

LIPIDS

FYBSc

DEFINITION

- Heterogeneous group of compounds
- Fats, oil, steroid, waxes
- Insoluble in water
- Soluble in organic solvents- ether, chloroform etc

CLASSIFICATION OF LIPIDS

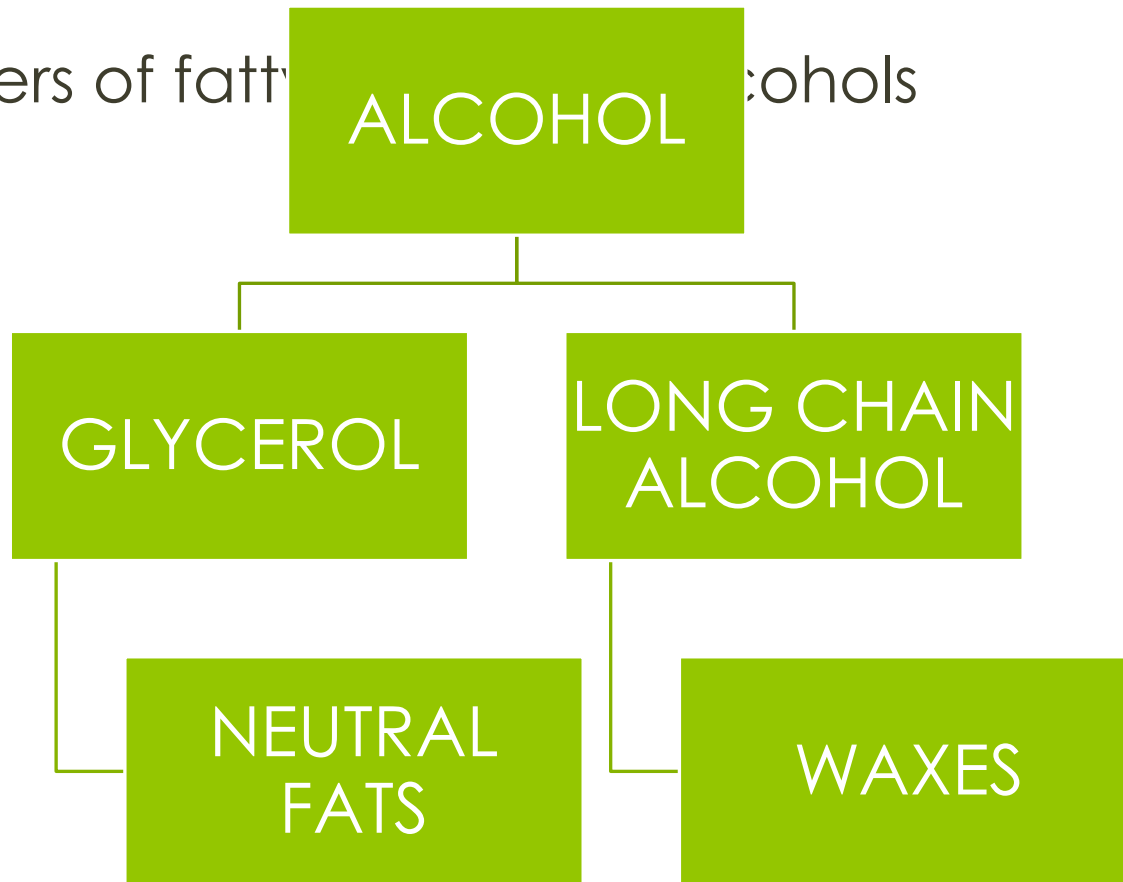
SIMPLE LIPIDS

COMPOUND LIPIDS

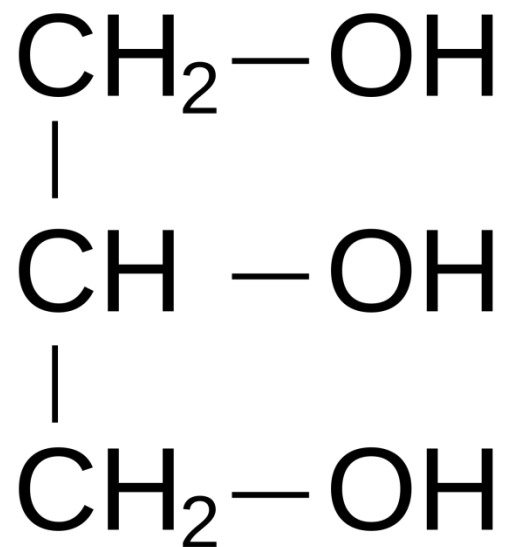
DERIVED LIPIDS

SIMPLE LIPIDS

- Esters of fatty acids and alcohols



GLYCEROL



LONG CHAIN ALCOHOL

- Cetyl alcohol
- $\text{CH}_3 (\text{CH}_2)_{14} \text{CH}_2\text{OH}$

- Myricyl alcohol
- $\text{CH}_3 (\text{CH}_2)_{28} \text{CH}_2\text{OH}$

○ Aliphatic carboxylic acids

○ R-COOH

○ R= Aliphatic hydrocarbon chain---- Nonpolar nature of fatty acids

CLASSIFICATION OF FATTY ACIDS

BASED ON LENGTH OF NONPOLAR HYDROCARBON CHAIN

BASED ON PRESENCE NUMBER OF BONDS

BASED ON LENGTH OF NONPOLAR HYDROCARBON CHAIN

SHORT CHAIN FATTY ACIDS
(2-6 CARBON ATOMS)

MEDIUM CHAIN FATTY ACIDS
(8-14 CARBON ATOMS)

LONG CHAIN FATTY ACIDS
(MORE THAN 16 CARBON ATOMS)

BASED ON NUMBER OF BONDS



SATURATED FATTY ACIDS

- Single bonds between carbon atoms
- Even number of carbon atoms
- Less than 1%--- odd number of carbon atoms

MOLECULAR FORMULA	COMMON NAME
$\text{CH}_3(\text{CH}_2)_{10}\text{COOH}$	LAURIC ACID (12:0)
$\text{CH}_3(\text{CH}_2)_{12}\text{COOH}$	MYRISTIC ACID (14:0)
$\text{CH}_3(\text{CH}_2)_{14}\text{COOH}$	PALMITIC ACID (16:0)
$\text{CH}_3(\text{CH}_2)_{16}\text{COOH}$	STEARIC ACID (18:0)
$\text{CH}_3(\text{CH}_2)_{18}\text{COOH}$	ARCHIDIC ACID (20:0)

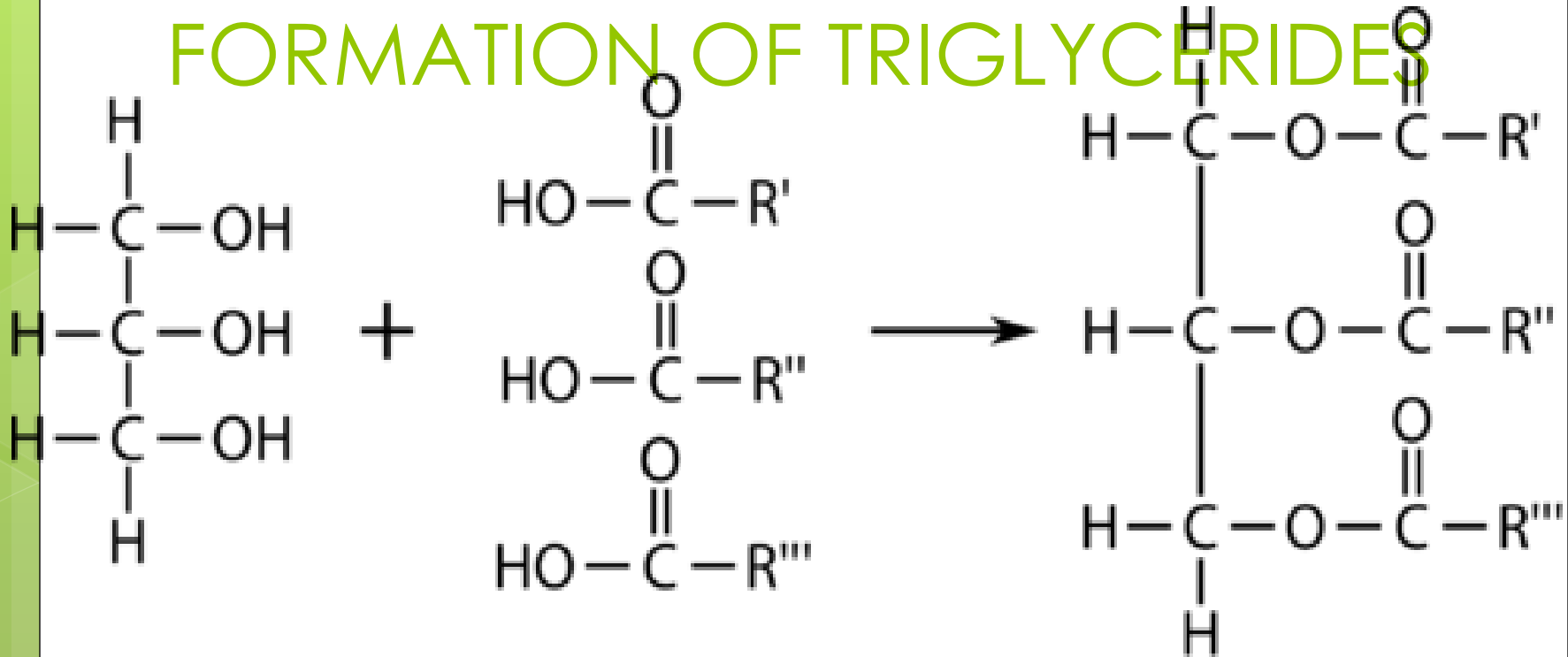
UNSATURATED FATTY ACIDS

MOLECULAR FORMULA	COMMON NAME
$\text{CH}_3(\text{CH}_2)_5\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$	OLEIC ACID 16:1(9)
$\text{CH}_3(\text{CH}_2)_4\text{CH}=\text{CHCH}_2\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$	LINOLEIC ACID 18:2(9,12)
$\text{CH}_3\text{CH}_2\text{C H}=\text{CH CH}_2\text{C H}=\text{CH C}$ $\text{H}_2\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$	LINOLENIC ACID 18:3(9,12,15)

NEUTRAL FATS

- Esters of fatty acids with glycerol
- Glycerol--- Trihydric alcohol
- Triglycerols (TAG)
- Triglycerides

