LIPIDS

FYBSc

DEFINITION

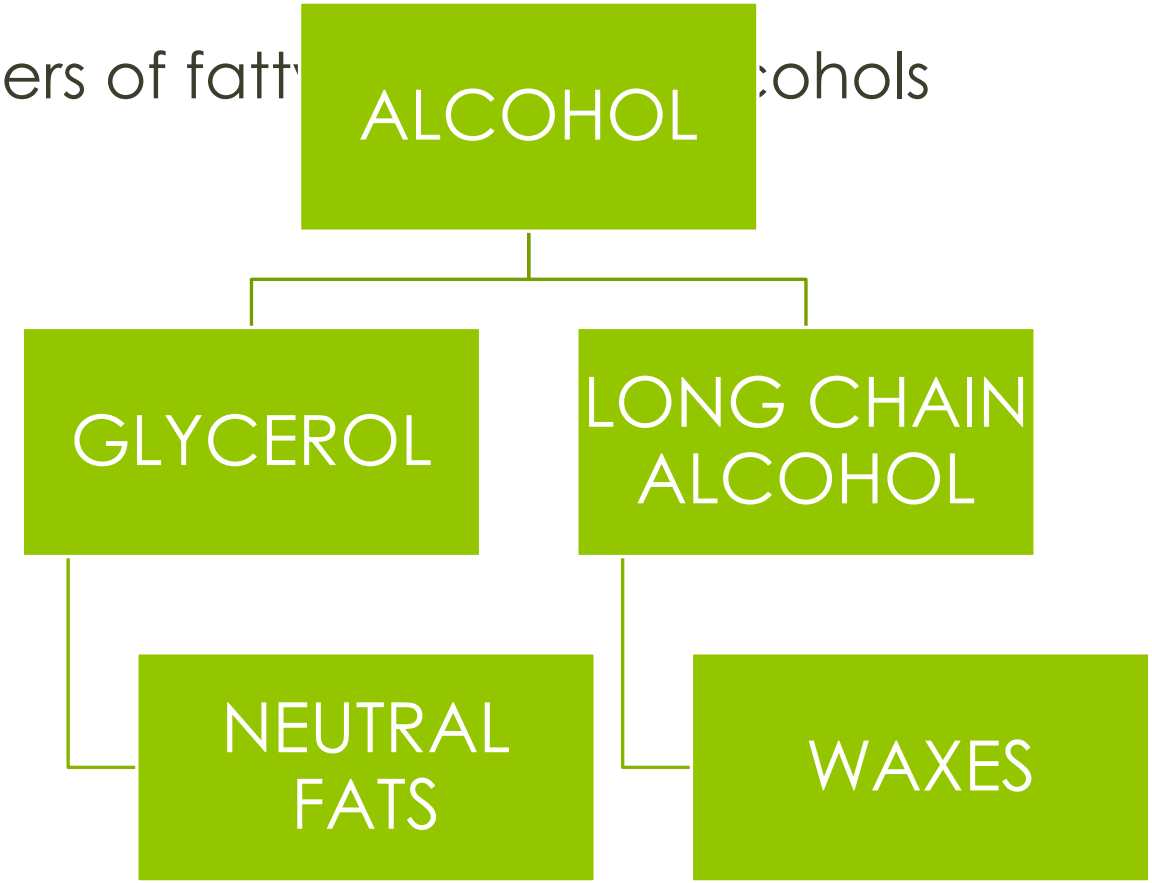
- Heterogeneous group of compounds
- Fats, oil, steroid, waxes
- Insoluble in water
- Soluble in organic solvents- ether, chloroform etc

CLASSIFICATION OF LIPIDS

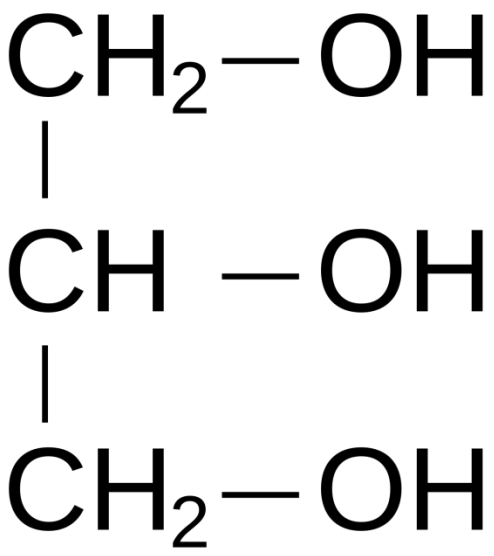
- SIMPLE LIPIDS
- COMPOUND LIPIDS
- DERIVED LIPIDS

SIMPLE LIPIDS

- Esters of fatt :ohols



GLYCEROL



LONG CHAIN ALCOHOL

- Cetyl alcohol
- $CH_3 (CH_2)_{14} CH_2OH$

- Myricyl alcohol
- $CH3 (CH_2)_{28} CH_2OH$

FATTY ACIDS

- 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
$CH_3(CH_2)_{10}COOH$	LAURIC ACID (12:0)
$CH_3(CH_2)_{12}COOH$	MYRISTIC ACID (14:0)
$CH_3(CH_2)_{14}COOH$	PALMITIC ACID (16:0)
$CH_3(CH_2)_{16}COOH$	STEARIC ACID (18:0)
$CH_3(CH_2)_{18}COOH$	ARCHIDIC ACID (20:0)

