جامعة الملك سعود
King Saud University

Biochemistry team 436

LIPIDS

- Color Index:

- Important.
- Extra Information.
- Doctors slides.

436 Biochemistry team

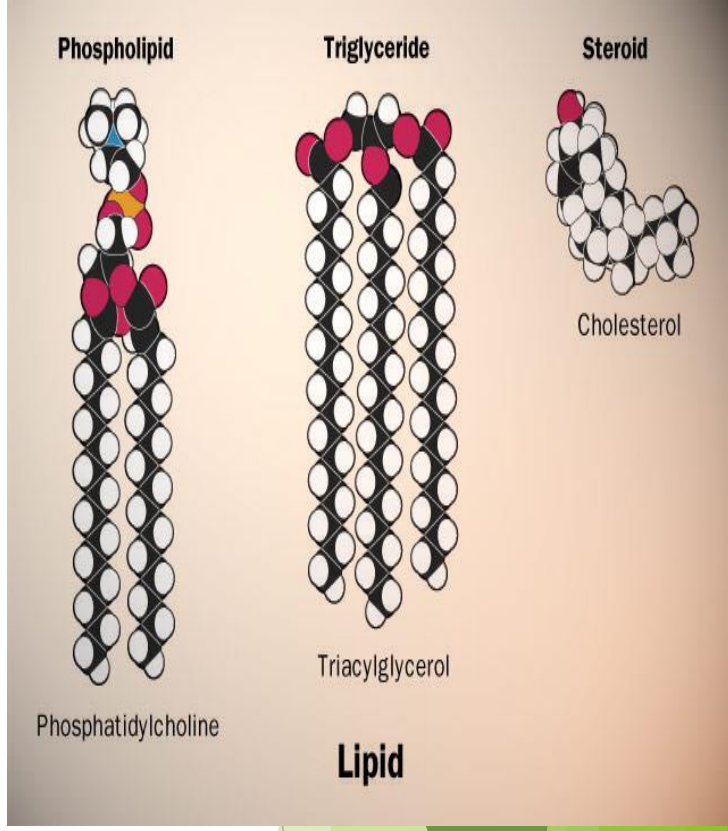
Objectives

- 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

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 = energy stores
  - Cell signaling involves lipid molecules e.g : inositol triphosphate
  - Fat-soluble vitamins , steroid hormones and prostaglandins are formed of lipids

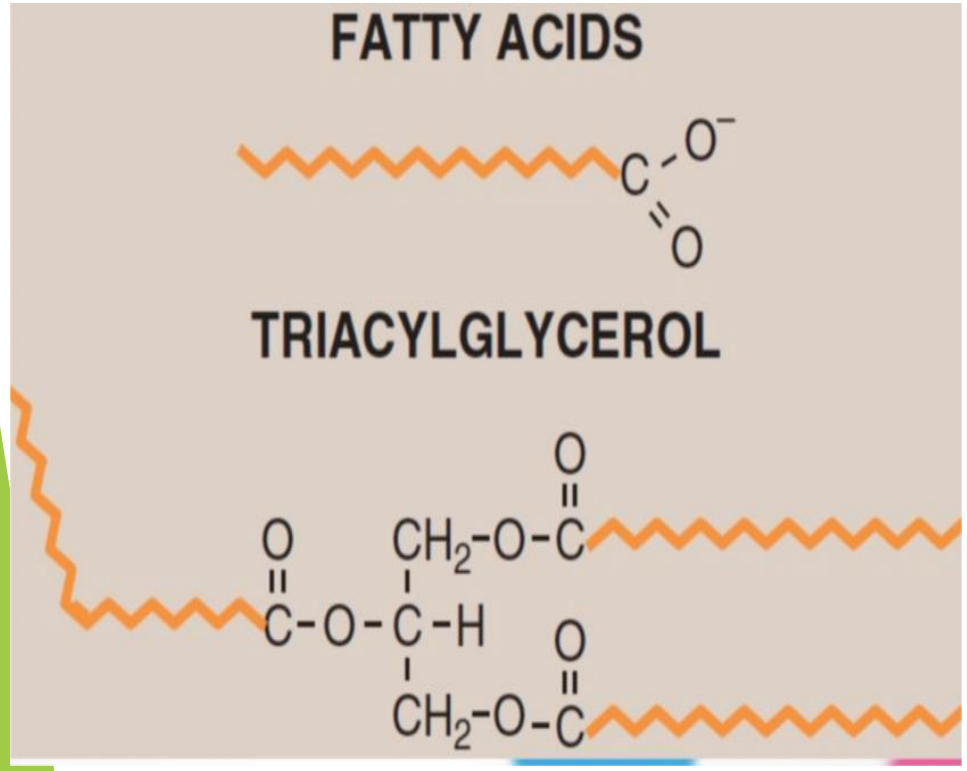
اللبيد تعطينا طاقة ضعف الكربوهيدرات



- Lipids and disease
  - Disease that are strongly associated with abnormal in lipids metabolism:
    - Metabolic syndrome
    - Obesity
    - Hypertension
    - Heart disease
      - Coronary artery disease
      - Atherosclerosis