FORMATION OF TRIGLYCERIDES

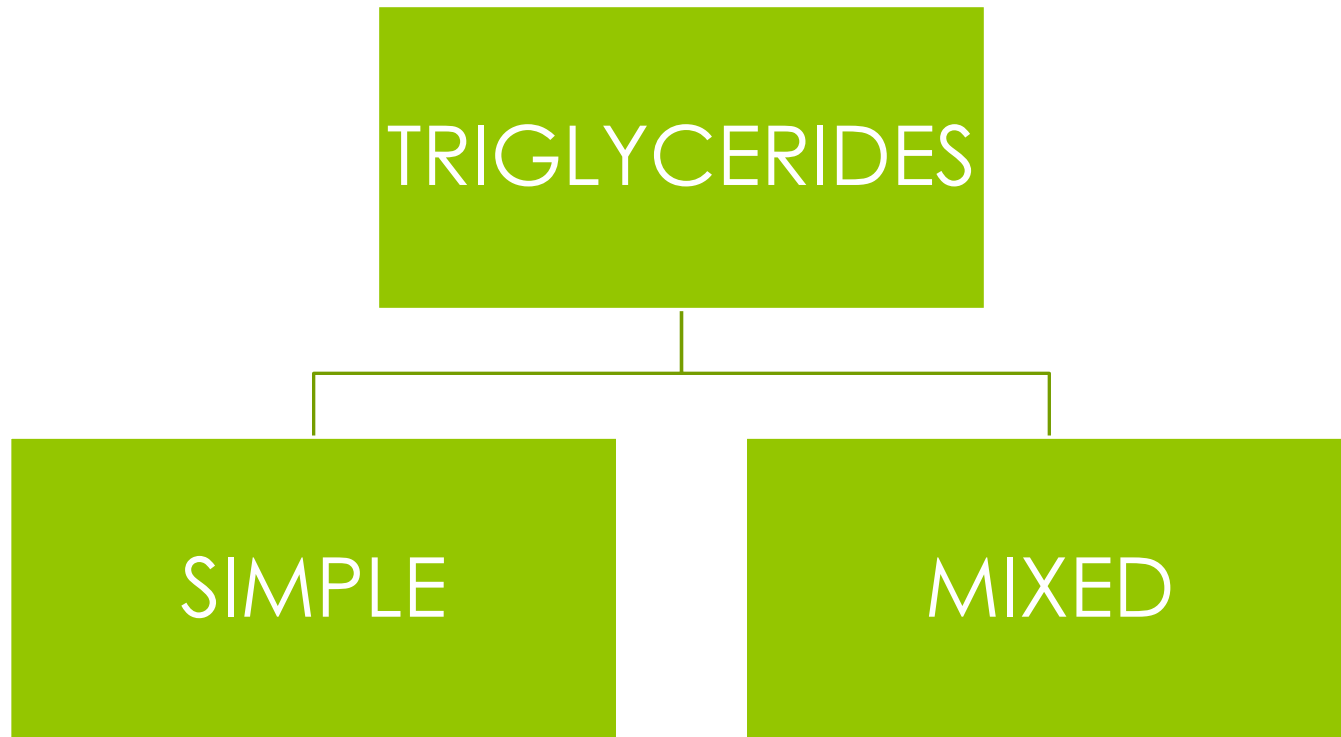


glycerol

3 fatty acids

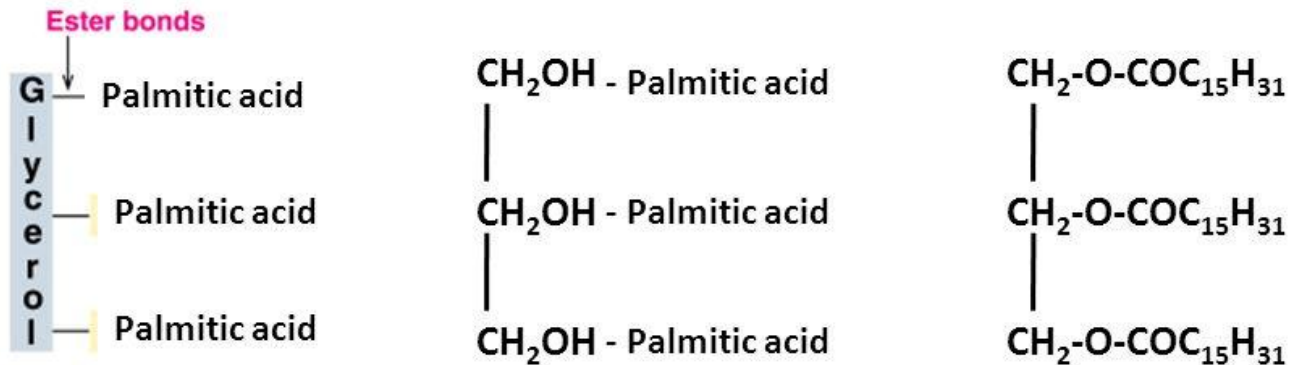
triglyceride
(triester of glycerol)

TRIGLYCERIDES



Tripalmitin

- Three molecules of palmitic acids combine with one molecule of glycerol.



Formation of a triglyceride, as simple lipid

MIXED TRIGLYCERIDES

- Oleodipalmitin
- Oleopalmitostearin

ANIMAL FAT

Animal fats

Rich in saturated fatty acids

High melting point

Solid at room temperature

PLANT FAT

Plant fats



Rich in Polyunsaturated fatty acids



Low melting point



Liquid state

WAXES

Wax---- Material of the honey comb

Esters of long chain saturated and unsaturated fatty acids with long chain mono hydroxy alcohol

Fatty acids= C_{14} - C_{36} and Alcohols C_{16} - C_{36}

Vertebrates- Cutaneous gland- pliable, lubricated and water proof

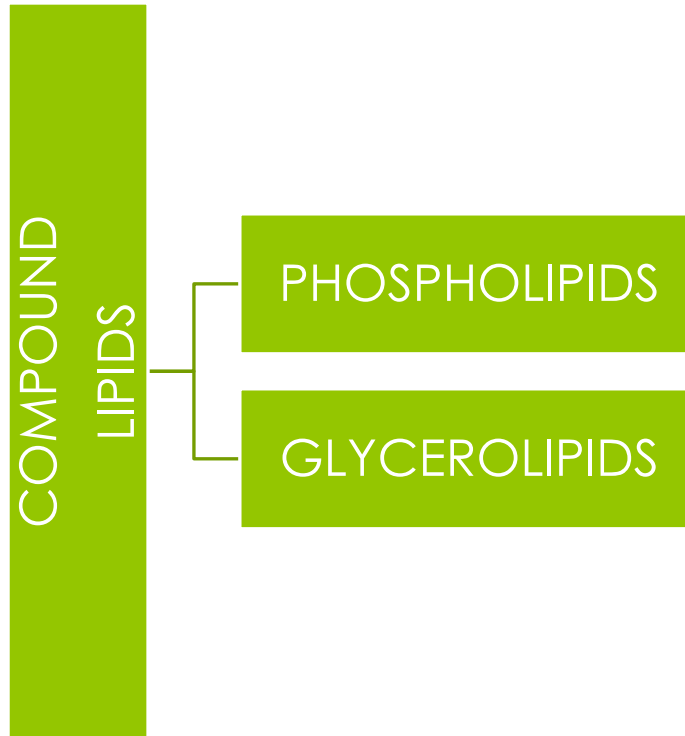
Hair, wool and fur are also coated with wax

Preening in birds

Rhododendron and Calotropis

- # WAXES
- Chief storage forms of fuel in planktons
 - Sperm Whale Wax- Spermaceti
 - Bee wax
 - Carnauba wax- (Brazil or Palm wax) Hardest known wax
 - Inert- Saturated hydrocarbon chain
 - Insoluble in water and highly resistant to atmospheric oxidation
 - Uses

COMPOUND LIPIDS

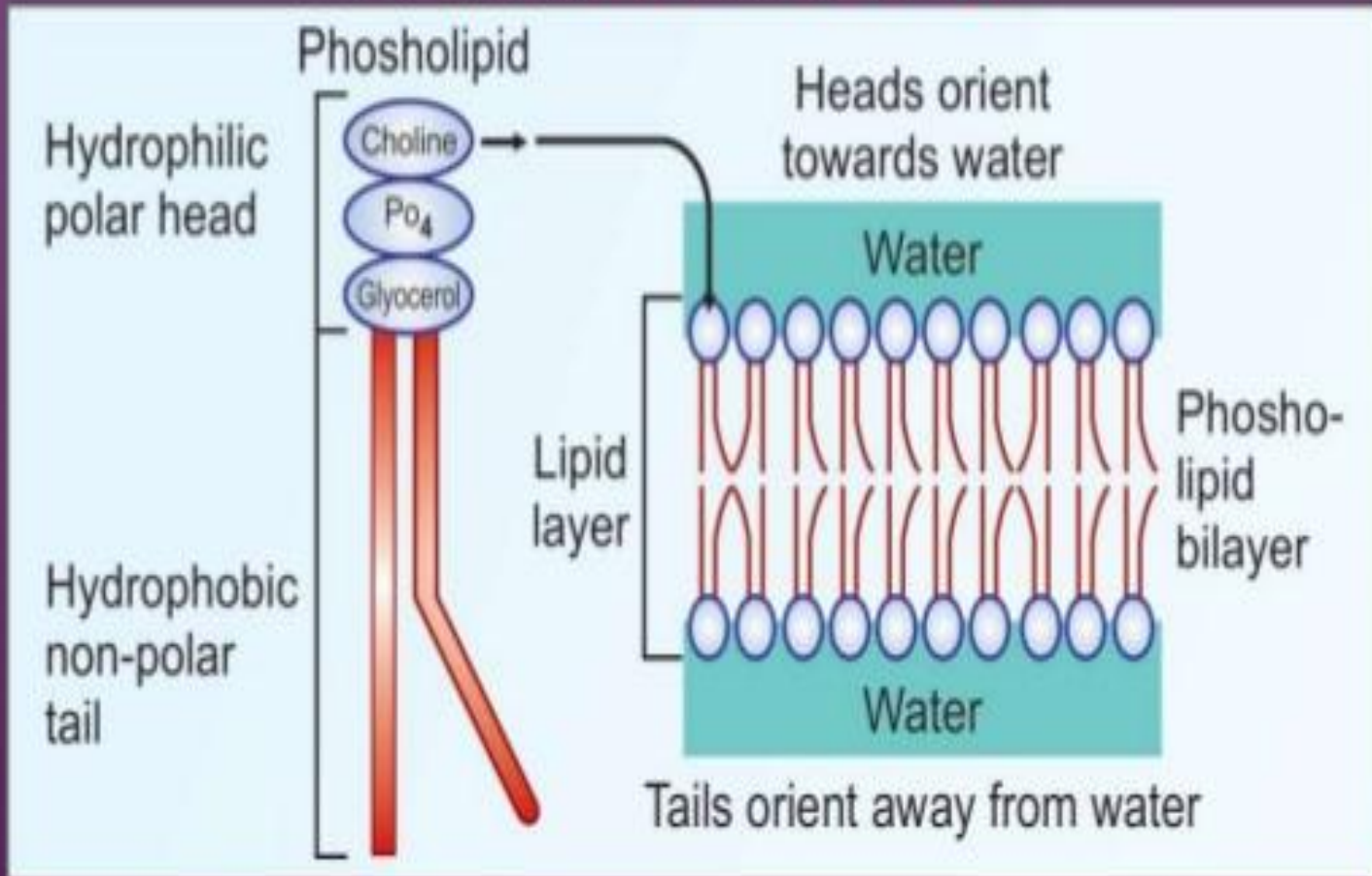


PHOSPHOLIPIDS

- Most abundant membrane lipids
- Structural components of membranes
- Never **stored** in large quantities
- Phosphoric acid
- 1 hydrophilic polar head + 2 hydrophobic non
polar tails
- Polar lipids
- Amphiphatic

