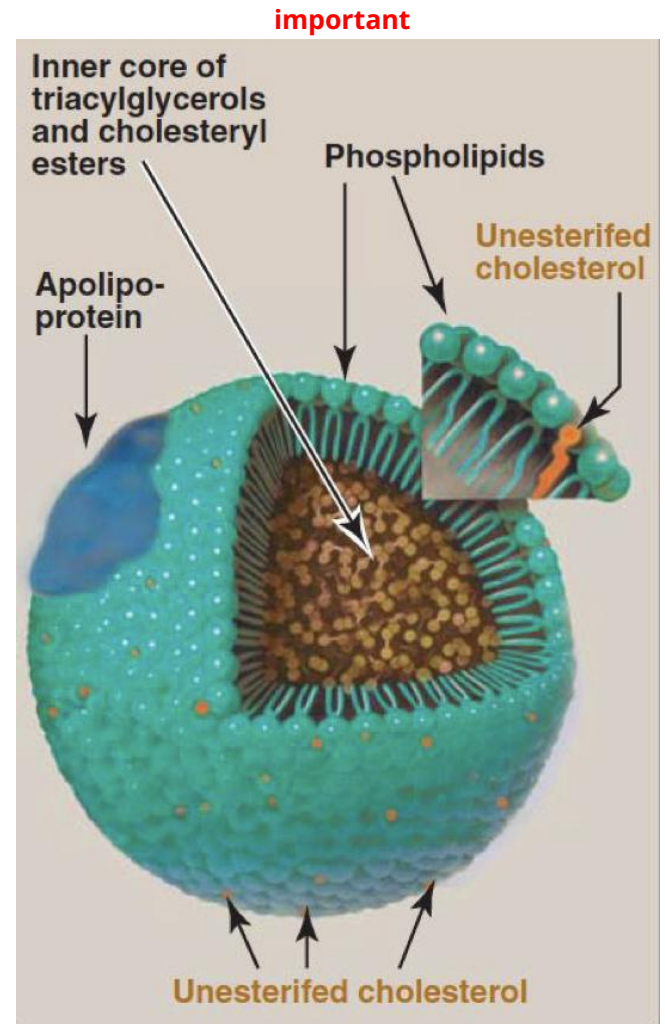


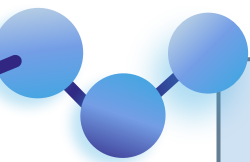
Figure 17.15
Structure of the ganglioside GM₂.

Transport of Plasma Lipids

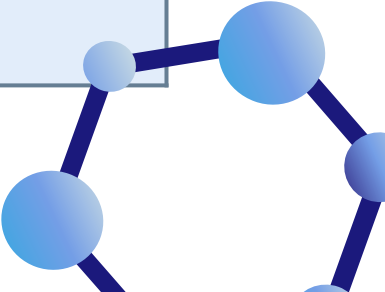
- Plasma Lipids are transported as **lipoprotein particles** (lipids + proteins)
- Protein part: **Apoproteins** or **Apolipoproteins**
- Examples: **Apolipoproteins A, B, C, E.**
- Functions: lipid transport, enzymatic functions, ligand for receptors
- Lipid part: **contains lipids of various types.**