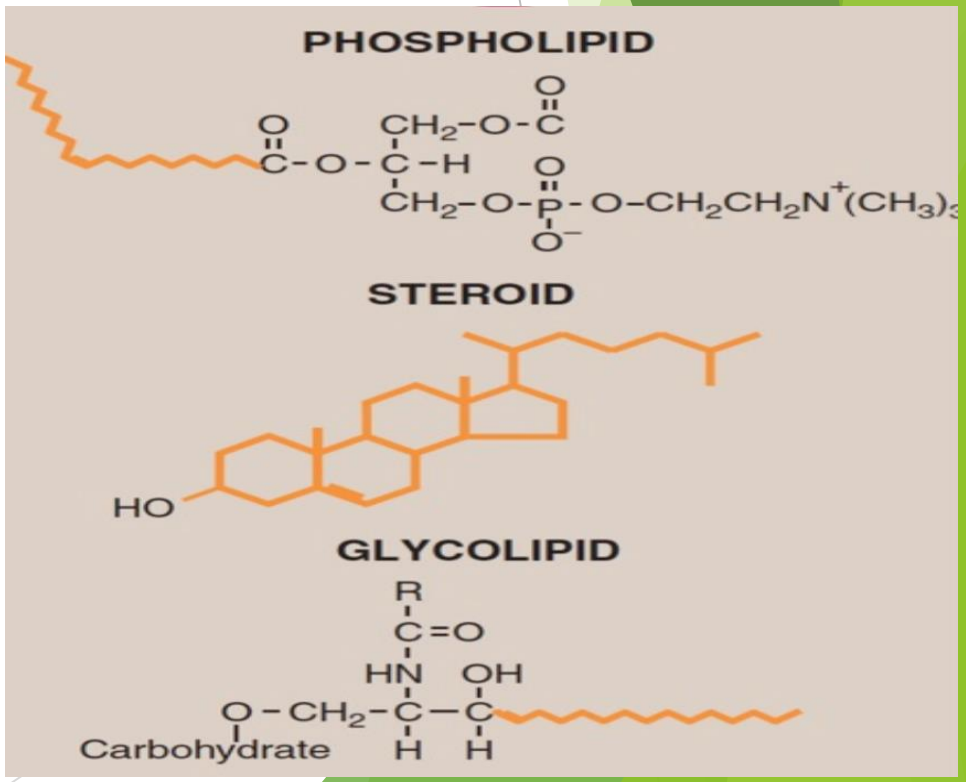
Classification of lipids

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



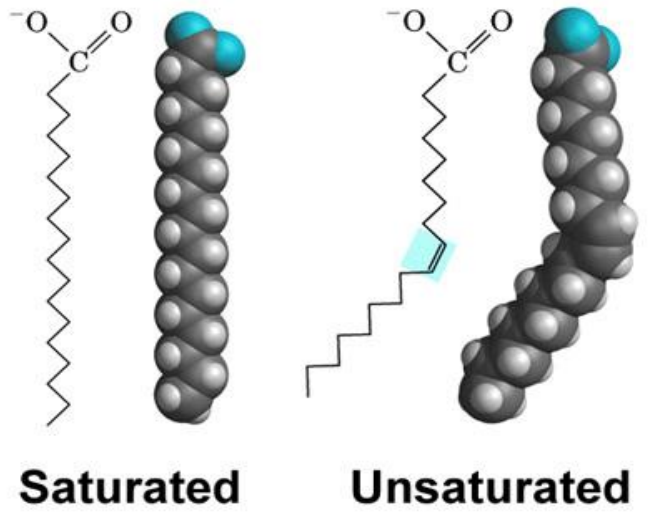
The lipids compound is heterogeneous group

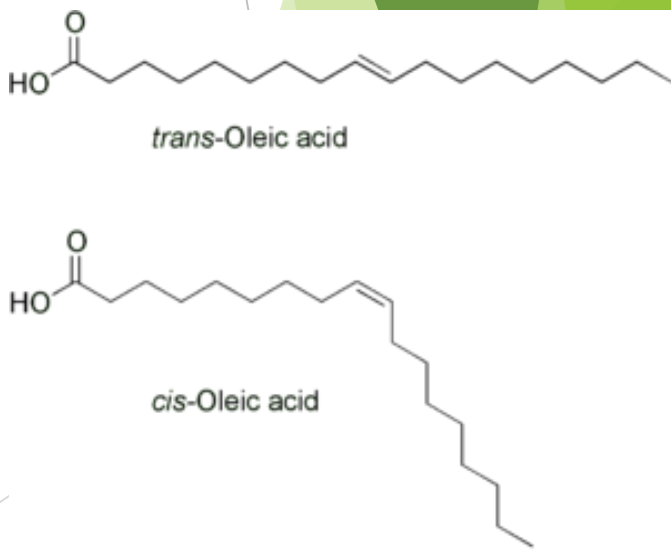
Glycolipids are lipids with a carbohydrate attached by a glycosidic bond.



Fatty Acids (FAs)

- FAs are carboxylic acid and long-chain of hydrocarbon.
- Amphipathic (hydrophobic tails and hydrophilic head).
- The hydrocarbon chain is hydrophobic.
- The carboxylic group(COOH) is hydrophilic.
- Insoluble in water.
- FAs must be transported in plasma via proteins (Albumin is an example of fatty acid transporter).
- The majority of plasma FAs are esters of (Triacylglycerol, Cholesterol, and Phospholipids).
- The FAs chain length in mammals it differs from C16-C18
- For example: palmitic, oleic and stearic acids





Degree of Saturation (مدى التشبع)

FAs may contain:

- No double bonds (saturated – trans form).
- One or more double bonds (mono or poly unsaturated – cis form).