Amphipathic Nature

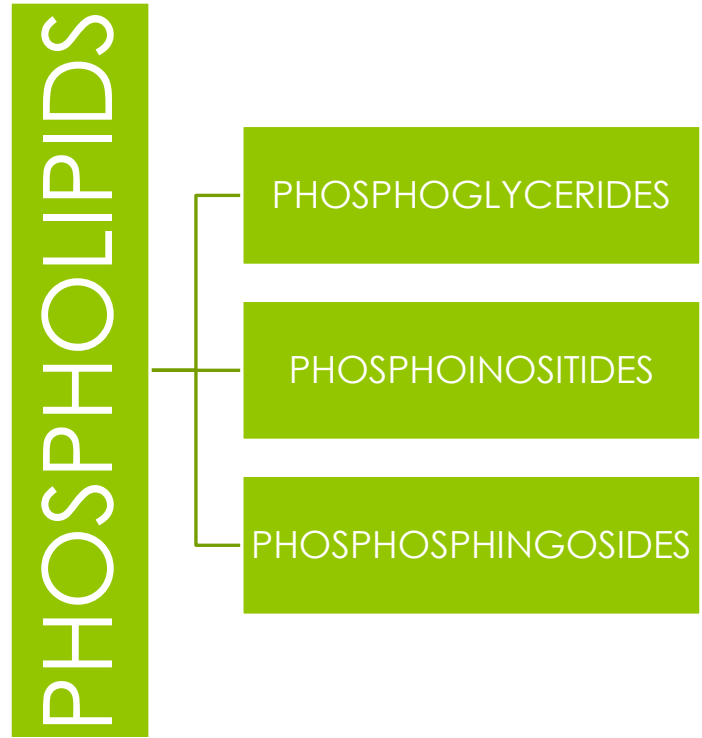
Phospholipids form the bilayer



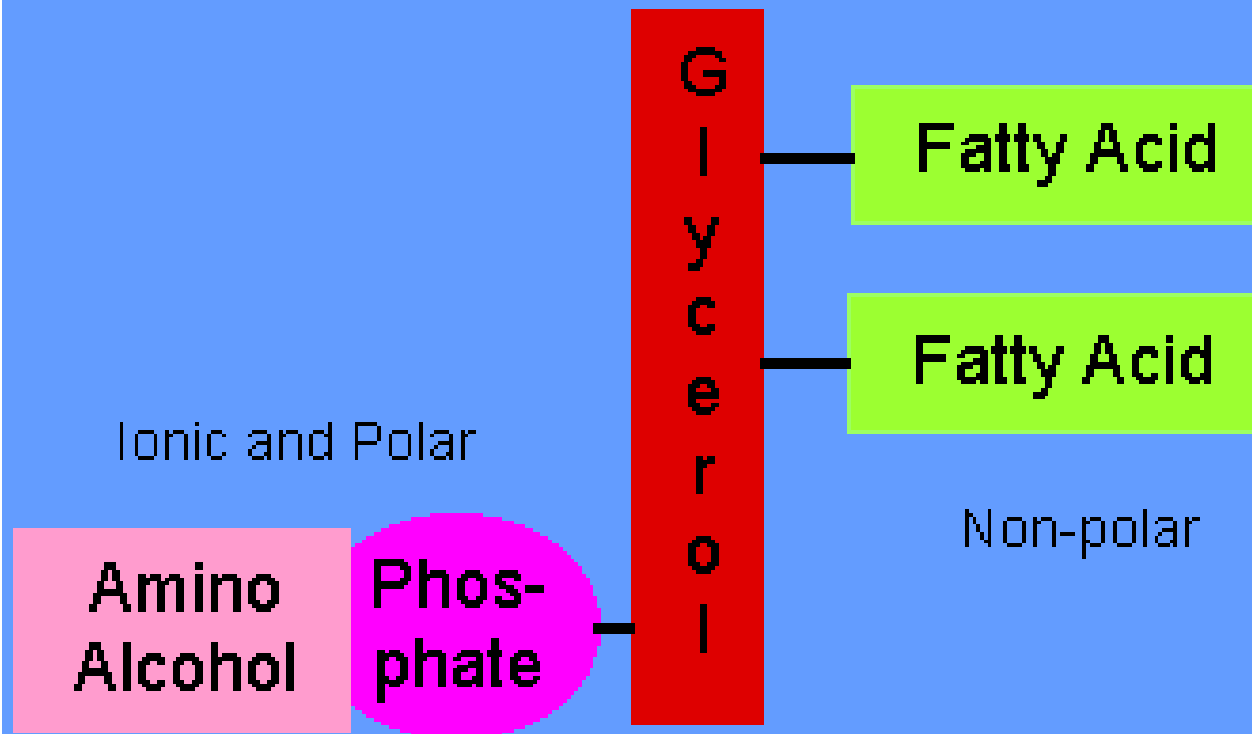
PHOSPHOLIPIDS

- Glycerol + 3 Fatty acids + Phosphoric acid

PHOSPHOLIPIDS



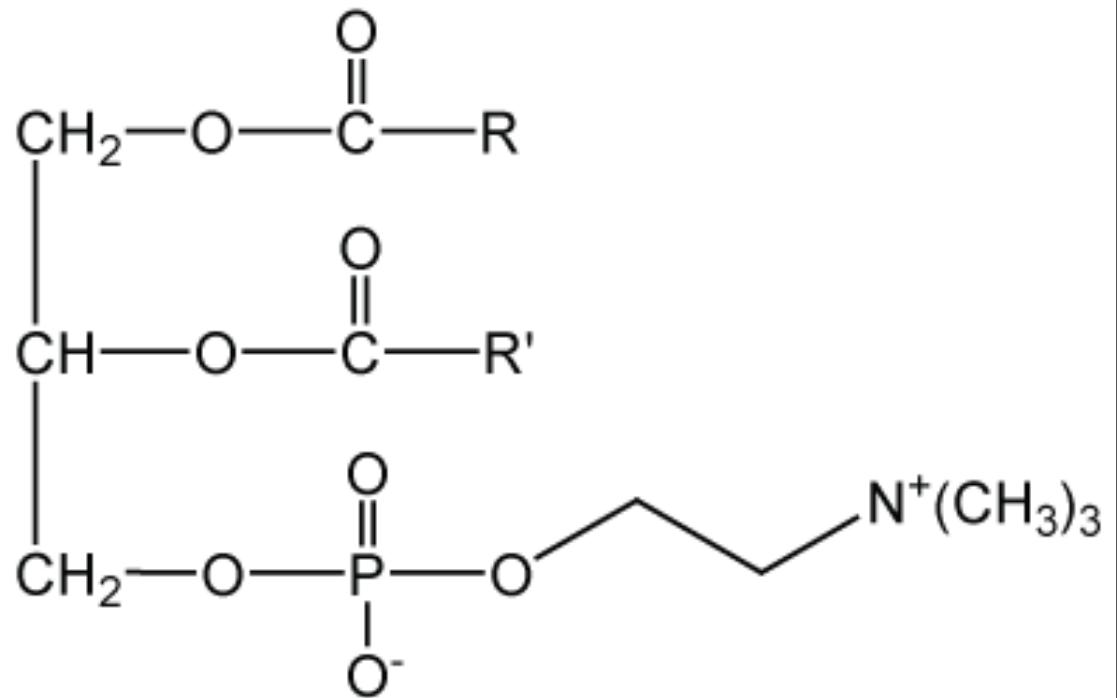
General Structure of a Phosphoglyceride



- Glycerol + 2 Fatty acids + 1 Phosphoric acid + Choline

LECITHIN

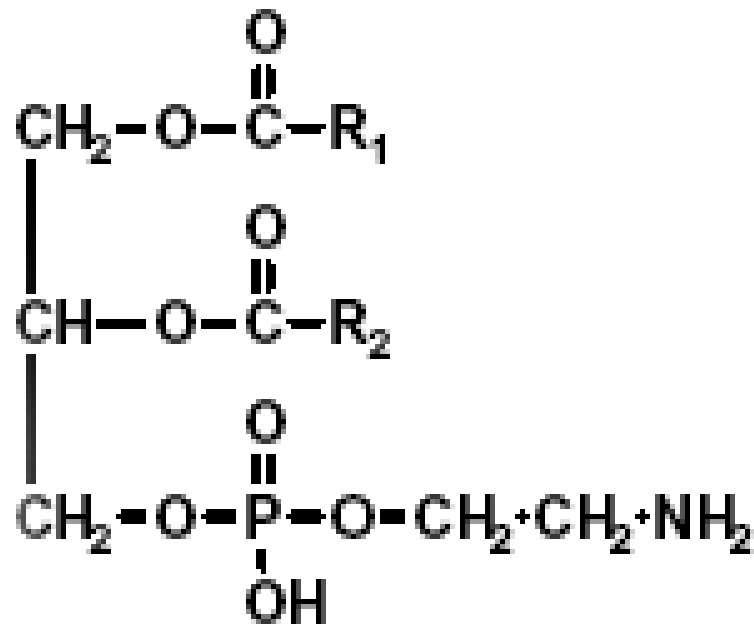
- Phosphatidyl choline



- Glycerol + 2 Fatty acids + 1 Phosphoric acid + Ethanolamine

CEPHALIN

- Phosphatidyl ethanolamine

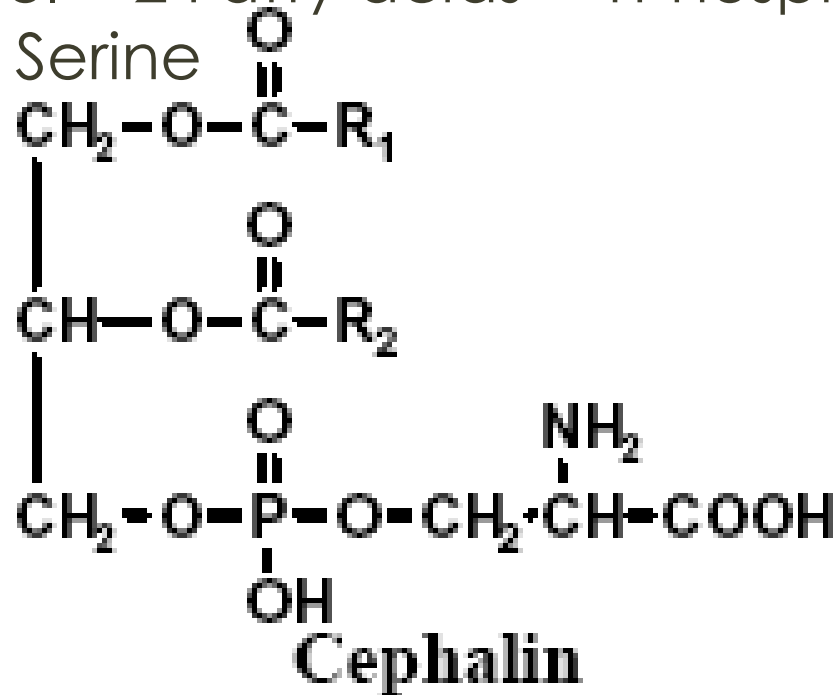


Cephalin

(Phosphatidyl ethanolamine)

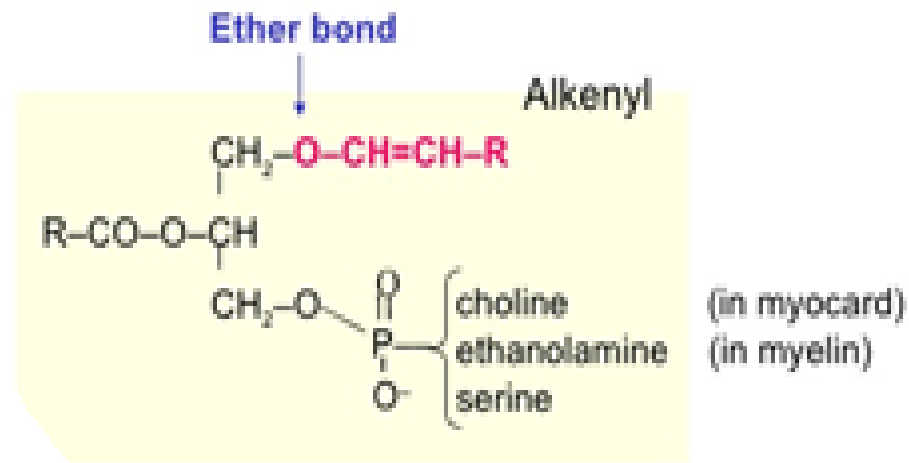
PHOSPHATIDYL SERINE

- Glycerol + 2 Fatty acids + 1 Phosphoric acid + Serine



Cephalin
(Phosphatidyl serine)