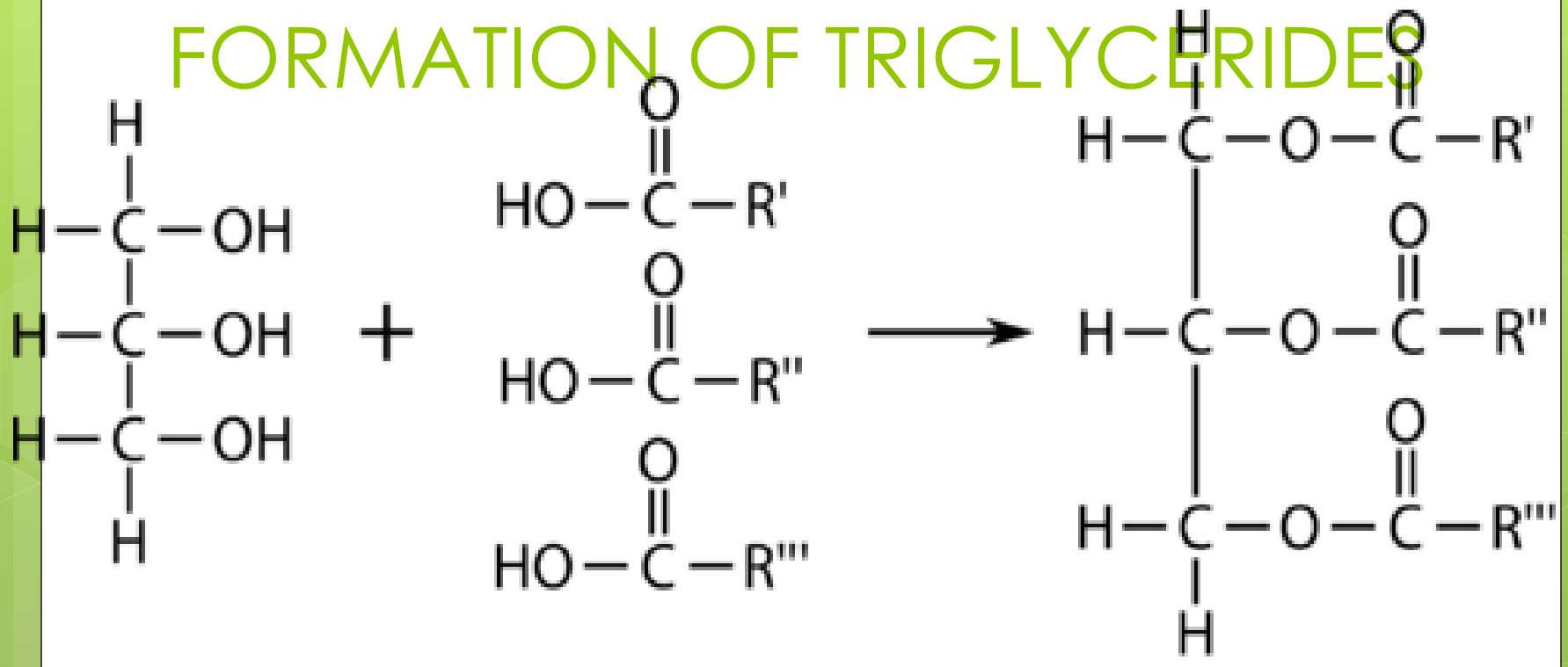
UNSATURATED FATTY ACIDS

MOLECULAR FORMULA	COMMON NAME
$CH_3(CH_2)_5CH=CH(CH_2)_7COOH$	OLEIC ACID 16:1(9)
$CH_3(CH_2)_4CH=CHCH_2CH=CH(CH_2)_7COOH$	LINOLEIC ACID 18:2(9,12)
$CH_3CH_2C\ H=CH\ CH_2C\ H=CH\ C\ H_2CH=CH(CH_2)_7COOH$	LINOLENIC ACID 18:3(9,12,15)