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

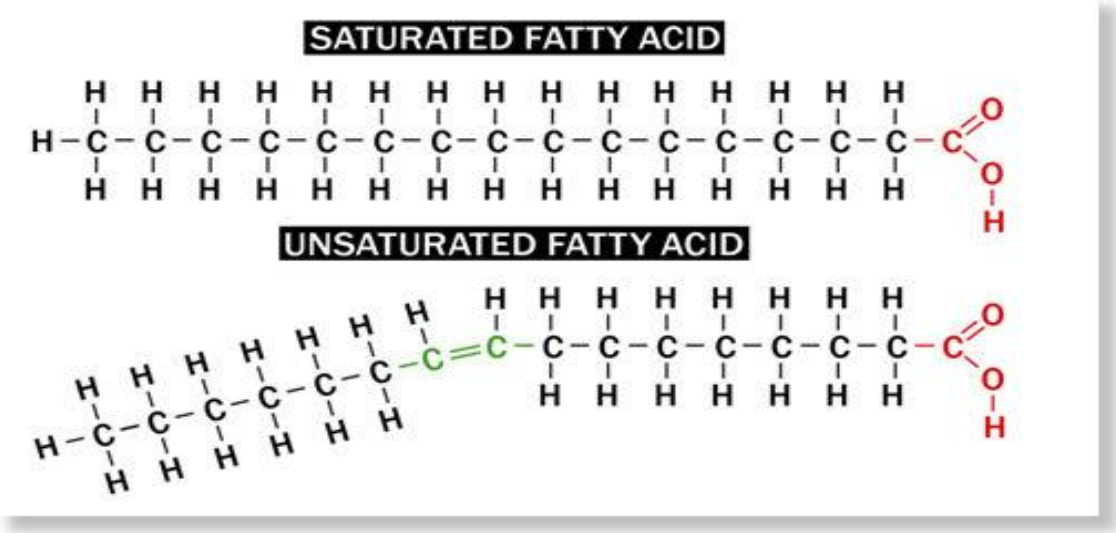


Figure 16.3
A saturated (A) and an unsaturated (B) fatty acid. Orange denotes hydrophobic portions of the molecules. [Note: Cis double bonds cause a fatty acid to "kink."]

لو كان عندي أكثر من رابطة ثنائية بالليبيد راح يكون بين كل وحدة واللي بعدها ثلاث كربونات بمعنى 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

دائما تكون (0) في حال كان الFA **مشبع..**

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, membrane function loss .
- Linoleic acid (precursor of arachidonic acid).

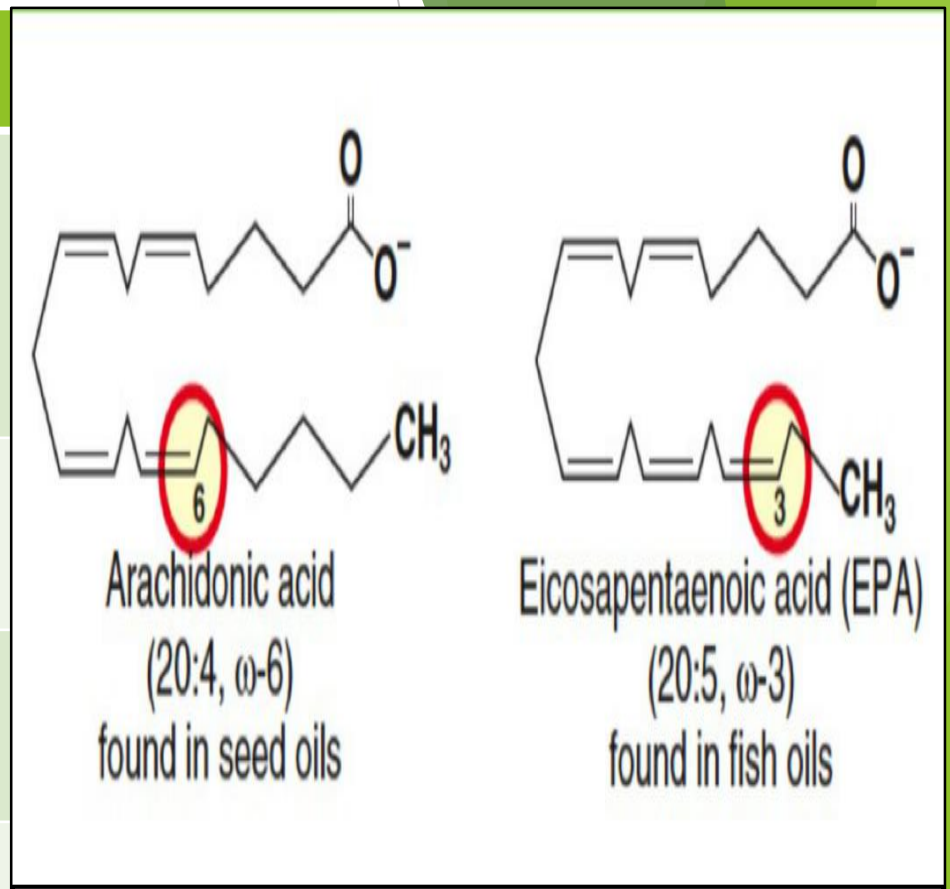
That means that Arachidonic acid is non essential so our bodies can produce it when Linoleic acid is present .