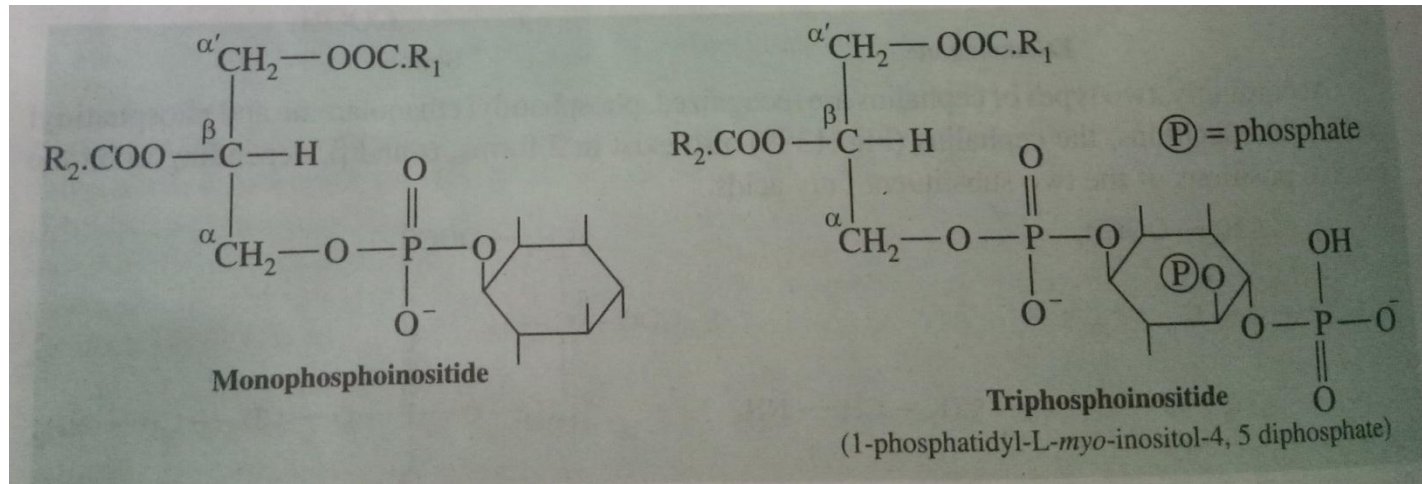
- Modified Glycerolipids Alkoxy lipids
- 1 Fatty acid + 1 Phosphoric acid + Choline/
Ethanolamine / Serine + Glycerol + Aldehyde



PHOSPHOINOSITIDES

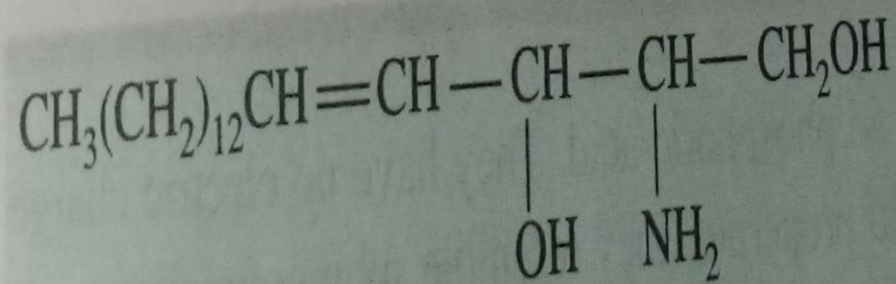
- Phosphatidyl inositol
- Brain cells, Soya bean
- Transport
- 1 Glycerol + 2 Fatty acids + 1 Phosphoric acid + Inositol

PHOSPHOINOSITIDES

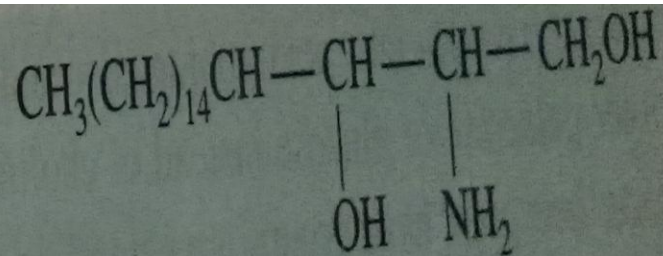


PHOSPHOSPHINGOSIDES

- Sphingomyelins
- Nerve tissue
- Absent in plant tissue
- Niemann- Pick Disease: Storage of large quantities of sphingomyelins in brain
- Lack glycerol
- Nitrogenous base –Sphingosine or Dihydrosphingosine



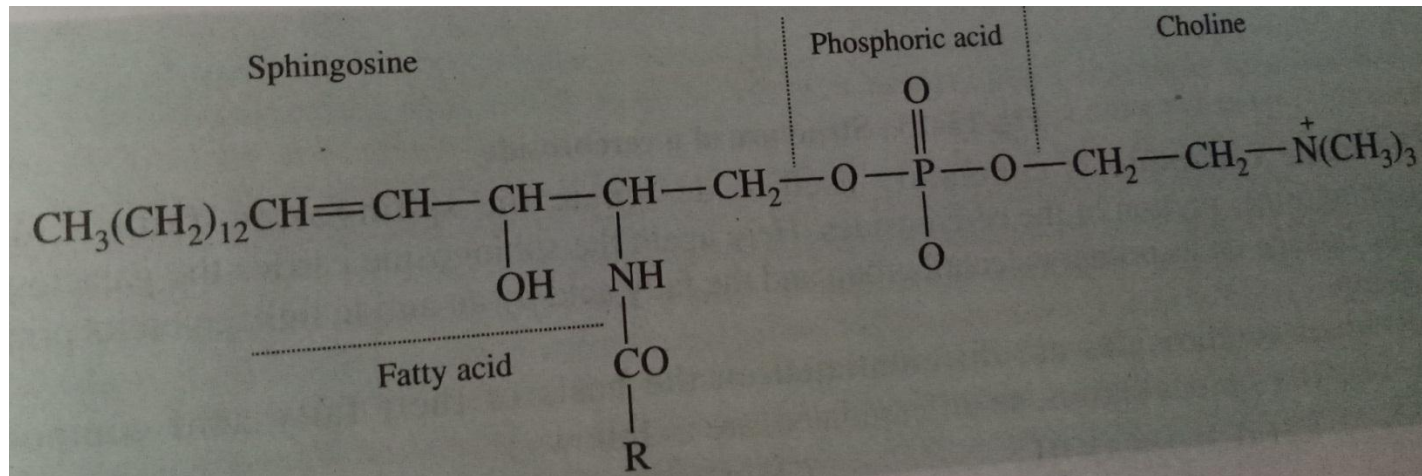
Sphingosine or 4-sphingenine
 (1, 3-dihydroxy-2-amino-*trans*-octadec-4-ene)



Dihydrosphingosine or sphinganine

... yield equimolar amounts of fatty acid, phosphoric acid, and the amino

SPHINGOMYELIN



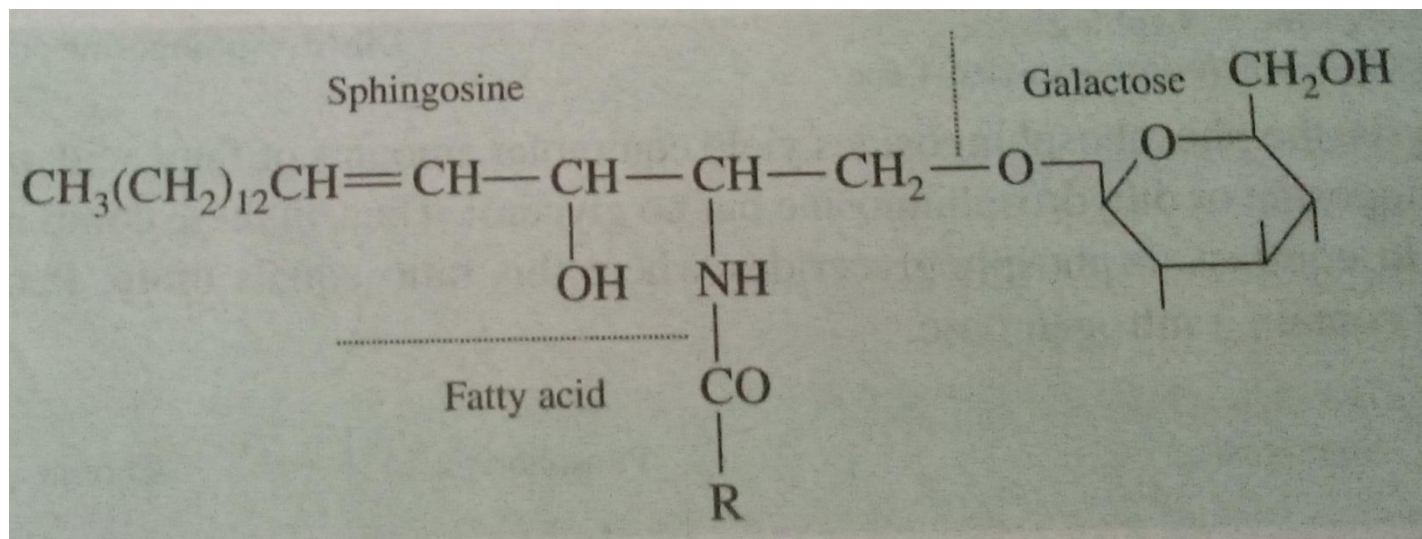
PHOSPHOSPHINGOSIDES

- Sphingosine + Fatty Acid
+ Phosphoric acid +
Choline

GLYCOLIPIDS

- Cerebrosides
- Glycosphingosides
- Brain
- Sphingosine + Fatty acid + Sugar
- Gaucher disease or Glucocerebrosidosis
- Lungs, bones
- Deficiency of enzyme Glucocerebrosidase

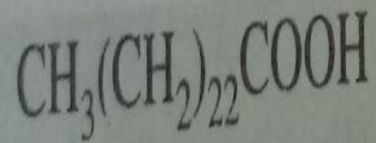
cerebrosides



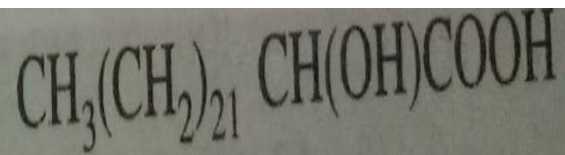
GLYCOLIPIDS

- Fatty acids:
- Lignoceric acid
- Cerebronic acid
- Nervonic acid
- Oxynervonic acid