NEUTRAL FATS

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

FORMATION OF TRIGLYCERIDES

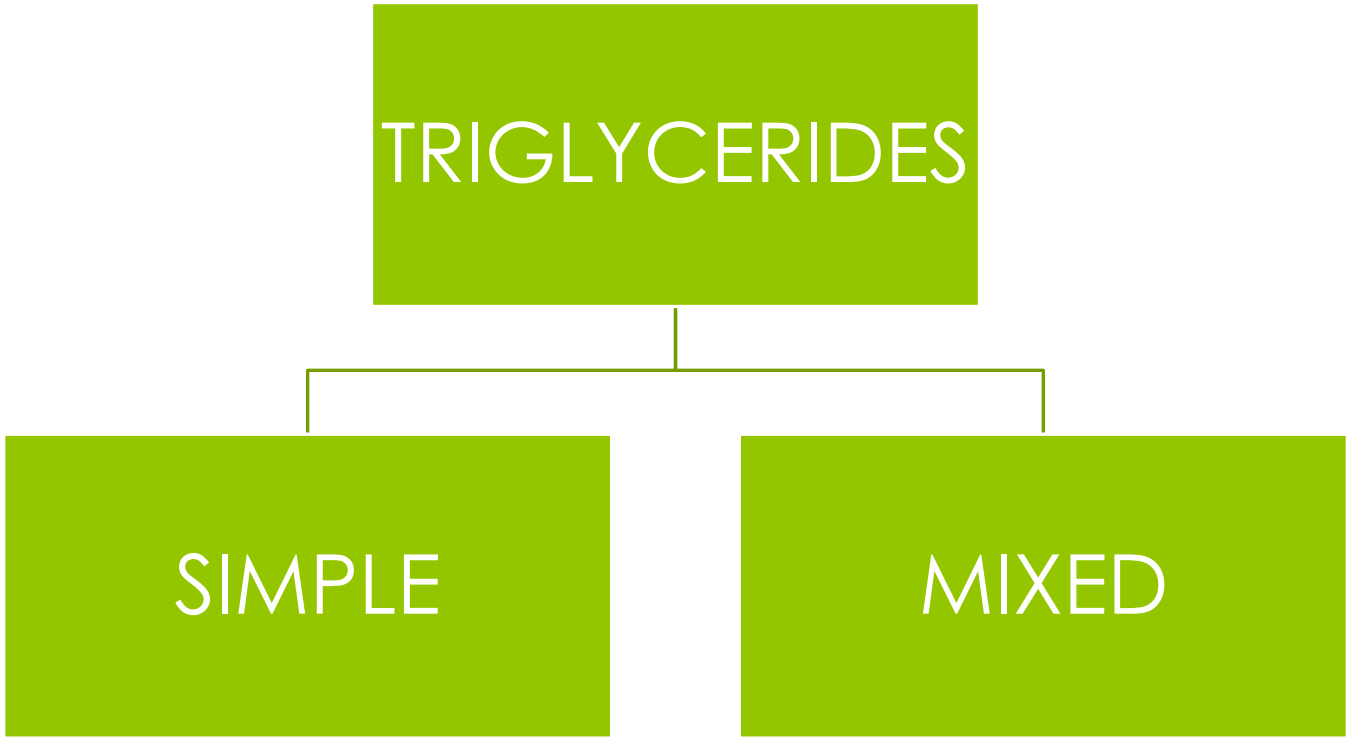


glycerol

3 fatty acids

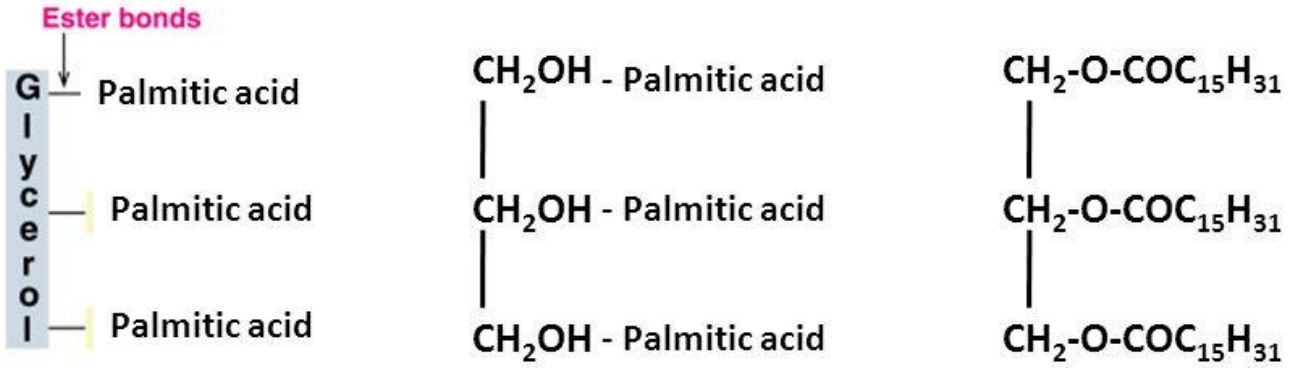
triglyceride
(triester of glycerol)

