

LIPIDS OF PHYSIOLOGICAL SIGNIFICANCE

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- 436 Notes
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- Extra information

رابط التعديل:

<https://docs.google.com/document/d/1WvdeC1atp7J-ZKWOUkSLsEcosjZ0AqV4z2VcH2TA0/edit?usp=sharing>



Biochemistry team 438

Objectives:

- Slides (3,4) **1. Define and classify lipids**
- Slide No. 3 **2. Understand the physiological importance of lipids**
- Slide No. 4 **3. List the examples of simple and complex lipids**
- 4. Correlate implications of lipids in clinical conditions**



Objective 1: Define lipids.

Objective 2: Understand the physiological importance of lipids

Lipids

What are lipids?	Function of lipids	Lipids and diseases
<ul style="list-style-type: none">▪ 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	<ul style="list-style-type: none">▪ Lipids are essential components of biological membranes (phospholipid)▪ Lipids with hydrocarbon chains serve as major energy stores (fat)<ul style="list-style-type: none">▪ Cell signaling involves lipid molecules e.g. Inositol tri-phosphate (IP3)▪ Fat-soluble vitamins (A, D, E,K), steroid hormones and prostaglandins* are formed of lipids	<p>Diseases that are strongly associated with <u>abnormality</u> in lipid metabolism:</p> <ol style="list-style-type: none">1) Atherosclerosis2) Coronary artery disease3) Obesity4) Metabolic syndrome5) Hypertension

Notes:

- heterogeneous means that's it's composed of different units (not a polymer)
- Prostaglandins means that it has hormone-like functions

Fatty Acids (FAs)

Characteristics	Essential Fatty Acids				
<ul style="list-style-type: none"> ▪ FAs are carboxylic acids with long-chain hydrocarbons side groups ▪ They are amphipathic in nature (both hydrophilic and hydrophobic): <ul style="list-style-type: none"> -The carboxylic group(COOH) is hydrophilic -The hydrocarbon chain is hydrophobic ▪ FAs are highly insoluble in water ▪ Must be transported in plasma with proteins (eg. Albumin) ▪ Majority of plasma FAs are esters* of: Triacylglycerol - Cholesterol - Phospholipids ▪ <u>Chain length</u>: In mammals it varies from C16 - C18. ▪ Examples of fatty acids: Palmitic – Oleic – linoleic – stearic acids. 	<ul style="list-style-type: none"> ▪ Body <u>cannot</u> synthesize ▪ Must be supplied in the diet ▪ Deficiency can cause <u>dermatitis</u>, membrane function loss ▪ Examples: <ol style="list-style-type: none"> 1) Linoleic acid (precursor of arachidonic acid) 2) a-Linolenic acid (انتبهوا على الحرف الزايد) <p style="text-align: center;">conditional</p> <p>(Arachidonic acid is essential when linoleic acid is deficient in the diet)</p> <table border="1" data-bbox="1112 625 1648 812" style="margin-left: auto; margin-right: auto;"> <tr> <td style="text-align: center;">CH₃(CH₂)_n</td> <td style="text-align: center;">COO⁻</td> </tr> <tr> <td style="text-align: center;">Hydrophobic hydrocarbon chain</td> <td style="text-align: center;">Hydrophilic carboxyl group (ionized at pH 7)</td> </tr> </table>	CH₃(CH₂)_n	COO⁻	Hydrophobic hydrocarbon chain	Hydrophilic carboxyl group (ionized at pH 7)
CH₃(CH₂)_n	COO⁻				
Hydrophobic hydrocarbon chain	Hydrophilic carboxyl group (ionized at pH 7)				

Notes:

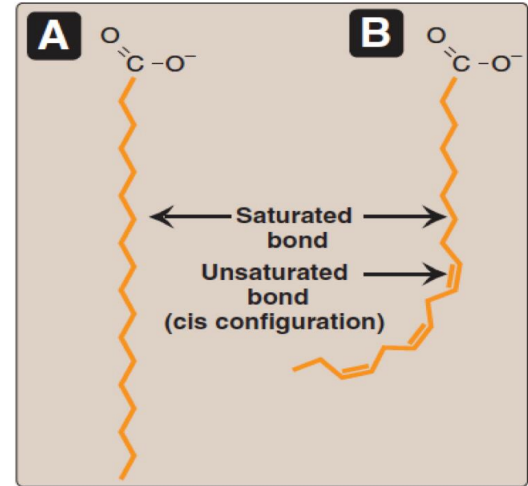
- **Triacylglycerol** and **cholesterol** → **Alcohol** (most common glycerol)