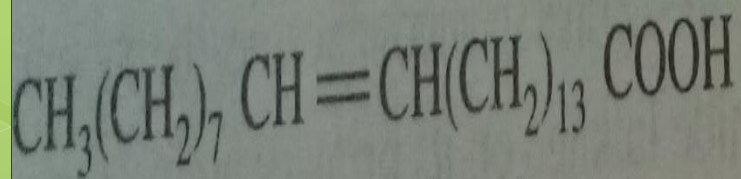
g. 13-14). The various classes, e-



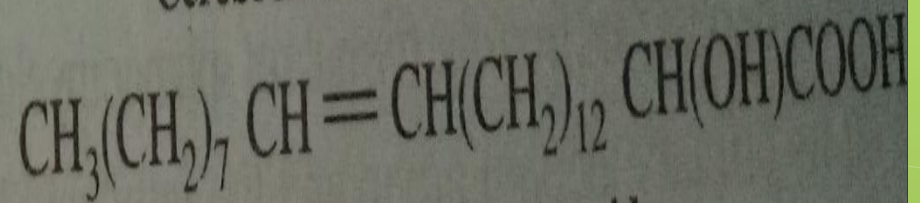
Lignoceric acid



Cerebronic acid



Nervonic acid



Oxynervonic acid

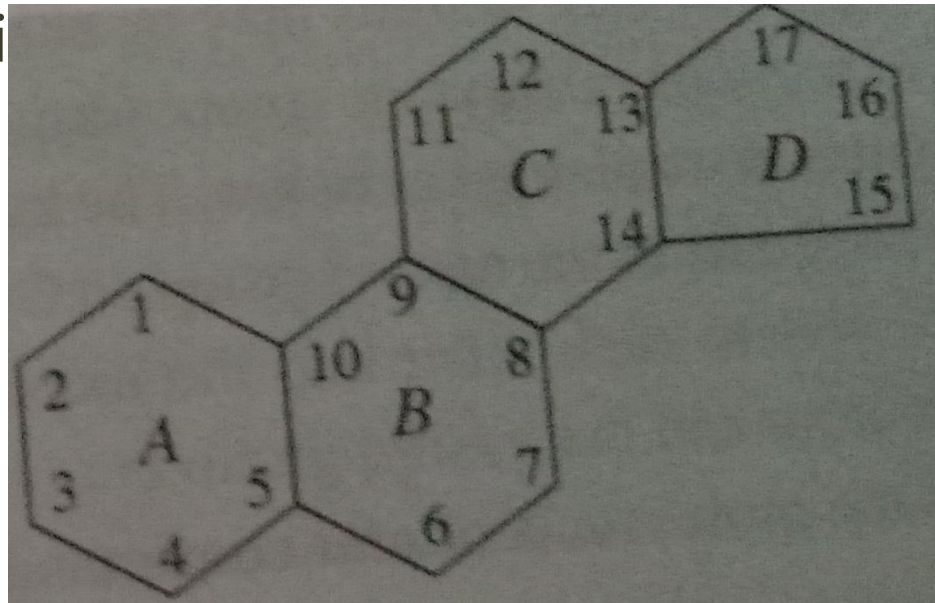
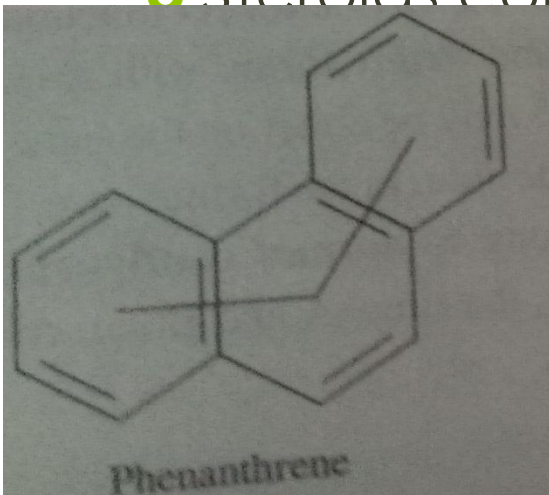
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DERIVED LIPIDS

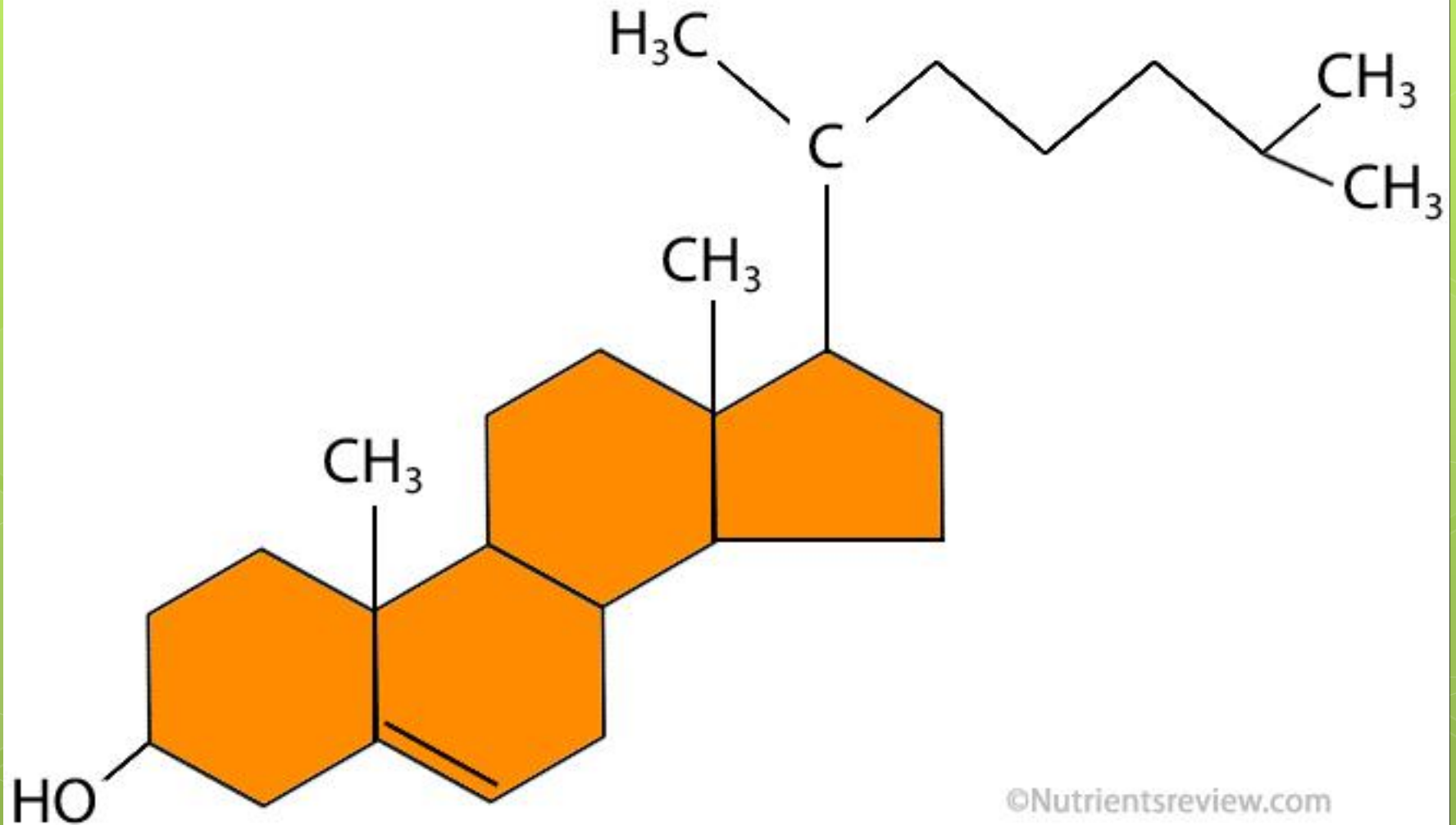
- Hydrolysis products of simple or compound lipids and also various other compounds such as steroids, terpenes etc

STEROIDS

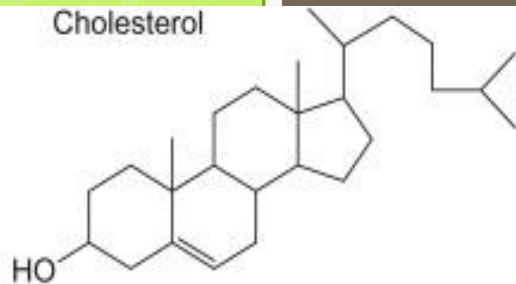
- Cyclopentanoperhydrophenanthrene
- Sterane
- Steroids contain



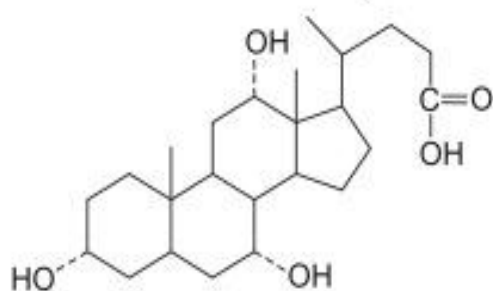
CHOLESTEROL



Cholesterol

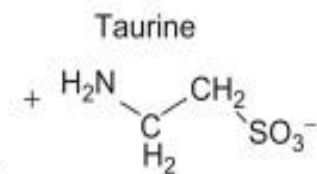
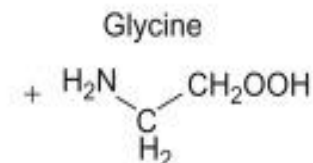
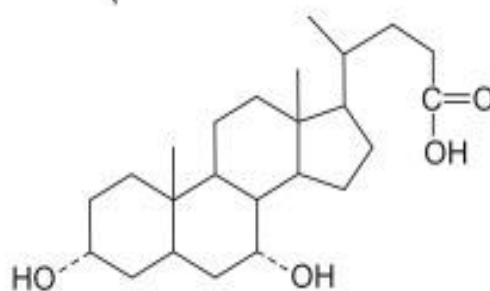


Cholic acid

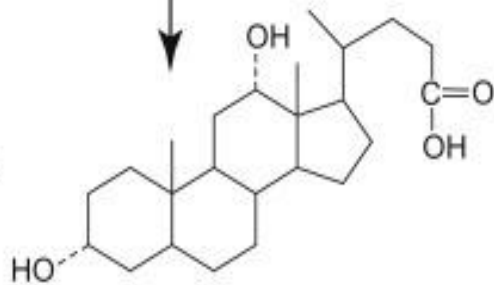


Primary bile acids

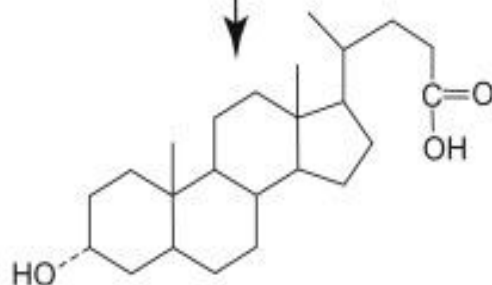
Chenodeoxycholic acid



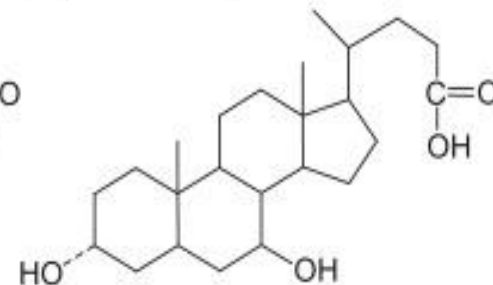
Secondary bile acids



Deoxycholic acid



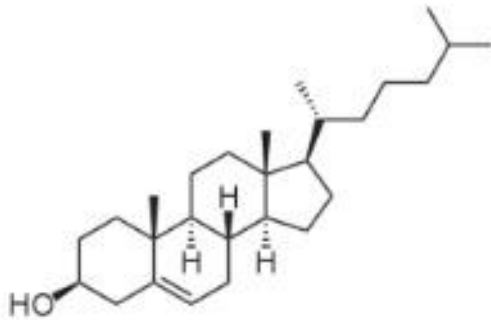
Lithocholic acid



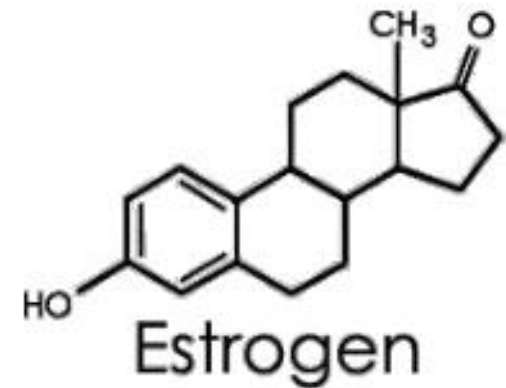
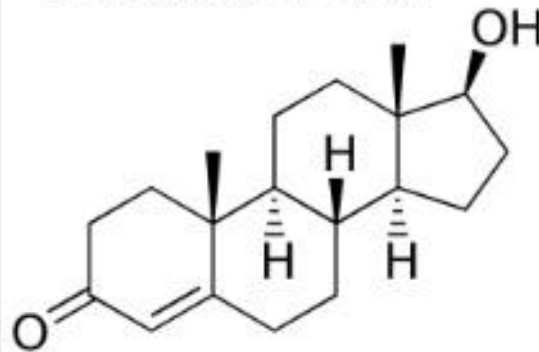
Ursodeoxycholic acid