TRIGLYCERIDES



Tripalmitin

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

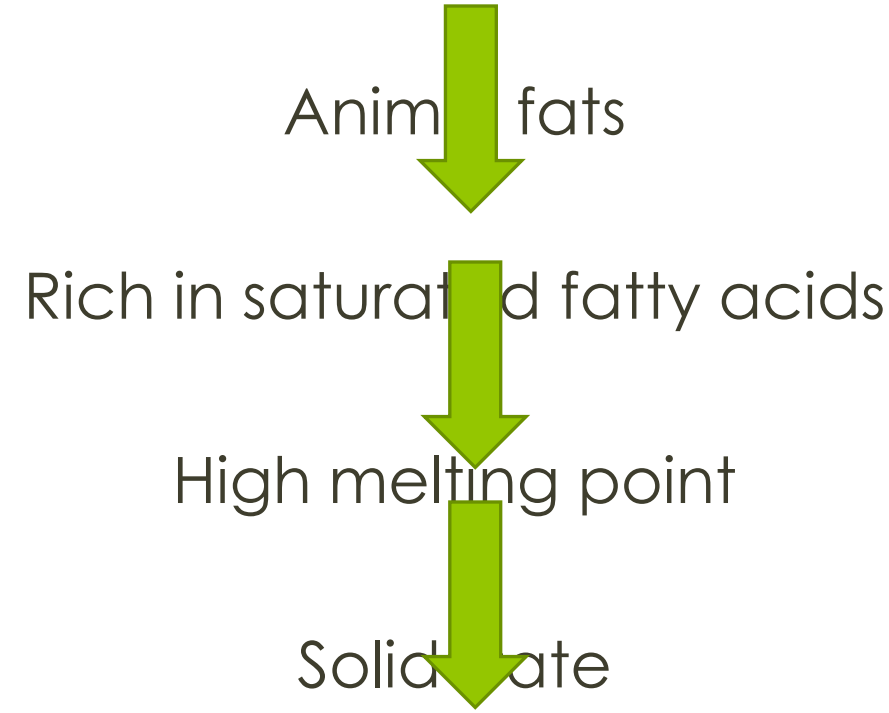


Formation of a triglyceride, as simple lipid

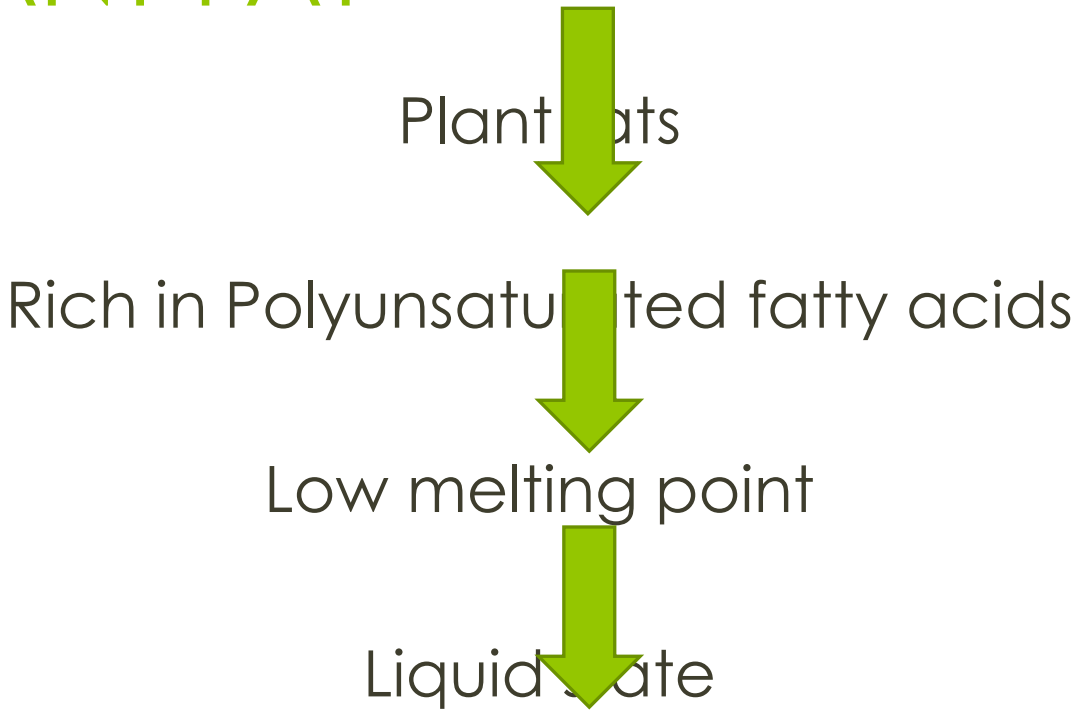
MIXED TRIGLYCERIDES

- Oleodipalmitin
- Oleopalmitostearin

ANIMAL FAT