But actually Arachidonic acid is considered as conditional fatty acid because …

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

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

W-3	W-6
Long chain polyunsaturated FA's with first double bond starting with **third carbon** from the methyl end	Long chain polyunsaturated with first double bond starting with the **sixth carbon** from the methyl end
They reduce serum triglycerides, blood pressure and risk for heart disease	They 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



نبدأ البحث عن ذرة الكربون التي تحمل "Double bond" من الجهة البعيدة عن (C=O).
اذا كانت الذرة الثالثة ----> Omega-3
اذا كانت الذرة السادسة ----> Omega-6

Triacylglycerols (TGs)

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

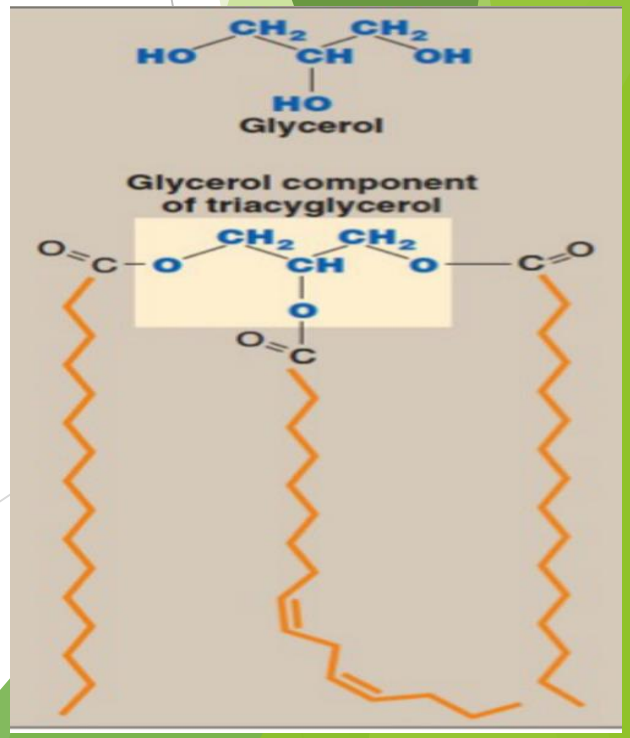
-A triglyceride (TGs) Are tri-ester** of fatty acid With a glycerol molecule bounded to them.

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

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

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

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



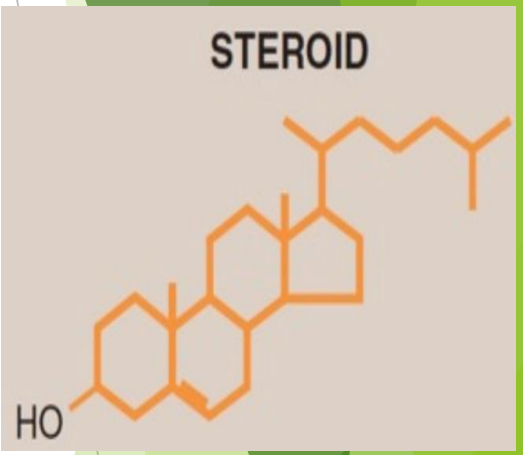
*also called triacylglycerol
**tri-ester means 3 ester, ester is a fatty acid with alcohol (in this case the alcohol is glycerol)
***reservoir: مخزن
**** تشكل طبقة تحت الجلد تعمل كعازل حراري تحمي الجسم من البرودة

Steroids

Steroids 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



- 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)

Functions of cholesterol

- Component of cell membranes

- Precursor for:
  - Bile acids / Bile salts
  - Vitamin D
  - Steroid hormones (Aldosterone, cortisol, testosterone, estrogen, progesterone)

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

- Major components of biological membranes.
- Examples:
  Phosphatidic acid , phosphatidyl – choline and serine.

Phospholipids

Tow classes:

Glycerophospholipids
(Contain glycerol backbone)

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

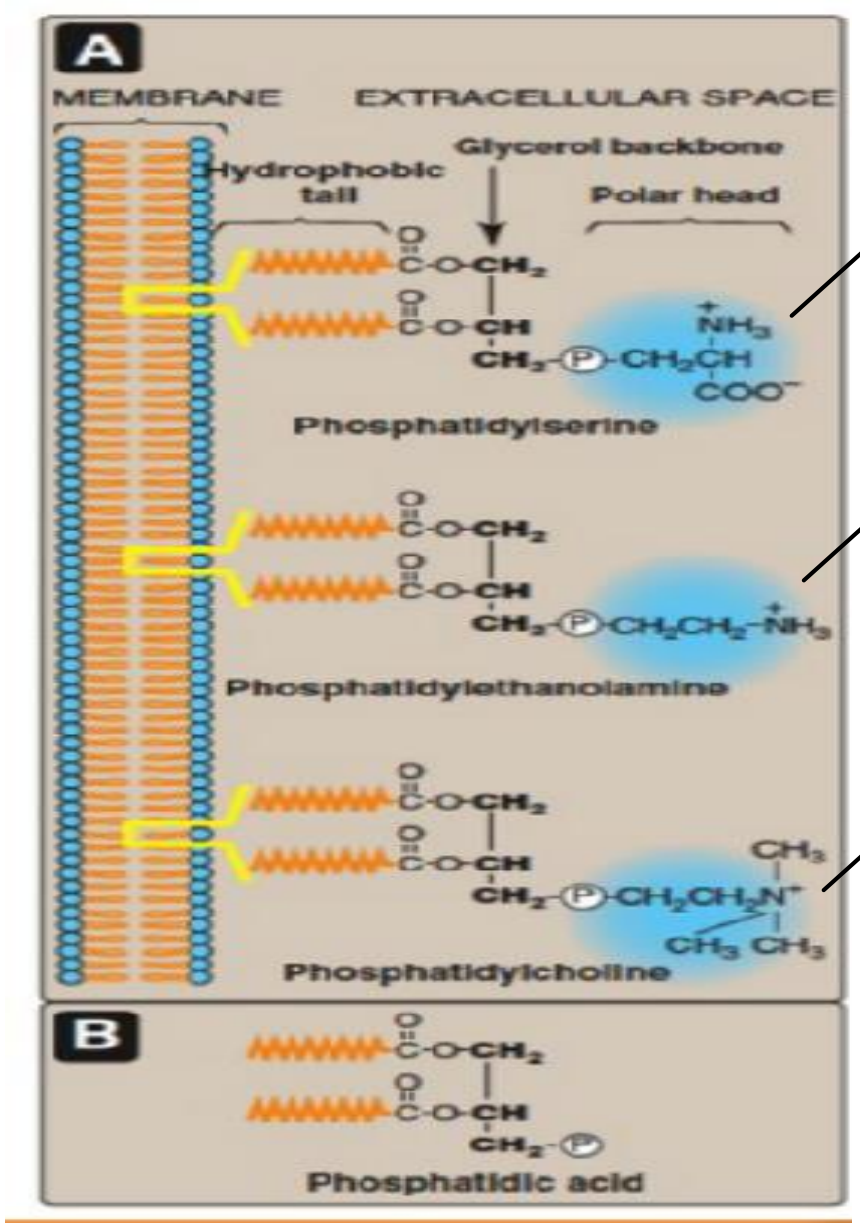
Sphingophospholipids
(Contain Sphingosine)