Degree of saturation

FAs may contain:

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

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



16:0

↙ ↘

No. of carbon atoms Zero double bonds

20:4

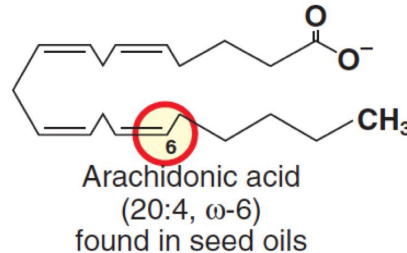
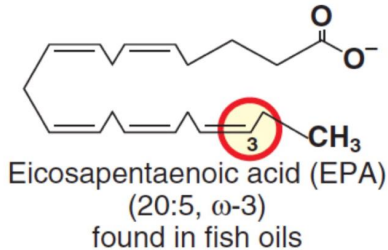
↙ ↘

No. of carbon atoms Four double bonds

Note:
Trans (saturated) is in a solid form (no kinks) meanwhile **Cis** (unsaturated) is in a liquid form (with kinks)

w -3 and w-6 fatty acids (w = Omega)

W-3	W-6
<ul style="list-style-type: none">▪ Long-chain poly unsaturated FAs with first double bond starting with 3rd carbon from the methyl end▪ They <u>reduce</u> serum triglycerides, blood pressure and risk for heart disease▪ Major source: Fish▪ Examples:<ol style="list-style-type: none">1) a-linolenic acid2) EPA (eicosapentaenoic acid)*3) DHA (Docosahexaenoic acid)*	<ul style="list-style-type: none">▪ Long-chain poly unsaturated FAs with first double bond starting with 6th carbon from the methyl end▪ They <u>reduce</u> serum cholesterol▪ Major source: Vegetable oils, nuts▪ Examples:<ol style="list-style-type: none">1) Linoleic acid 18:2



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

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Note:
In the exam they will give the abbreviation so no need to memorize the name for EPA and DHA

Triacylglycerols (TGs)

Definition

Three **fatty acids** (tri-ester) are bonded to a **glycerol** molecules are called triacylglycerole * also known as **fat**.

*also called **triglyceride**

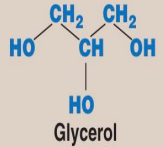
****reservoir** : مخزن

*** تشكل طبقة تحت الجلد تعمل كعازل حراري يحمي الجسم من البرودة

- Constitutes majority of **dietary lipids**. معظم الدهون في غذائنا من هذا النوع.
- Stored in adipocytes (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 membranes.**
- Subcutaneous layer of fats provides thermal insulation ***.



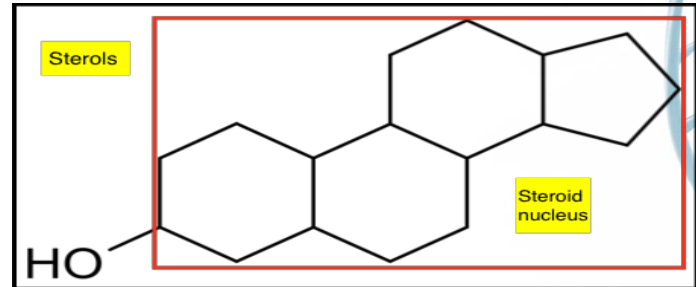
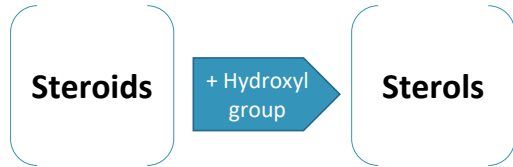
Glycerol component of triacylglycerol