Anim fats
Rich in saturat d fatty acids
High melting point
Solid ate

PLANT FAT


Plant fats
Rich in Polyunsaturated fatty acids
Low melting point
Liquid state

WAXES

Weax---- 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

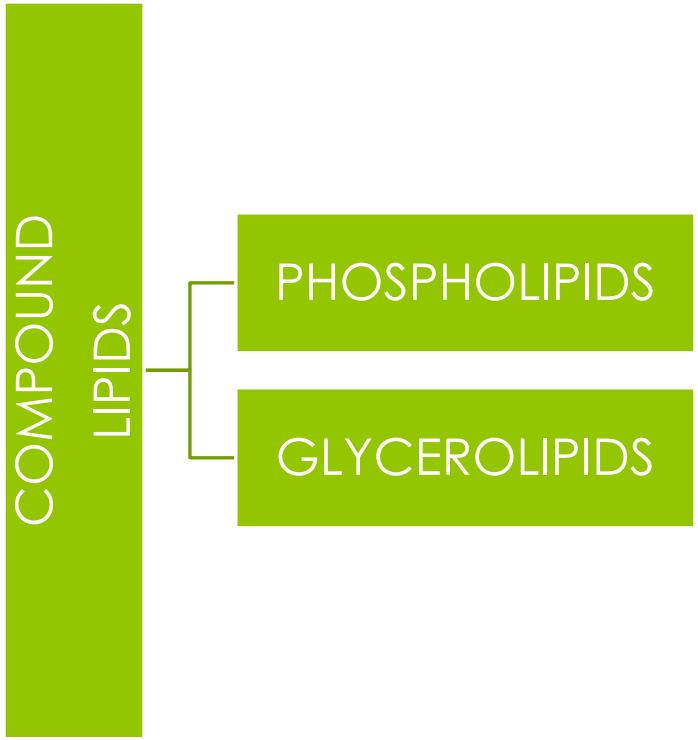