- Long-chain fatty acids attached to sphingosine.

Example: Sphingomyelin.
*An important component of myelin that protects and insulates nerve fibers *axons*.
* Sphingomyelin is the only type of Sphingophospholipids in human.

Glycerophospholipids

*You don't have to memorize the structure



Serine

Ethanolamin

Choline

Sphingophospholipids

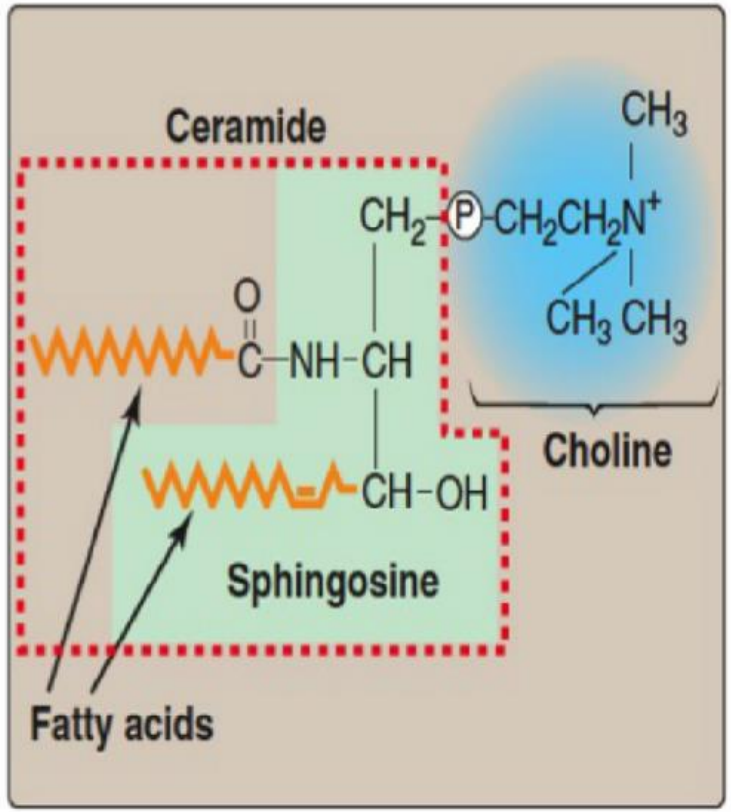


Figure 17.4
Structure of sphingomyelin, showing sphingosine (in green box) and ceramide components (in dashed box).

Glycolipids (glycosphingolipids)

- Contain both carbohydrate and lipid components.
- glycolipids are derivatives of ceramides (A long-chain fatty acid is attached to the amino alcohol sphingosine. Also called glycoshpingolipids).

Examples: Ganglioside, glactocerebroside.

- Act as : blood group antigens , cell surface receptors for bacteria and viruses.
- glycosphingolipids are essential components of all membranes in the body, but they are found in great amounts in nerve tissue