Steroid

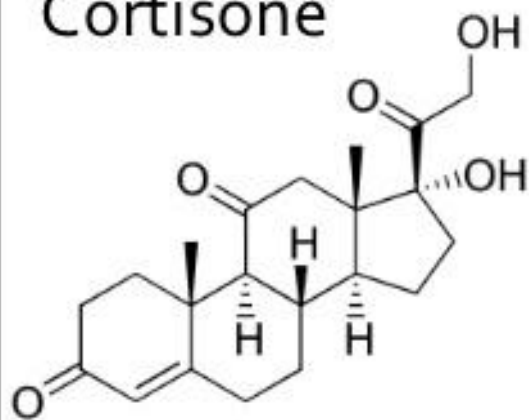
Cholesterol



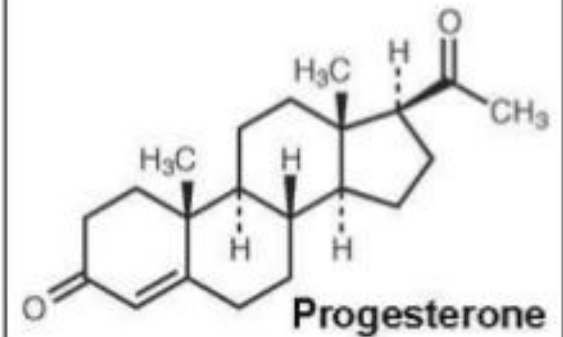
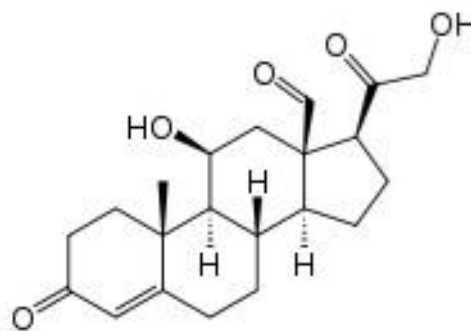
Testosterone



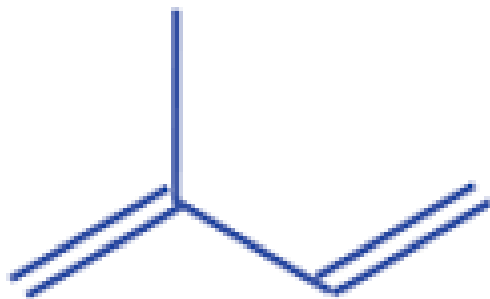
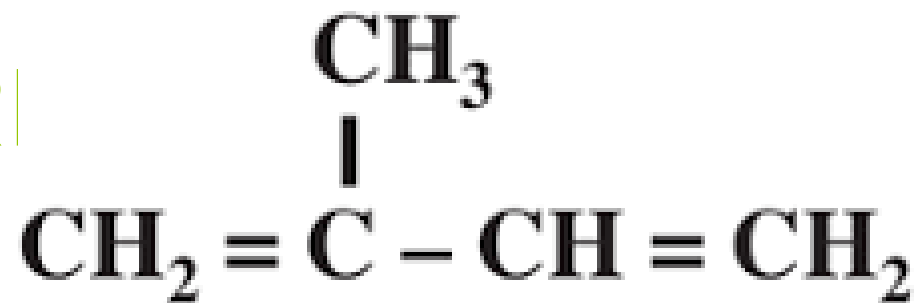
Cortisone



Aldosterone



TERI



Isoprene



MONOTERPENE

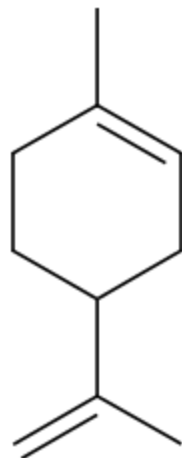


MYRCENE, $C_{10}H_{16}$

OIL OF BAY

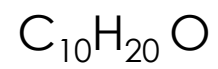
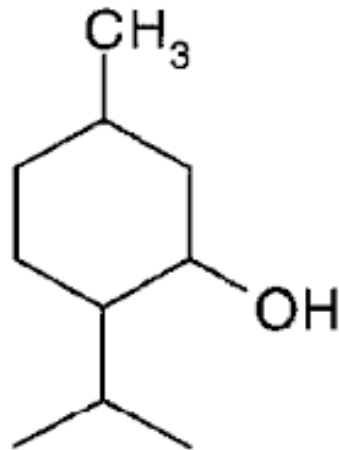
MONOTERPENE

- $C_{10}H_{16}$
- LEMON OIL

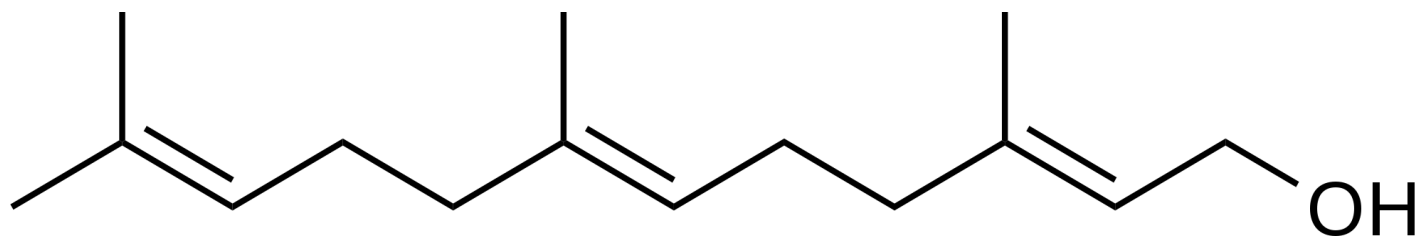


MONOTERPENES

Menthol



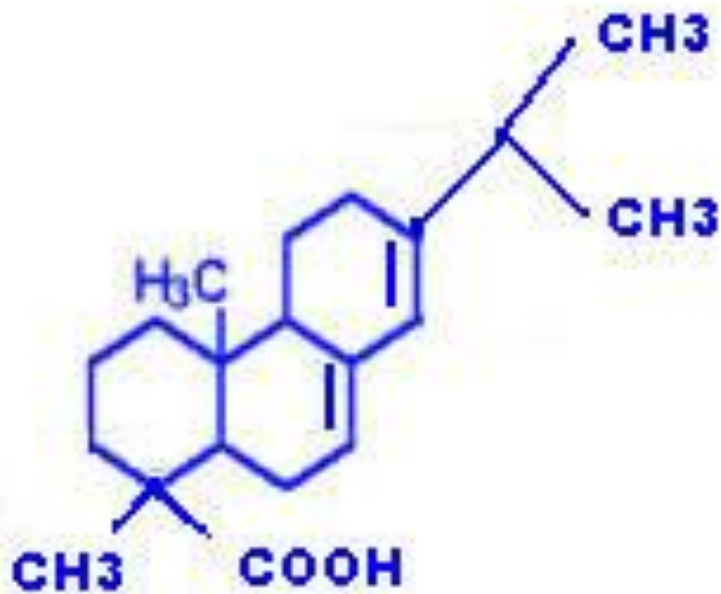
SESQUITERPENES



FARNESOL

DITERPENES (RESINS)

$C_{20}H_{30}O_2$

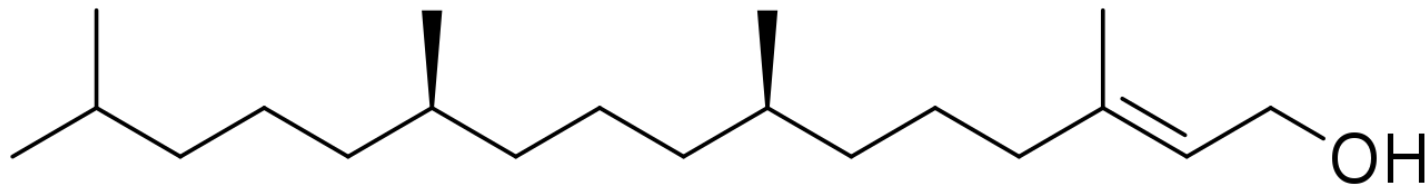


ABIETIC ACID



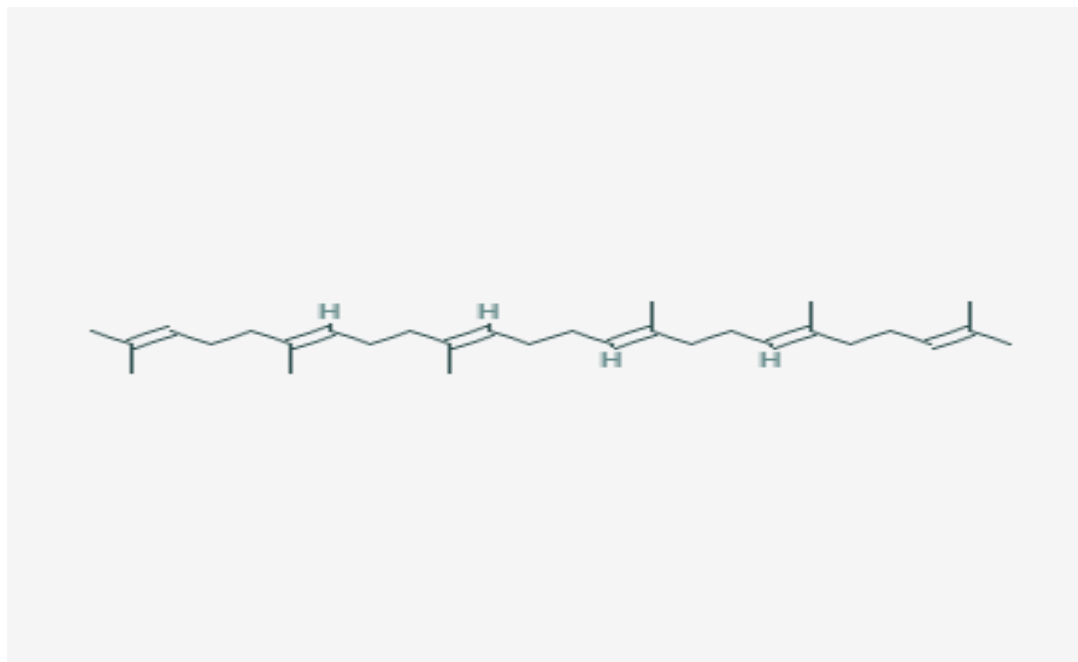
SAPIETIC ACID

DITERPENE

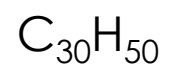


PHYTOL
ACYCLIC DITERPENE
HYDROLYSIS OF CHLOROPHYLL

TRITERPENE

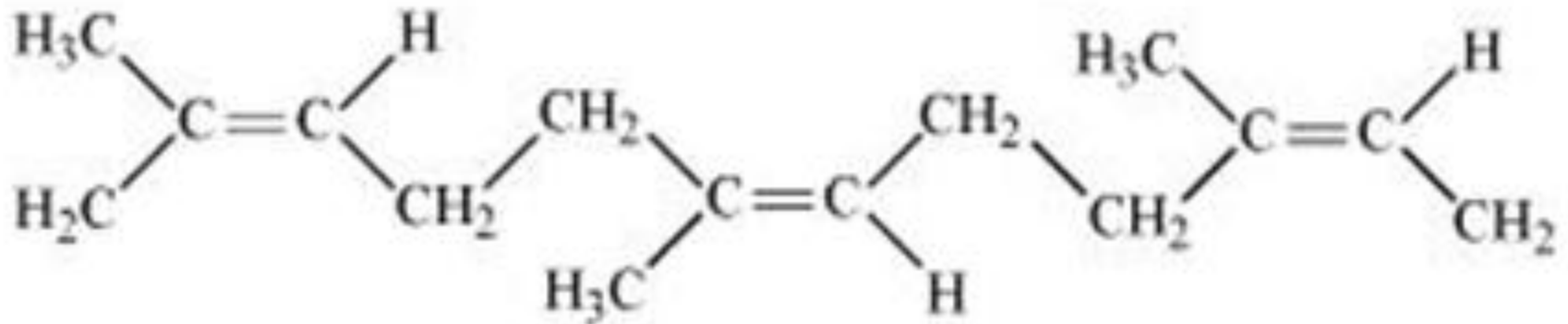


SQUALENE



POLYTERPENE

500 TO 5000 ISOPRENE UNITS



Natural rubber

CAROTENOIDS

- Tetraterpenes
- Both plants and animals
- Isoprene derivatives with high degree of unsaturation
- Presence of many unconjugated double bonds they are coloured red or yellow