Preening in birds

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

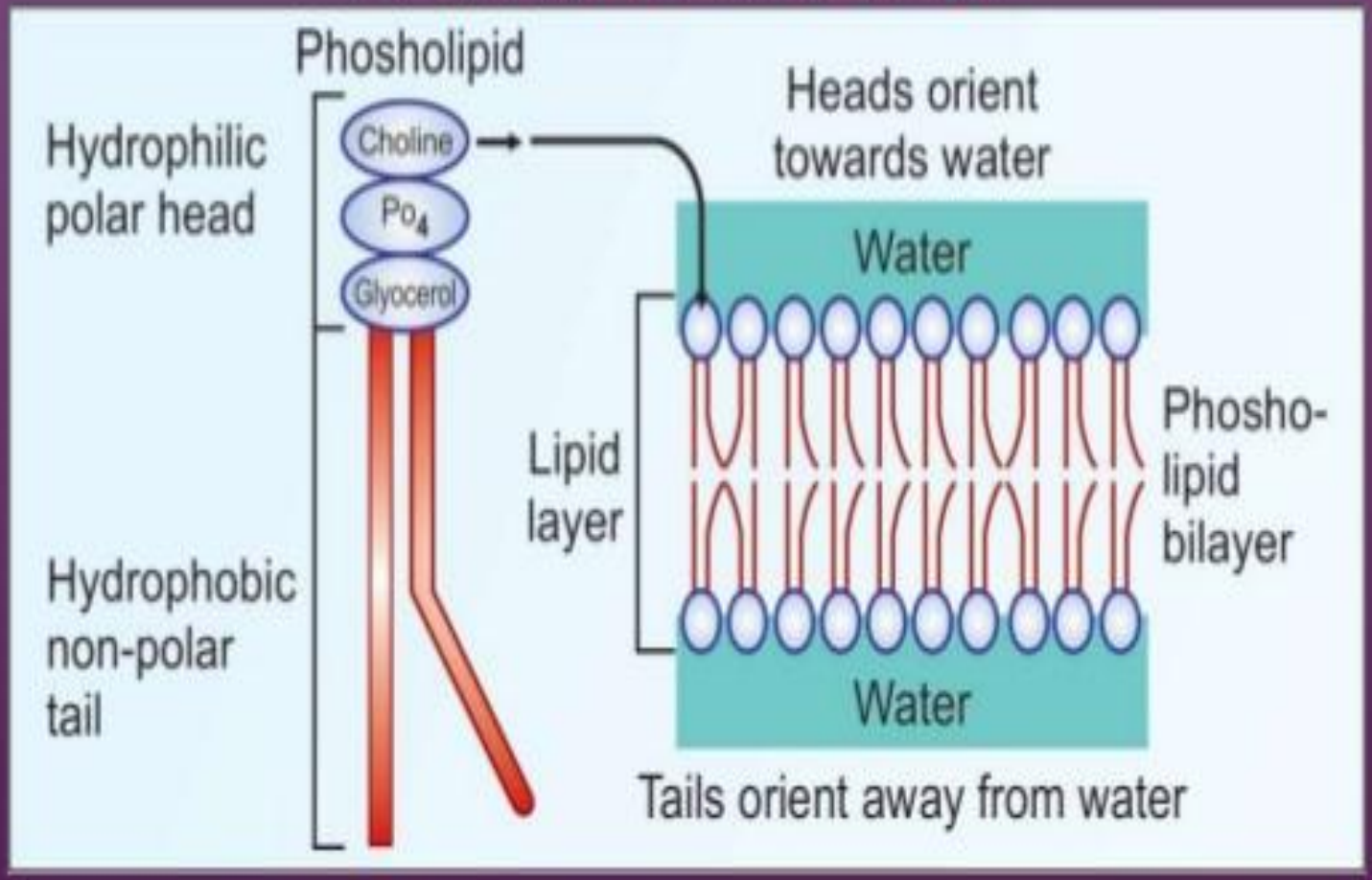


PHOSPHOLIPIDS

- 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

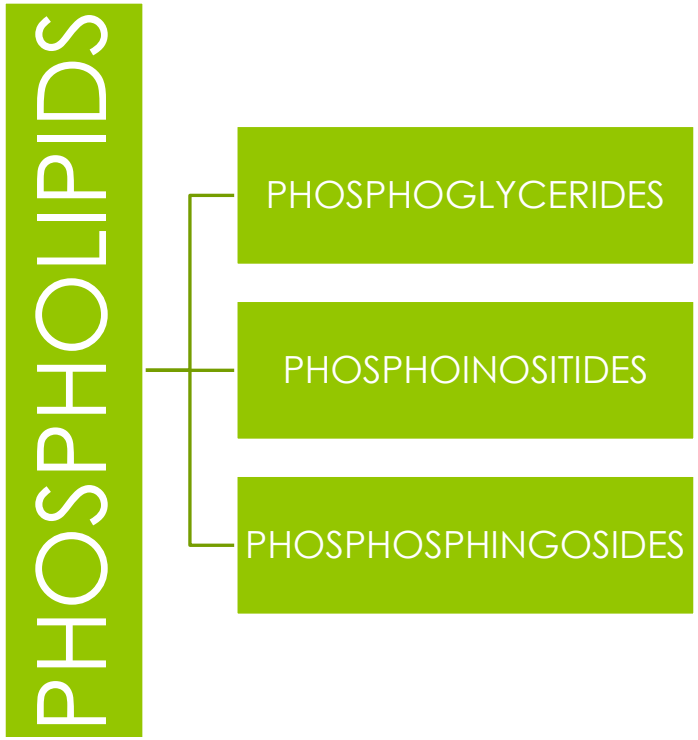
Phospholipids form the bilayer

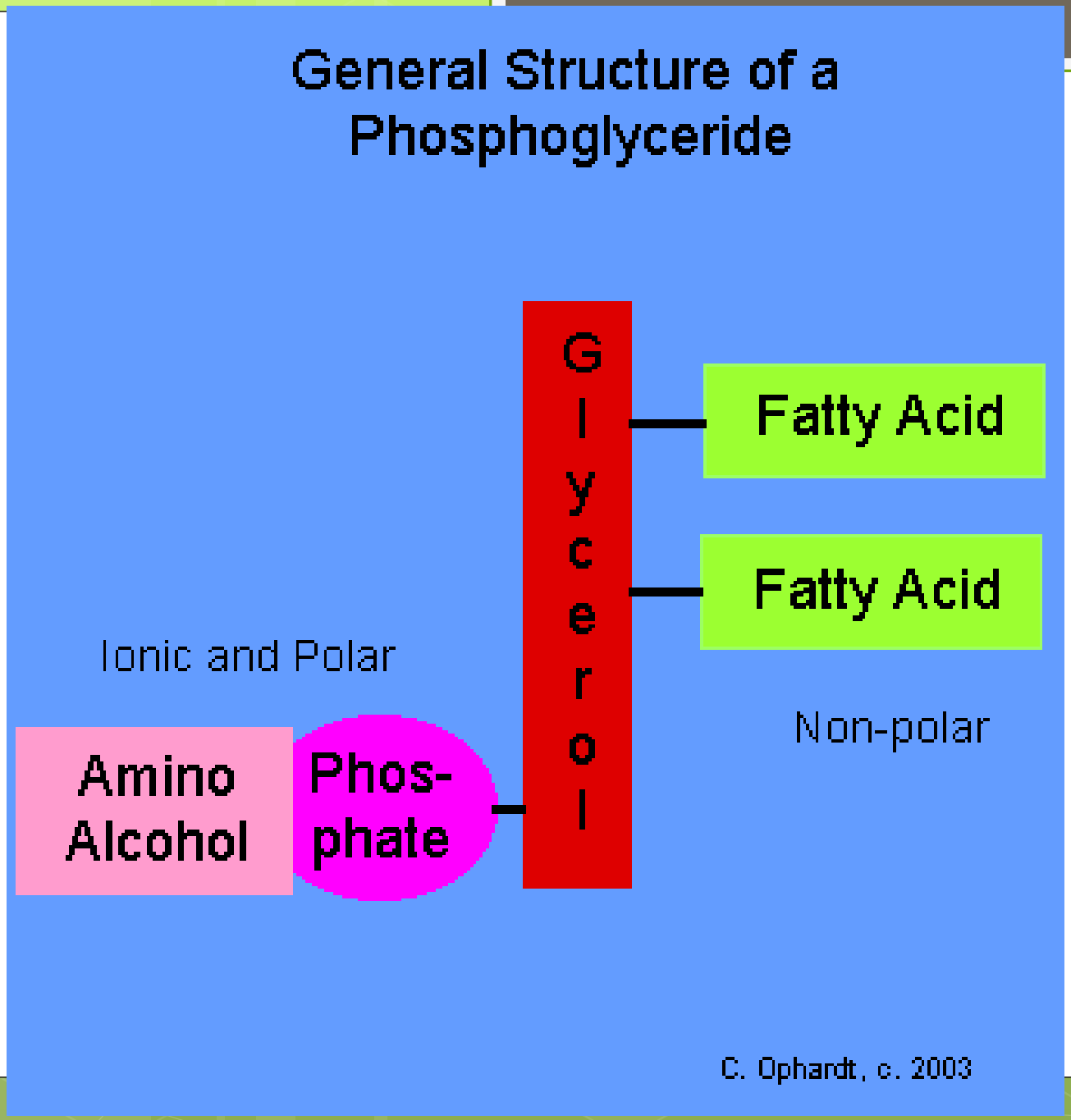