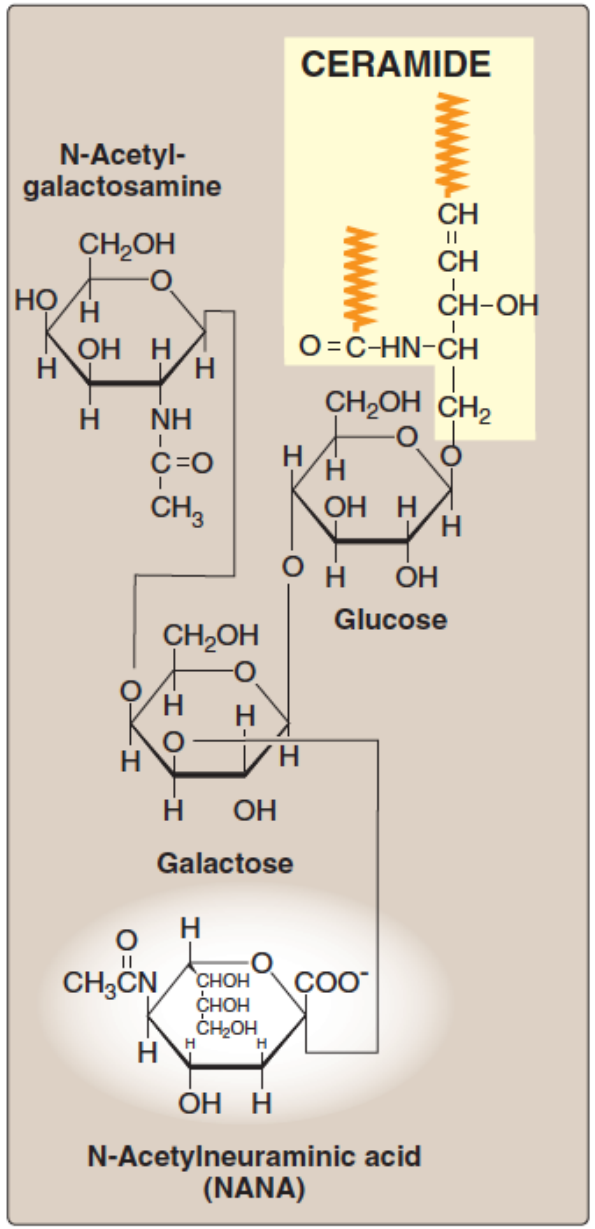
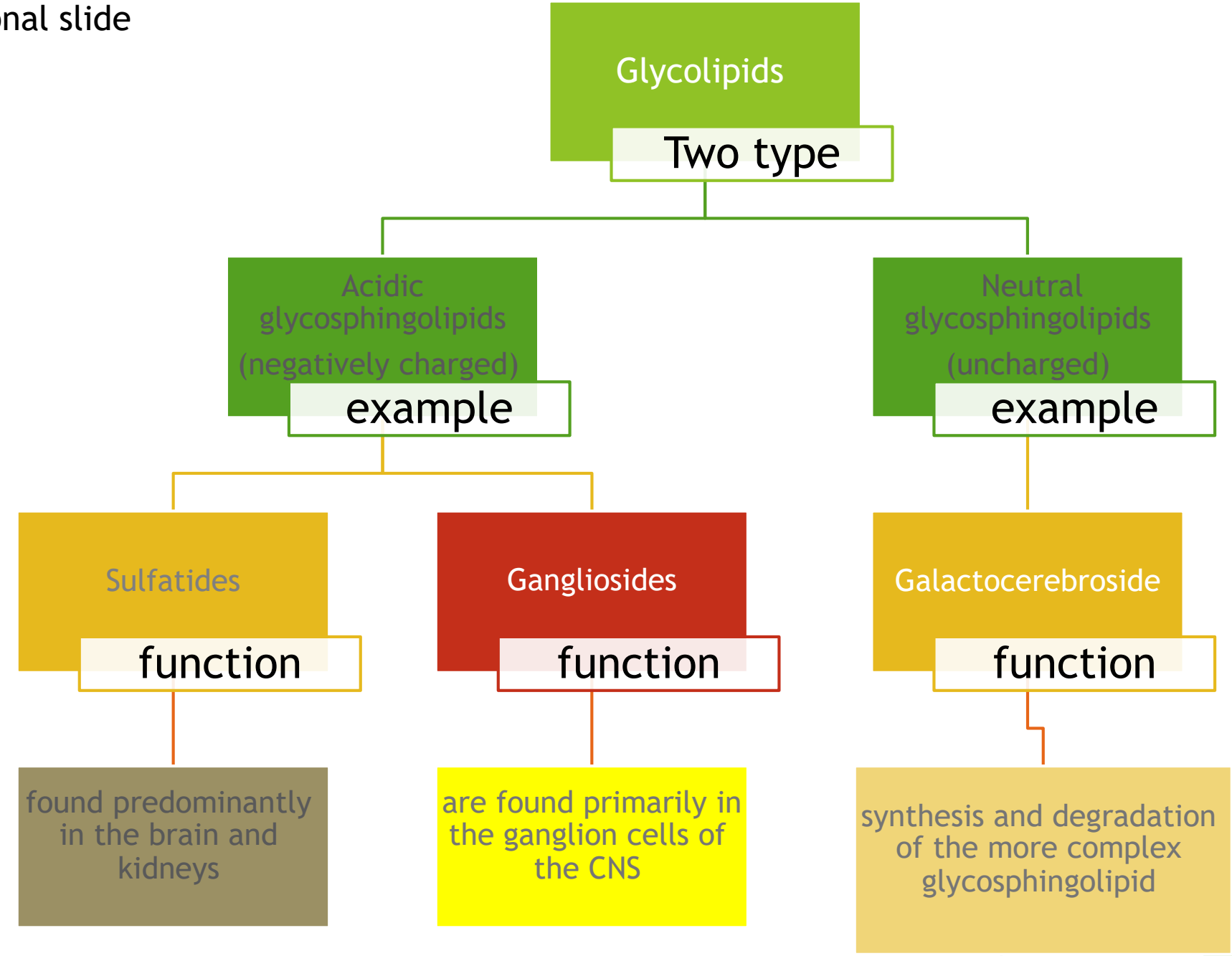


Figure 17.15
Structure of the ganglioside G_{M2}.

*Additional slide



Transport of plasma lipids

definition	• Plasma lipids are transported as lipoprotein particles (lipids + protein)
Protein part	• Apoprotein or Apolipoprotein
examples	• apolipoprotein A,B,C
Function	• Lipid transport, enzymatic function, ligands for receptor
lipid part	• Contains lipids of various types
Apolipoprotein	• The apolipoproteins associated with lipoprotein particles have a number of diverse functions, such as providing recognition sites for cell-surface receptors and serving as activators or coenzymes for enzymes involved in lipoprotein metabolism.