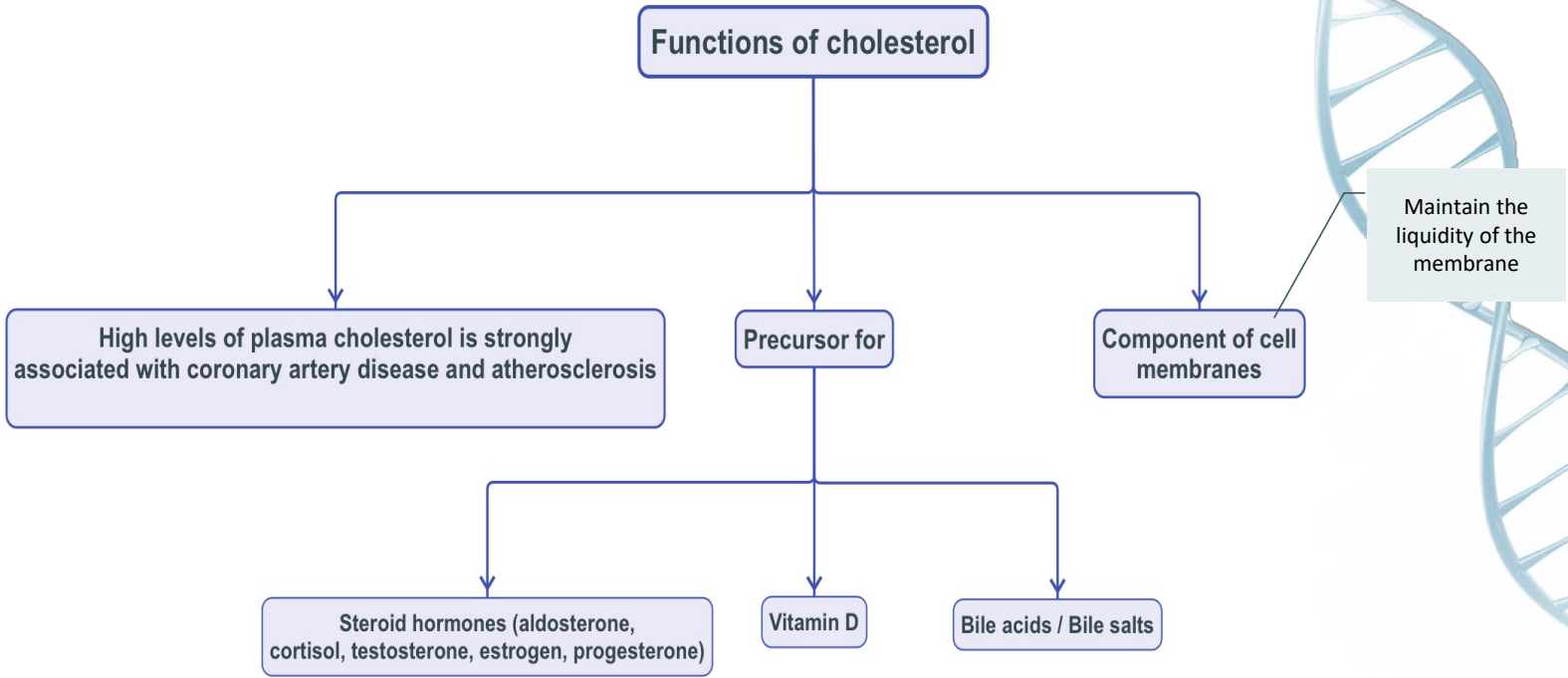


Steroids

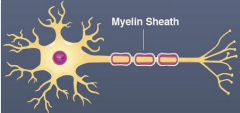
- Derivatives of cyclopentanoperhydrophenanthrene ring.
- Consists of **four fused rings** called steroid nucleus with an **8-carbon chain**. (VERY IMPORTANT)
- Steroids with a hydroxyl (OH) group are called **sterols**.
- **Cholesterol** is a major sterol in humans and animals.
- Cholesterol in plasma is bound to fatty acids called **cholesteryl esters**.

No need to memorize it





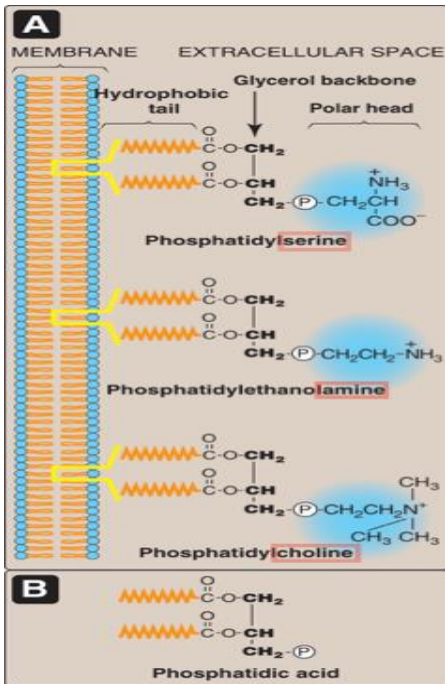
Phospholipids

Glycerophospholipids	Sphingophospholipids
contain glycerol backbone	contain sphingosine
<ul style="list-style-type: none">• Glycerol-3-PO₄ is bonded to two fatty acid chains• The PO₄ group is linked to a hydrophilic group	Long-chain fatty acids attached to sphingosine
Major components of biological membranes	An important component of myelin that protects and insulates nerve fibers
Examples: phosphatidic acid, phosphatidyl –choline and serine	Example: Spingomyelin
Amphiphilic in nature : 1- Hydrophobic tail 2- Hydrophilic phosphoryl heads	