PHOSPHOLIPIDS

- Glycerol + 3 Fatty acids + Phosphoric acid

PHOSPHOLIPIDS

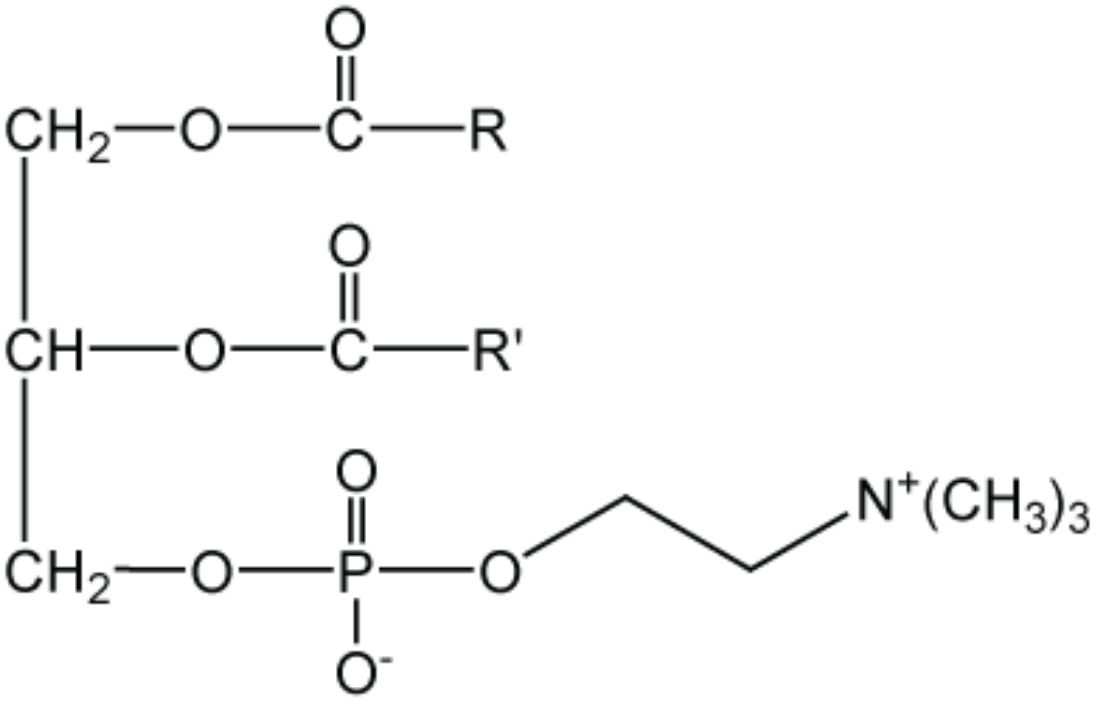



General Structure of a Phosphoglyceride
Glycerol
Fatty Acid
Fatty Acid
Ionic and Polar
Non-polar
Amino Alcohol
Phos-phate
C. Ophardt, c. 2003