CAROTENOIDS



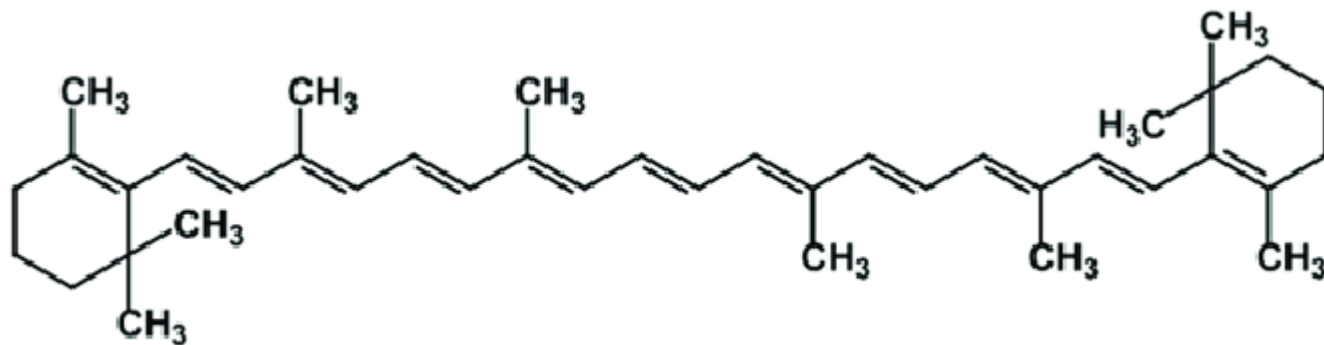
Lycopene

Molecular weight: 536.89

Molecular formula. $C_{40}H_{56}$

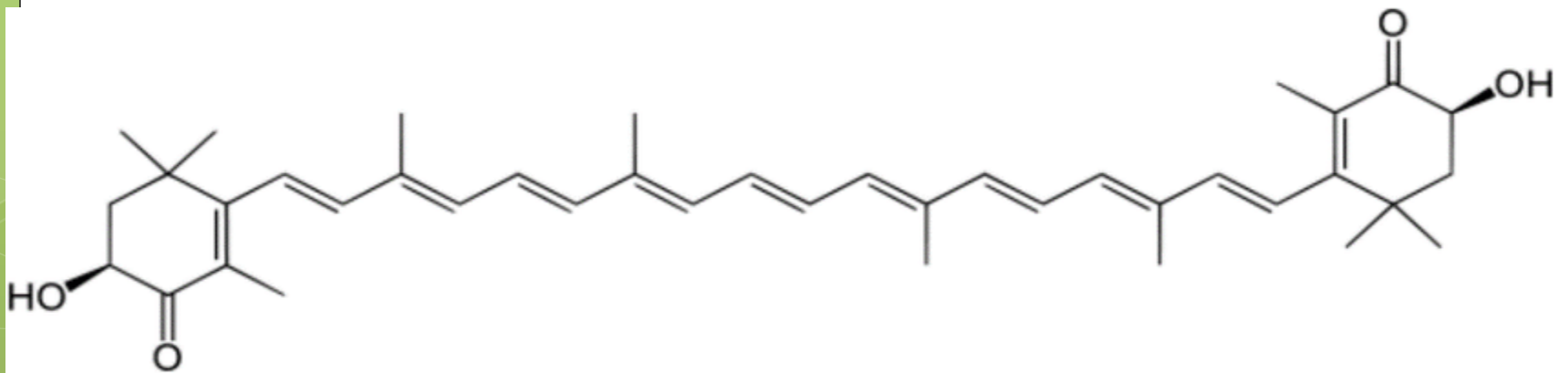
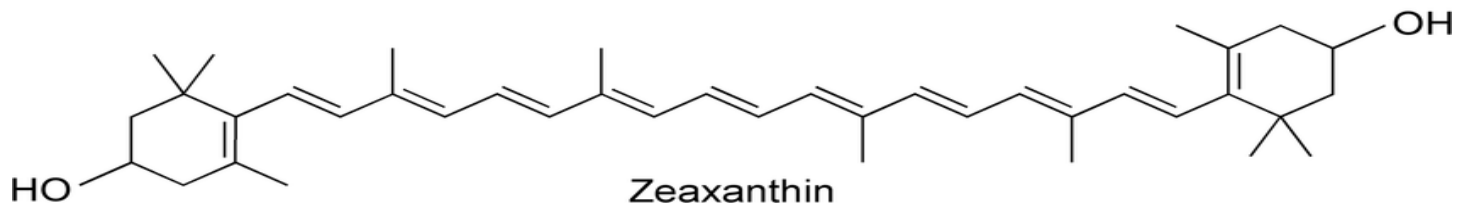
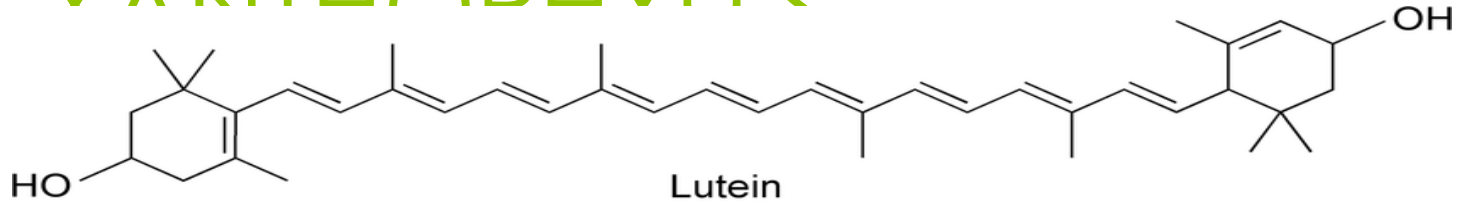
Molecular composition: C: 9.49%; H: 10.51%

CAROTENOIDS



β CAROTENE

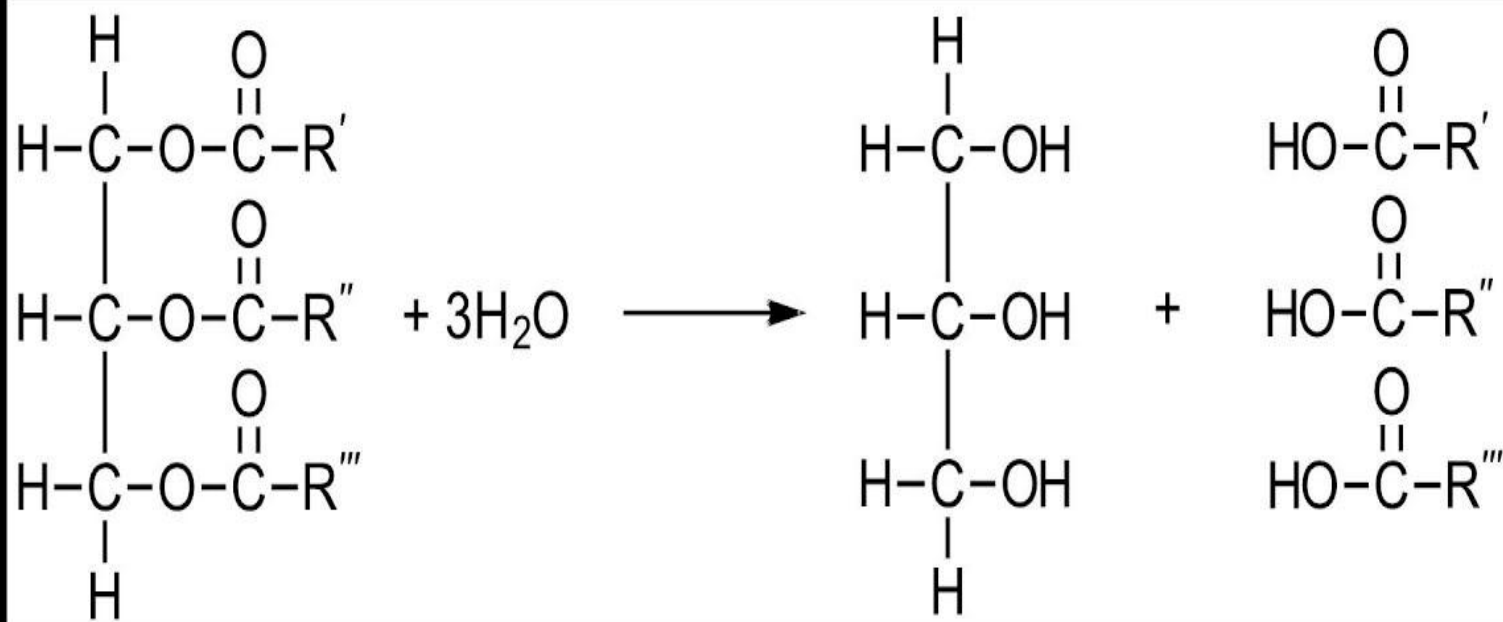
VANTUODUVIIC



ASTAXANTHINE

Hydrolysis

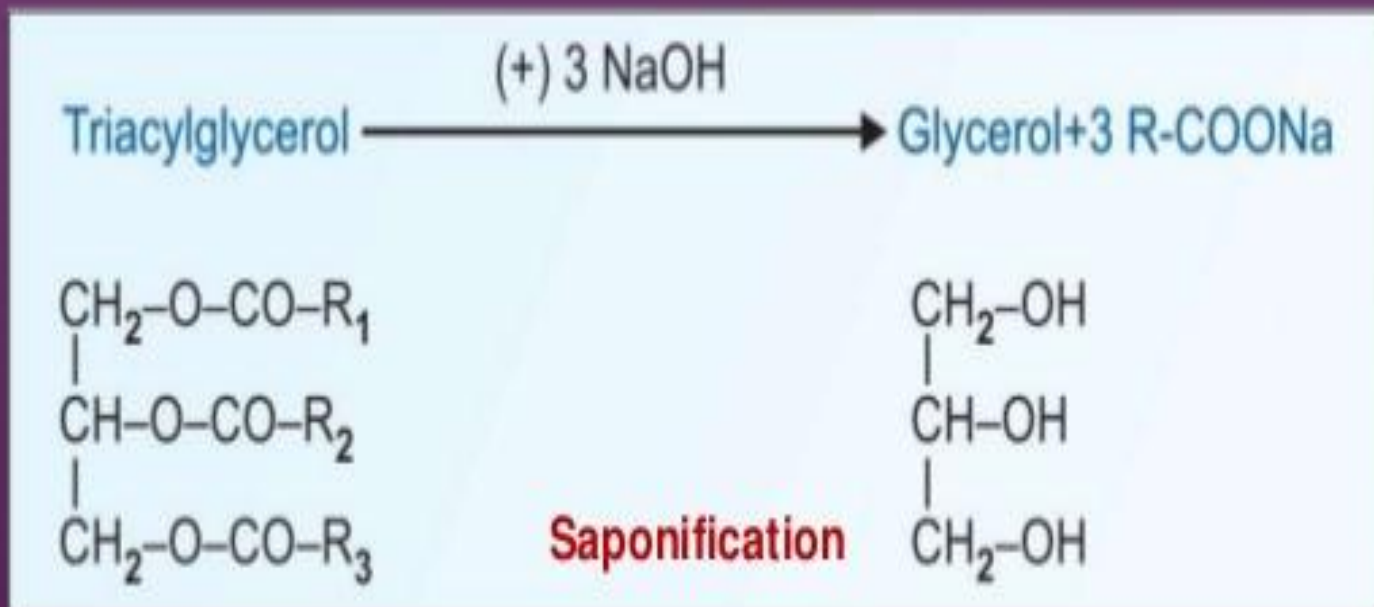
- Fats and oils are hydrolysed in the human body by the enzyme **lipase**.



triglyceride + water \longrightarrow glycerol + 3 fatty acids

Saponification

- When triacylglycerols are hydrolyzed by alkali, the process is known as saponification. The products are glycerol and soaps.