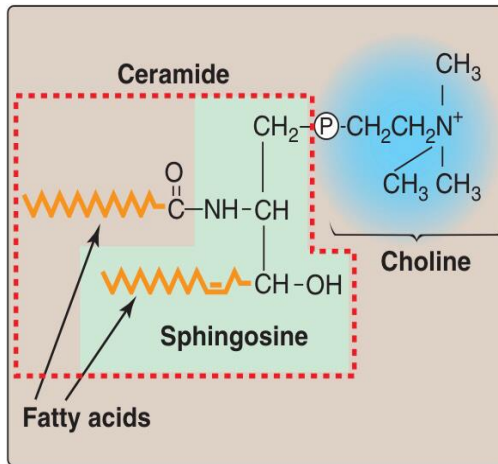
Phospholipids

You don't have to memorize the structure only the component names

Glycerophospholipids



Sphingophospholipids



Ceramide : fatty acid + sphingosine
 Phosphorylcholine : choline + phosphate
 Sphingomyeline : ceramide + choline

Figure 17.4

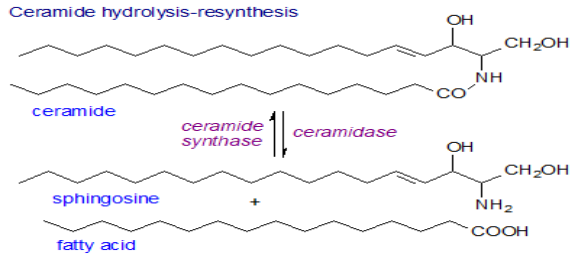
Structure of sphingomyelin, showing sphingosine (in green box) and ceramide components (in dashed box).

Glycolipids

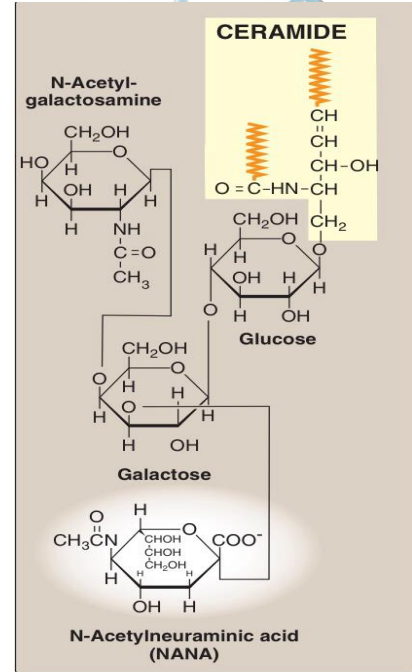
No need to memorize the structure or the components

- Contain both **carbohydrate** and **lipid** components.
- Derivatives of **ceramide** :

A long chain fatty acid is attached to sphingosine.