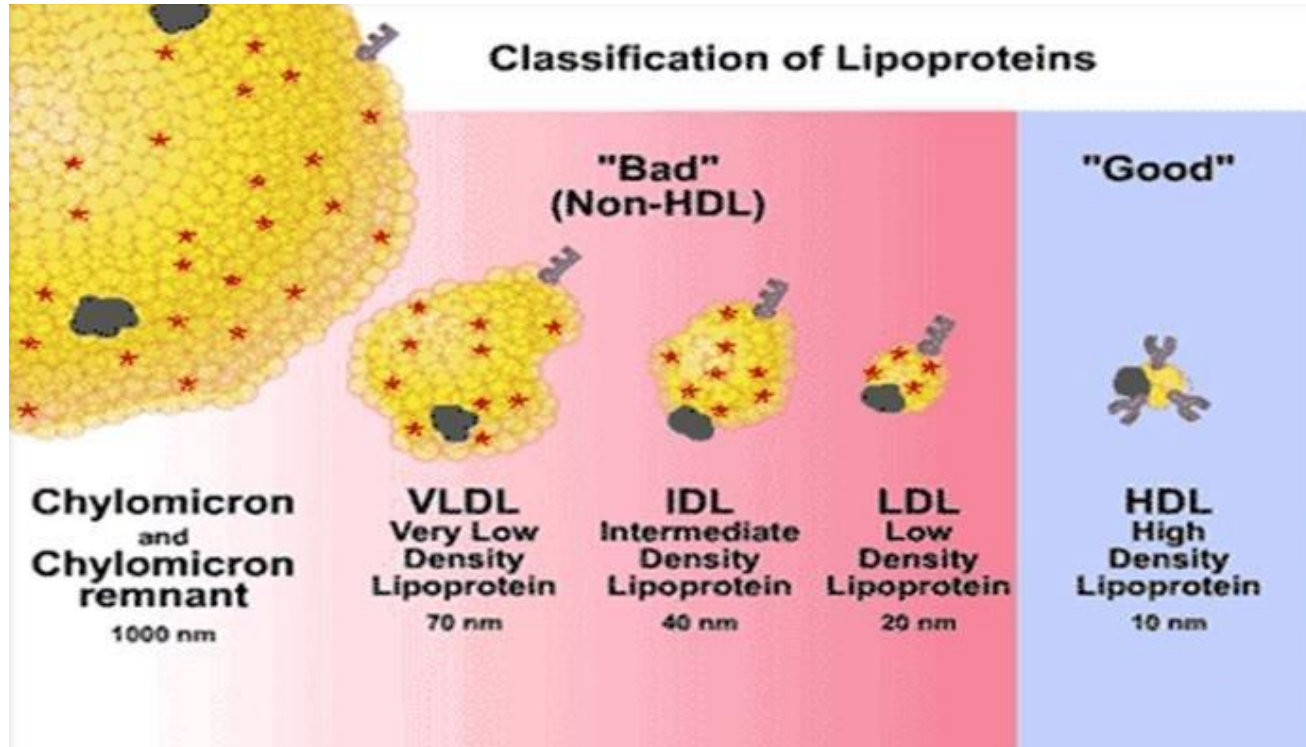
Types & Functions of Lipoproteins



Lipoprotein	What It Transports
Chylomicrons	Dietary TGs
Very Low Density Lipoprotein (VLDL)	Endogenous TGs
Low Density Lipoprotein (LDL)	Free Cholesterol
High Density Lipoprotein (HDL)	Cholesteryl Ethers

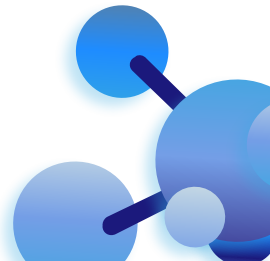


Quick Comparison





Take Home Messages

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

Quiz

1- Lipids are an essential component of which of the following?

a) cytoplasm

b) cytoskeleton

c) cell membranes

d) mitochondria

2- In mammals, the chain length varies from:

a) C12-C14

b) C10-C12

c) C14-C16

d) C16-C18

3- Which of the following is NOT an example of an ω -3 fatty acid?

a) EPA

b) Linoleic acid

c) α -Linolenic acid

d) DHA

4- Cholesterol can be a precursor for:

a) stomach acids

b) bile acids

c) Vitamin C

d) Vitamin A

5- Which of the following do high-density lipoproteins transport?

a) cholesteryl esters

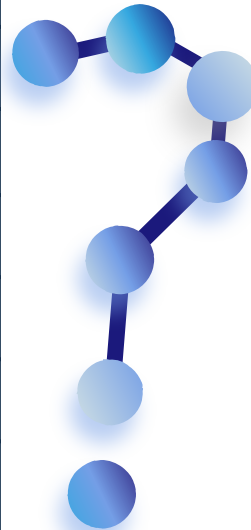
b) dietary TAGs

c) endogenous TAGs

d) free cholesterol



5. A
4. B
3. B
2. D
1. C



Our Team

Meshari Alshathri
Talal Alharbi
Azzam Alotaibi
Basel Al-Zahrani
Saleh Aldeligan
Mohammed AlGhamdi
Abdulaziz Lafy
Rayan Alahmari
Mohammed Alrobeia

Ajwan Aljohani
Mashael Alasmri
Razan Almanjomi
Razan Almohanna
Mashael Alsuliman
Reema Alhussien
Moudi Alsubaie
Renad Alayidh
Roaa Alharbi

Leaders

Sara Alsheikh & Mohammed Alshehri

 biochemksumed442@gmail.com

 slidesgo



Biochemistry
442