Lipoproteins are composed of a neutral lipid core (containing triacylglycerol [TAG] and cholesteryl esters) surrounded by a shell of amphipathic apolipoproteins

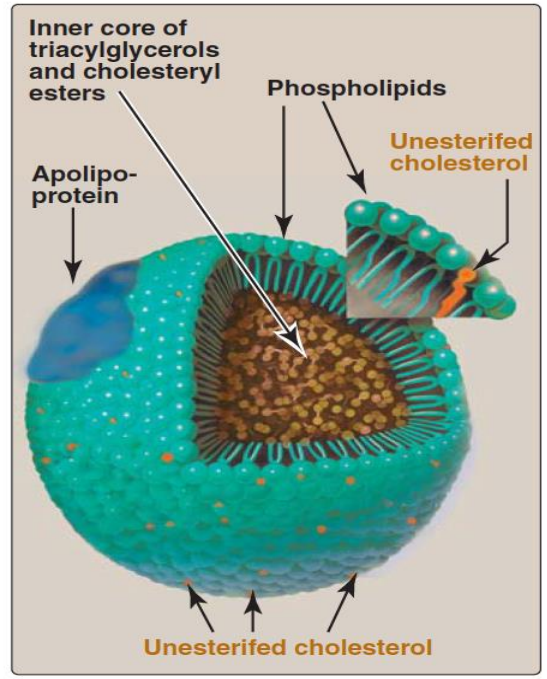


Figure 18.14
Structure of a typical lipoprotein particle.

Types and function of lipoprotein

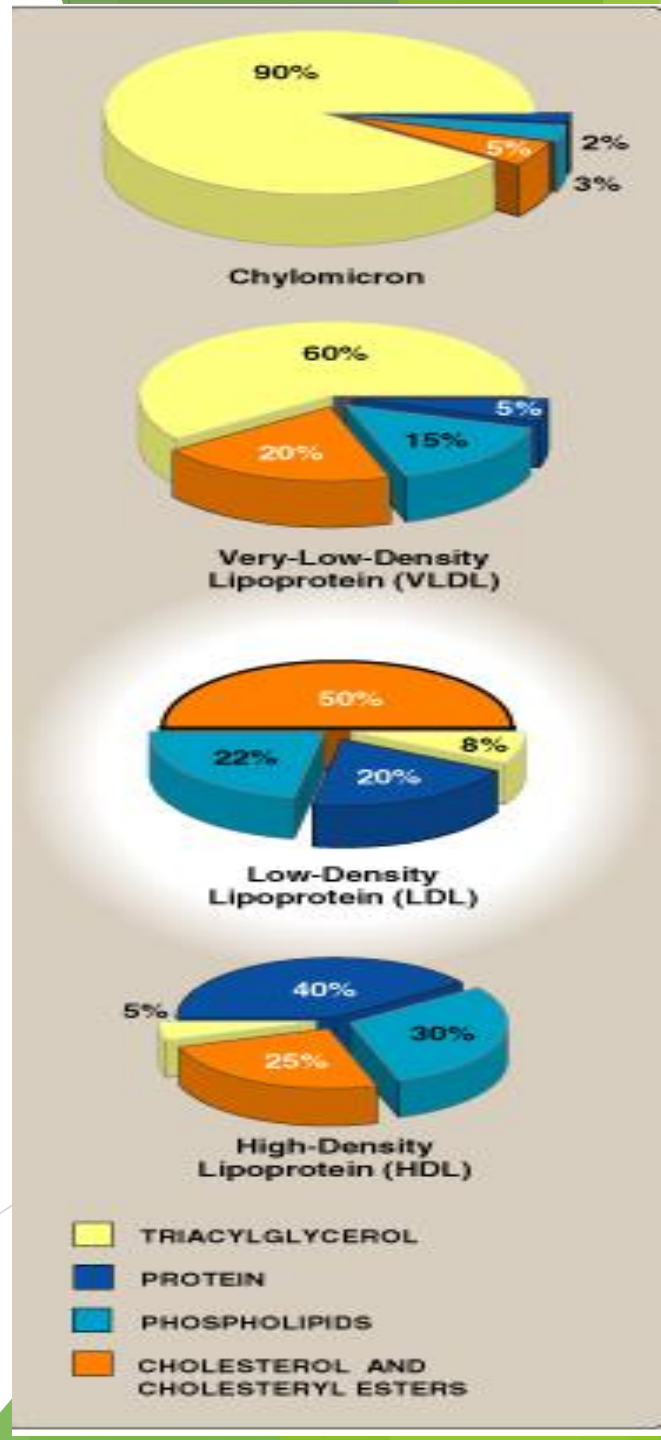
*You have to know the majority of every Lipoprotein

Lipoprotein	Transports	Majority
Chylomicrons	Dietary TGs	Triacylglycerol
Very low density lipoprotein (VLDL)	Endogenous TGs	Triacylglycerol
Low density lipoprotein (LDL)	Free cholesterol	Cholesterol
High density lipoprotein (HDL)	Cholesteryl esters	Protein

The more Triacylglycerol are there the size is bigger and the density is low.

Density is how viscous or how fatty the substance is.