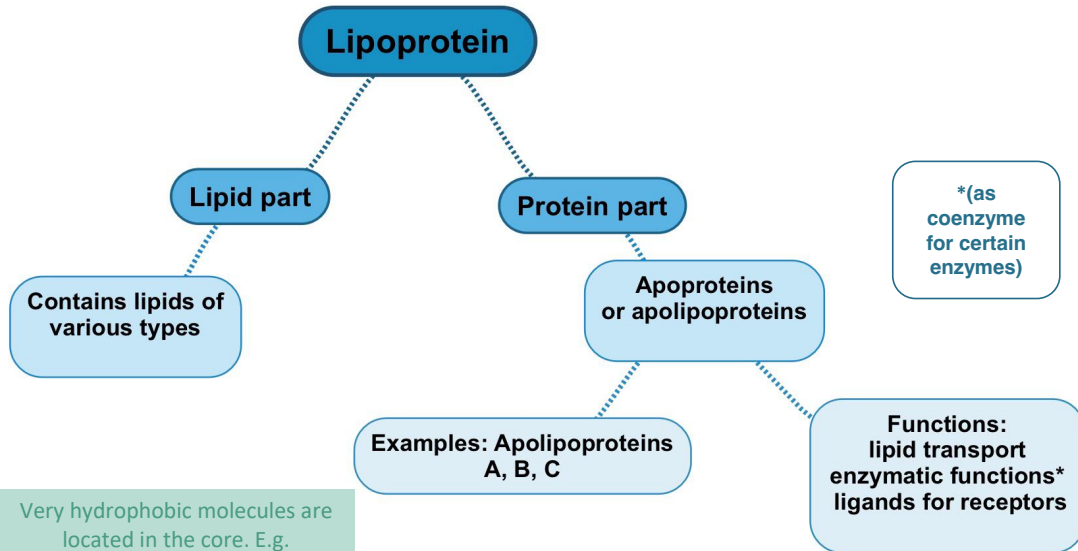


- Also called **glycosphingolipids**.
- Examples: Ganglioside, galactocerebroside.
- Act as: Blood group **antigens**, cell surface **receptors** for bacteria/viruses.



Transport of plasma lipids

- Plasma lipids are transported as lipoprotein particles (lipids + protein)



Very hydrophobic molecules are located in the core. E.g. cholesteryl esters

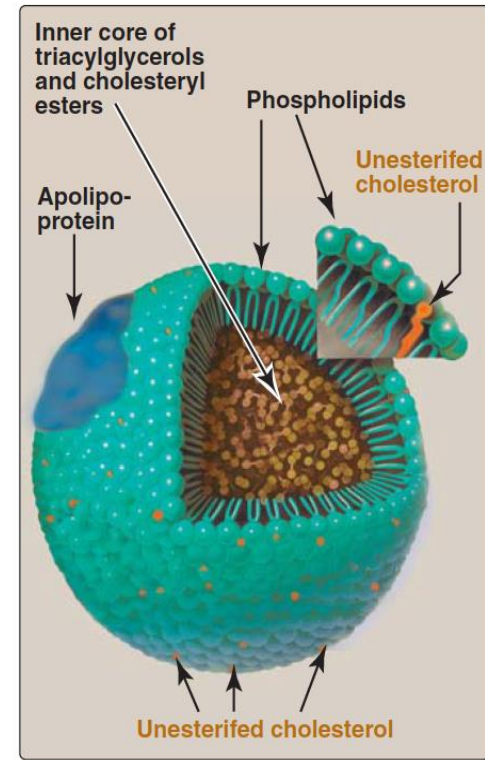
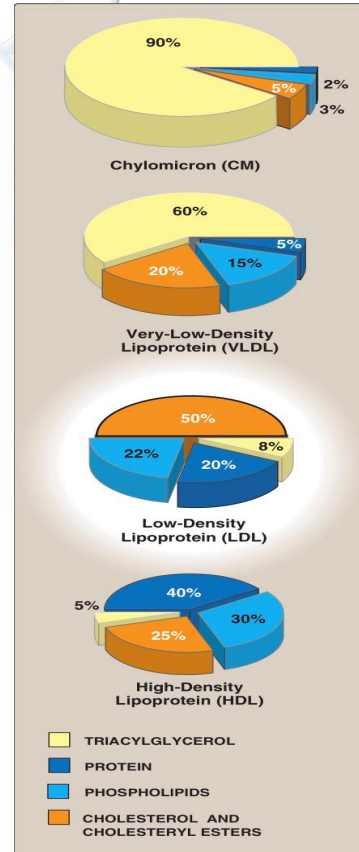


Figure 18.14
Structure of a typical lipoprotein particle.

Types and functions of lipoproteins

Lipoprotein	Transports	Major components
Chylomicrons	Dietary TGs	Triacylglycerol
Very low density lipoprotein (VLDL)	Endogenous TGs	Triacylglycerol
Low density lipoprotein (LDL)	Free cholesterol	1- Cholesterol 2- cholesteryl ester (more hydrophobic)
High density lipoprotein (HDL)	Cholesteryl esters	Protein