RANCIDITY

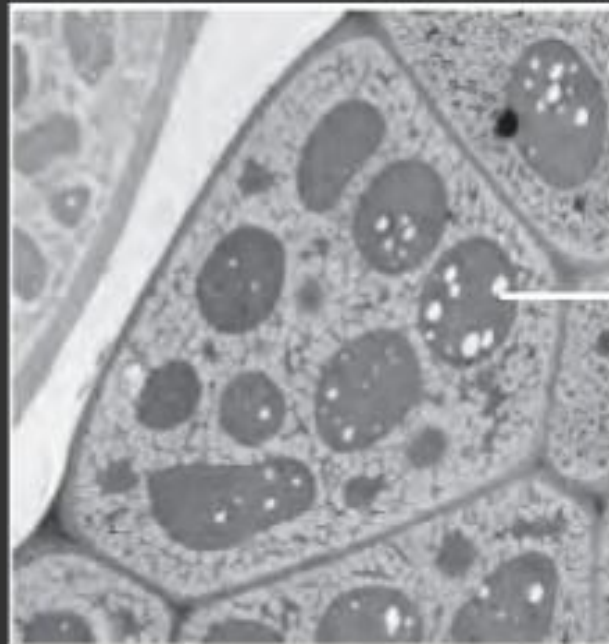
What is rancidity?

- Rancidity is the development of unpleasant smells in fats and oils, which are often accompanied by changes in their texture and appearance.
- Two types of rancidity:
 - Hydrolytic rancidity
 - Oxidative rancidity (auto-oxidation)



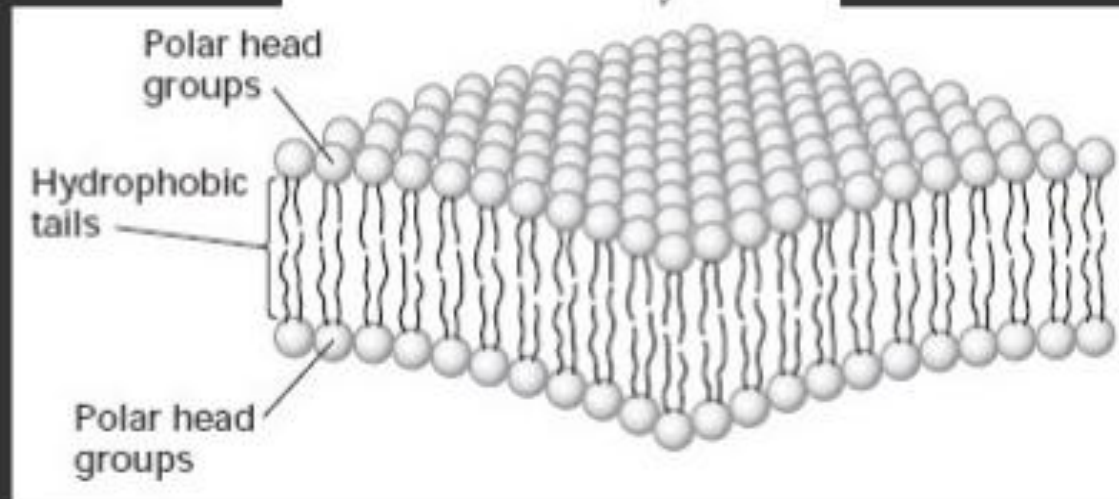
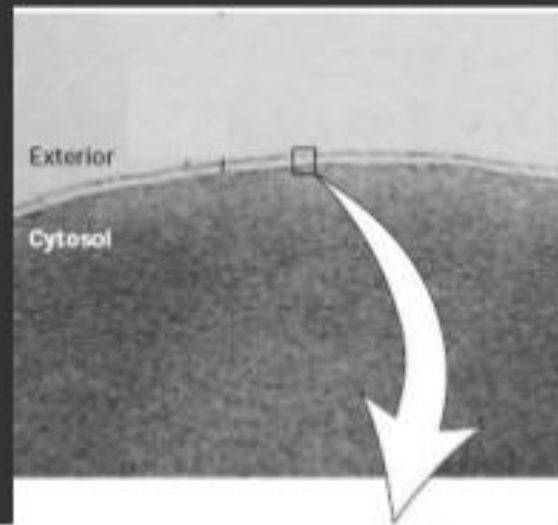
BIOMEDICAL IMPORTANCE

1. Stored as a source of energy in the body.

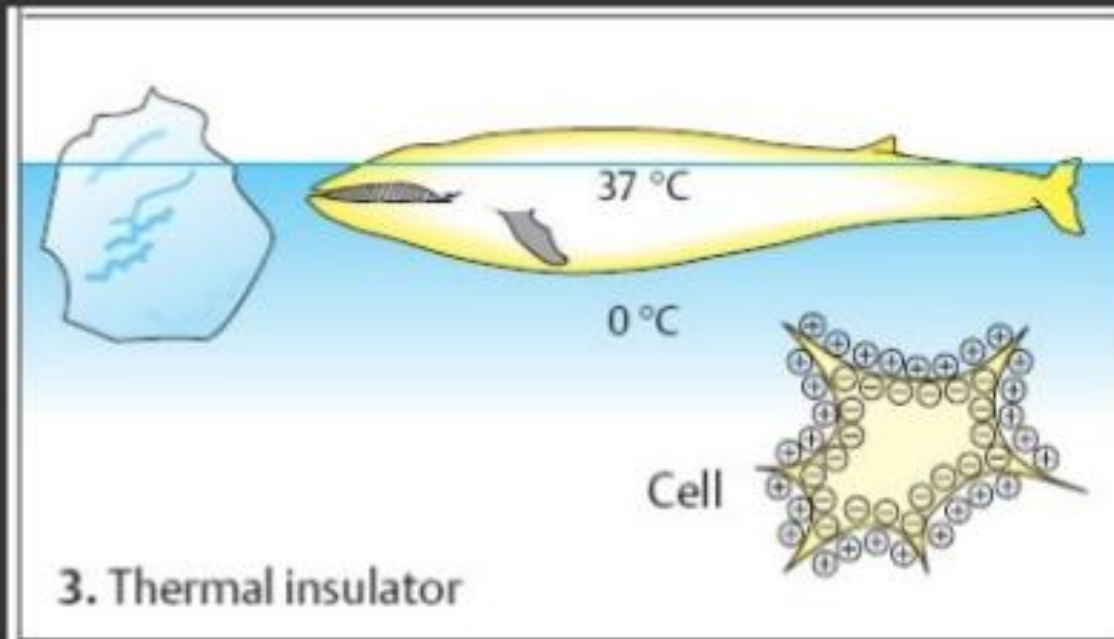


Lipid (TGL)
Droplets In
Adipose tissue

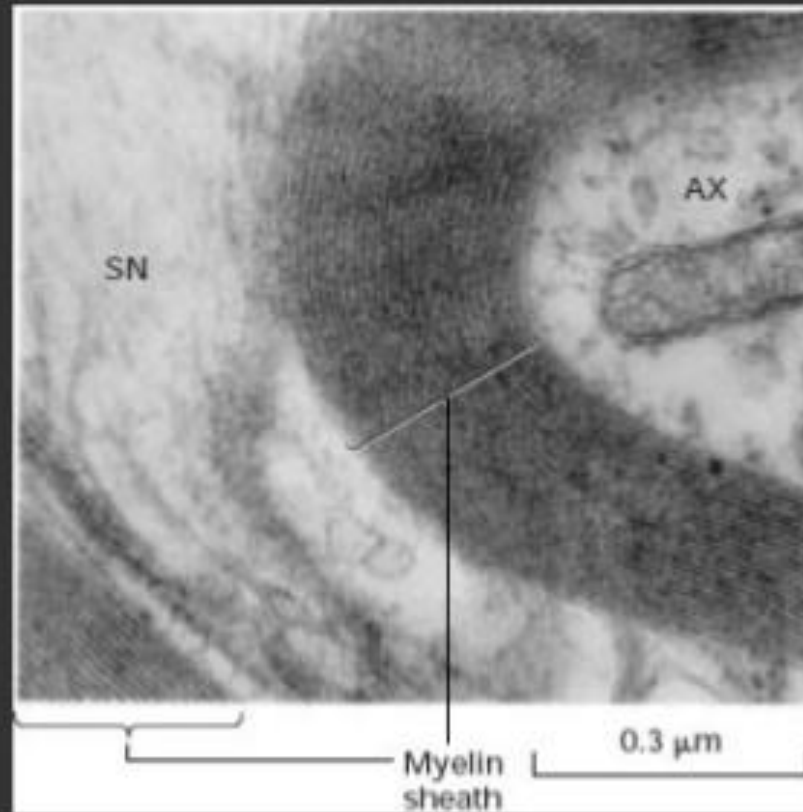
2. Structural components of biomembranes.



3. Thermal Insulator :
Provides insulation against changes in external temperature.



4. Lipids act as electric insulators in neurons.



5. Act as metabolic regulators (steroid hormones and prostaglandins).
6. Act as surfactants and prevents collapse of lungs during expiration.
7. Lipids are used as detergents.
8. Lipids used in emulsification and intestinal absorption of non polar nutrients like fatty acids and fat soluble vitamins.
9. Associated with diseases such as atherosclerosis, diabetes mellitus and obesity.
10. Gives shape and contour to the body.

Biological importance of phospholipids:

1-they form the cell membrane, mitochondria and golgi apparatus.

2-the brain and nerves are rich in cephalins and sphingomyelin.

3-cephalins are necessary for blood clotting.

4-phospholipids are necessary for absorption of lipids from the intestine.

5-phospholipids are necessary for transport of fat from the liver to the its stores.

deficiency of choline, inositol and the amino acid methionine lead to accumulation of fat in the hepatic cells a condition called **fatty liver**.

These substances are called **lipotropic factors**

Biological Importance of Lipids:

- 1. Source of energy.**
- 2. Carrier of vitamins.(A,D,E,K)**
- 3. Structural function.(phospholipids and spingolipids Inter in the construction of the plant cell wall)**
- 4. Protective coating. Such as waxes that important as Aprotective cover the tissues of plants and some animals.**