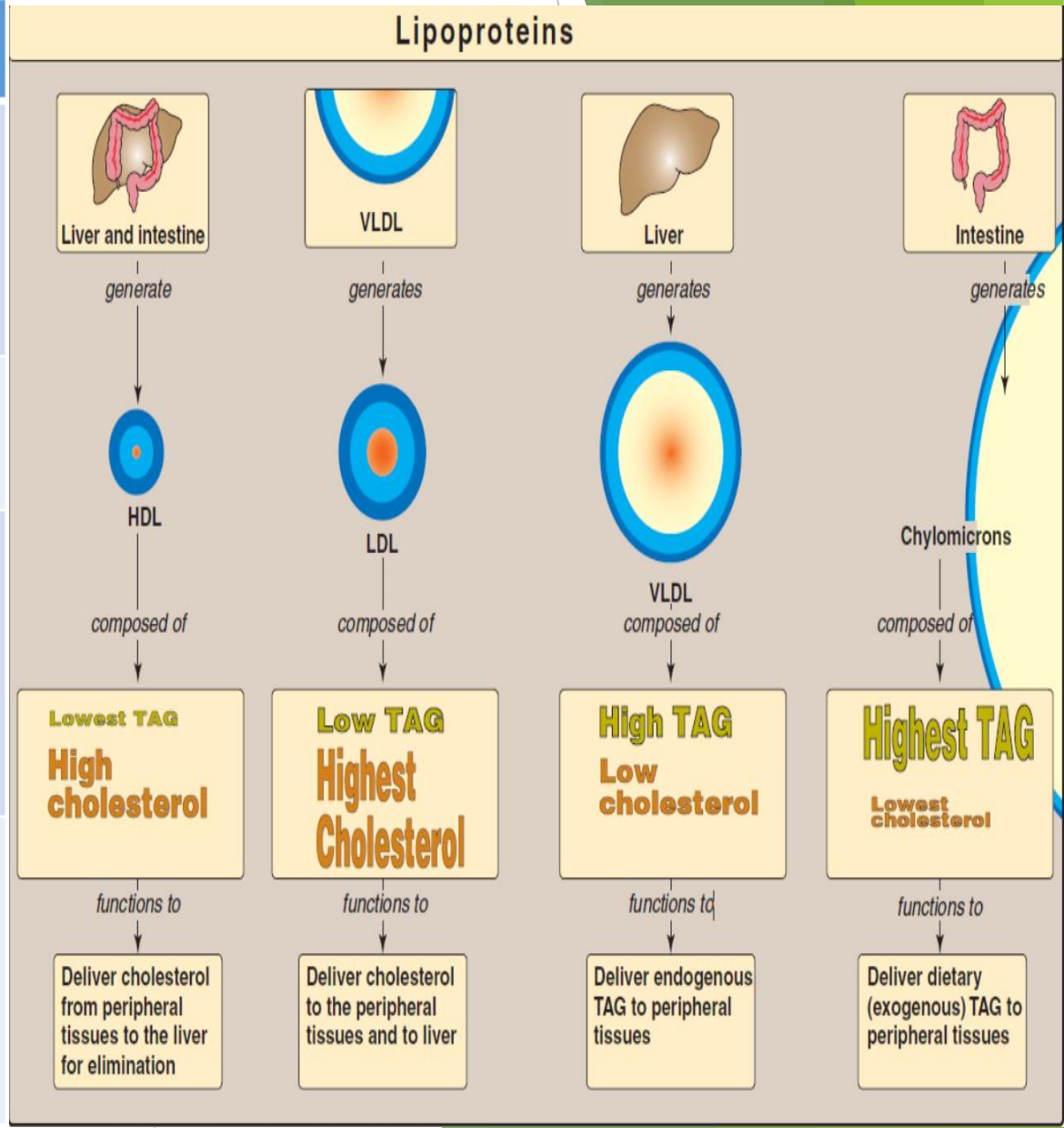
HDL they are the heaviest and the highest density and the smallest in size.
Chylomicron they are the biggest in size and the lowest density.



*Additional slide

Types and function of lipoprotein

Lipoprotein	Where it is made	Main component(s)	Main function
Chylomicron	Small intestine	Triglyceride, also some cholesterol and fat soluble vitamins	• Deliver dietary fat from the small intestine to the cells. • Bring dietary cholesterol to the liver.
VLDL-cholesterol	Liver	Triglyceride (mostly), cholesterol	• Transport lipid from the liver to the cells.
LDL-cholesterol (the "bad" cholesterol)	Remnant of VLDL that forms in the blood as VLDL loses its triglyceride content	Cholesterol (mostly), triglyceride	• Transport cholesterol (dietary and cholesterol made by the body) to the cells.
HDL-cholesterol (the "good" cholesterol)	Liver (mostly), we also make some in the small intestine	Protein (mostly)	• Cholesterol "scavenger" that picks-up cholesterol from cells and tissue. HDL brings cholesterol back to the liver so that it can eventually be excreted.



MCQs + vedios

4-d

3-a

2-b

1-b

1- What statement from the following is false.

a. Atherosclerosis can be caused by lipids

b. The carboxylic group in fatty acids is hydrophobic

c. Lipids store energy d. Fatty acids are amphipathic

2- the fatty acid chain length in mammals varies between.

a. c12-c19 **b. c16-c18** **c. c17-c19** **d. c14-c16**

3- what is the major source of w-3 .

a. Fish **b. Chicken** **c. Nuts** **d. Dairy products**

4- What statement is false about lipoprotein's functions.

a. Ligands for receptors **b. lipid transport** **c. enzymatic functions** **d. lipid protection**

- https://youtu.be/H8WJ2KENlK0?t=6m56s
- https://www.youtube.com/watch?v=O9lL2KStW9s

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2- محمد حكمي.
3- خالد الراجح.
4- محمد حبيب.
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