- HDL is good for the body

- LDL & VLDL are bad for the body

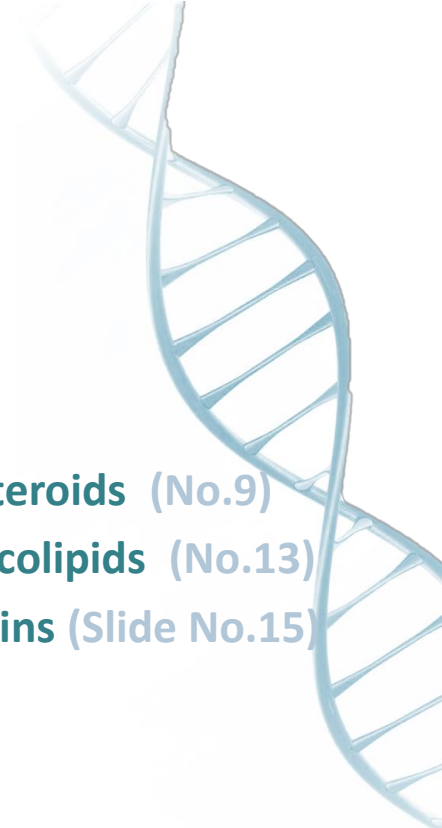
Review:

Lipid	Structure	Main Role	Other Features
Triglyceride	Glycerol and three fatty acids	Compact energy store, insoluble in water so doesn't affect water potential	Stored as fat, used for thermal insulation and protective properties
Phospholipid	Glycerol plus two fatty acids and a phosphate group	Molecule is part hydrophobic, part hydrophilic, ideal for membranes	Phosphate parts have carbohydrate parts attached called glycolipids for cell signalling
Cholesterol	Four carbon based ring structures joined together	Forms a small, thin molecule that fits to a lipid bilayer giving strength and stability	Used to form steroid hormones



Review:

- **What are lipids?** (Slide No.3)
- **Classification of lipids** (Slide No.4)
- **Functions of lipids** (Slide No.3)
- **Simple lipids: Fatty acids(No.5), triacylglycerols(No.8),steroids (No.9)**
- **Complex lipids: Phospholipids, sphingolipids(No.11),glycolipids (No.13)**
- **Plasma lipid transport: types and functions of lipoproteins (Slide No.15)**



MCQs

Q1; an example for complex lipids is:

- A- steroids
- B- phospholipid
- C- fatty acids

Q2; which one of the following is a saturated fatty acid:

- A- oleic acid
- B- linoleic acid
- C- lauric acid

Q3; chylomicrons transport :

- A-Endogenous TGs
- B-cholesterols
- C-Dietary TGs

Q4; Constitutes majority of dietary lipids :

- A-steroids
- B-triacylglycerols
- C-cholesterols

Answer key:

- 1) B
- 2) C
- 3) C
- 4) B



SAQs

Q1: When do Arachidonic acid becomes essential?

when linoleic acid is deficient in the diet

Q2: What are the functions of lipids?

components of biological membranes

Serves as major energy stores

Cell signaling involves lipid molecules

Q3: what is a ceramide ?

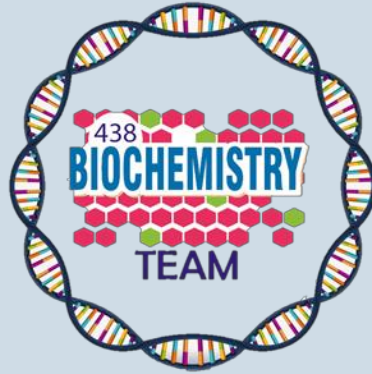
It is a fatty acid attached to sphingosine

Q4: what does steroid nucleus consist of ?

four fused rings.



➤ Special thanks to:



Our logo designer:

Reem AlMazyad



swereem@hotmail.com



 [@435biochemteam](https://twitter.com/435biochemteam)

 435biochemistryteam@gmail.com

 [@biochemteam435](https://www.instagram.com/biochemteam435)



teambiochem437@gmail.com



Biochemistry team 436



[@436biochemteam](https://twitter.com/436biochemteam)



biochemistrytem436@gmail.com

❖ Girls team:

- أجدد آل رشود
- الوتين البلوي
- إيلاف المسيلح
- جود الخليفة
- جود العتيبي
- ريم القرني
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- لينا العصيمي
- نورة التركي
- نورة المزروع
- نوف الحميضي
- هيفاء الوابلي

❖ Boys team:

- بدر الشهري
- حميد حميد
- سهيل باسهيل
- عمر الغامدي
- مهند القرني
- نايف السبر

❖ Team leaders:

ديما المزيد
رائد العجيري

❖ Contact us:

Biochemistryteam438@gmail.com