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

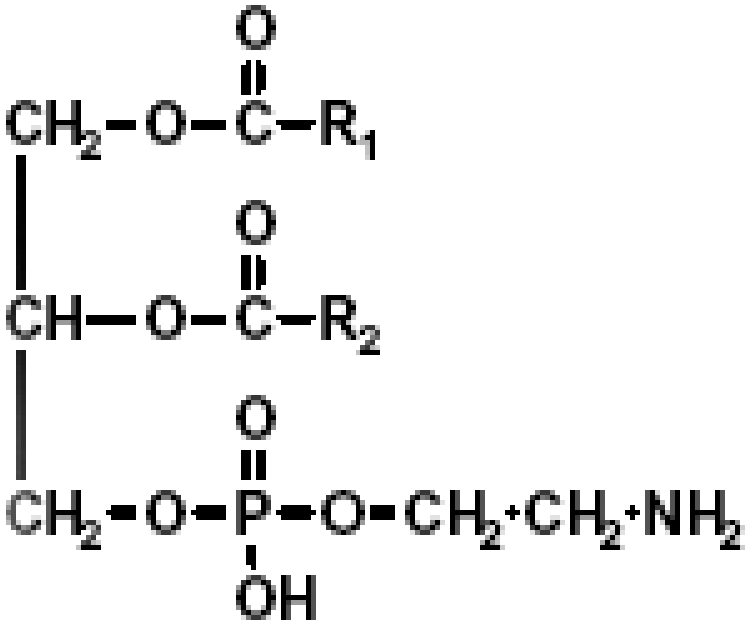
LECITHIN

- Phosphatidyl choline



CEPHALIN

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

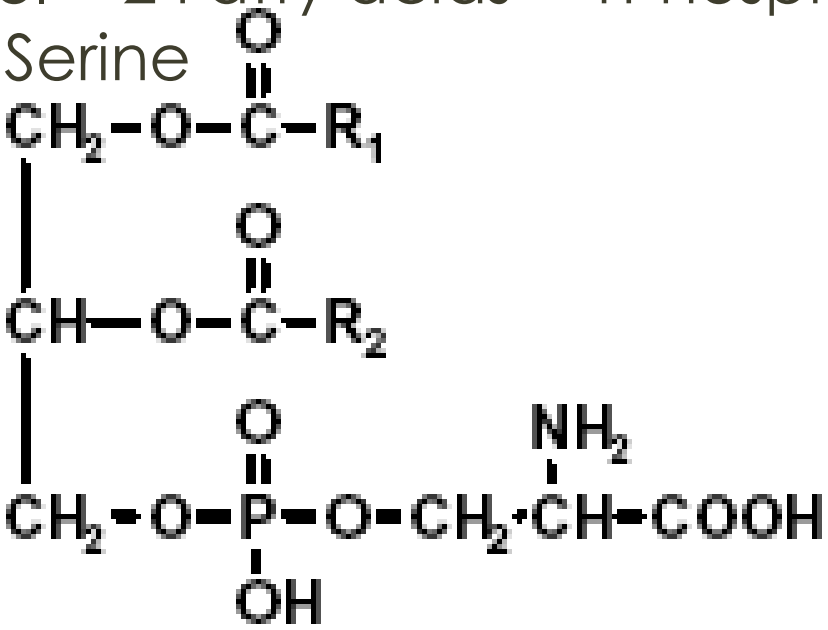


Cephalin

(Phosphatidyl ethanolamine)

PHOSPHATIDYL SERINE

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

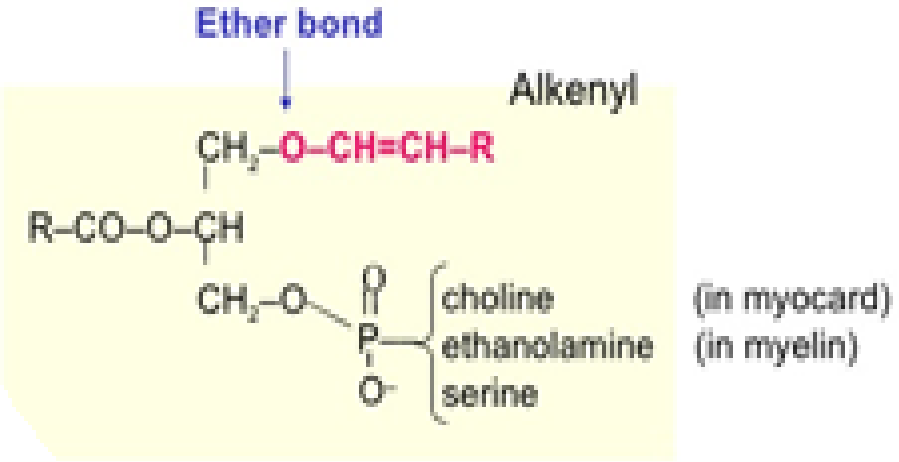


Cephalin

(Phosphatidyl serine)

PLASMALOGENS

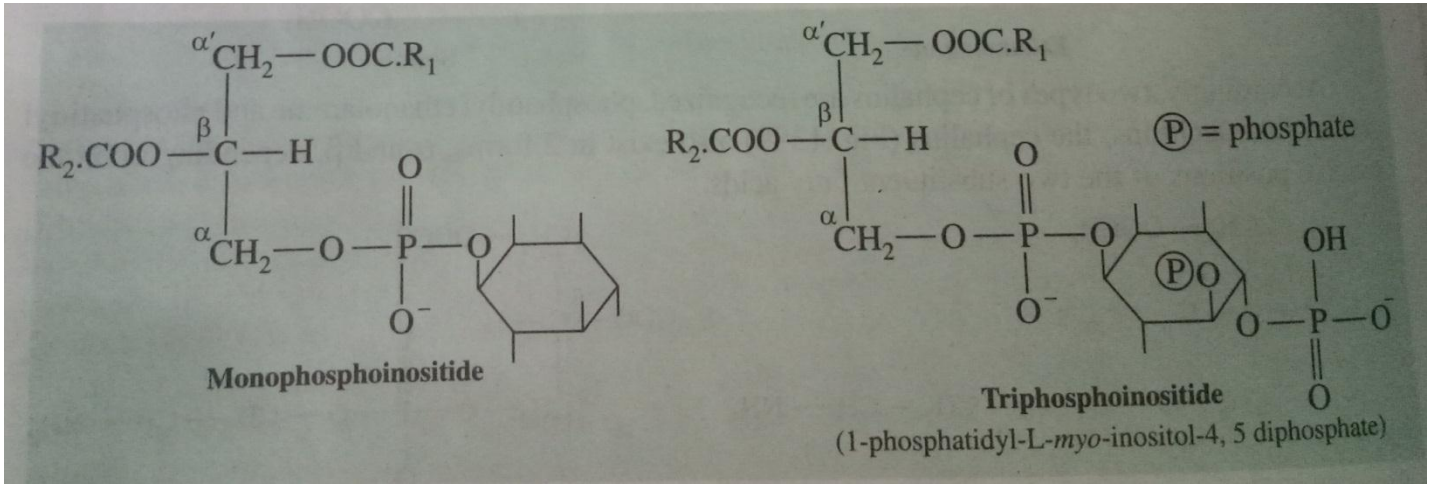
- Modified Glycerolipids Alkoxy lipids
- 1 Fatty acid + 1Phosphoric acid + Choline/ Ethanolamine / Serine + Glycerol + Aldehyde



PHOSPHOINOSITIDES

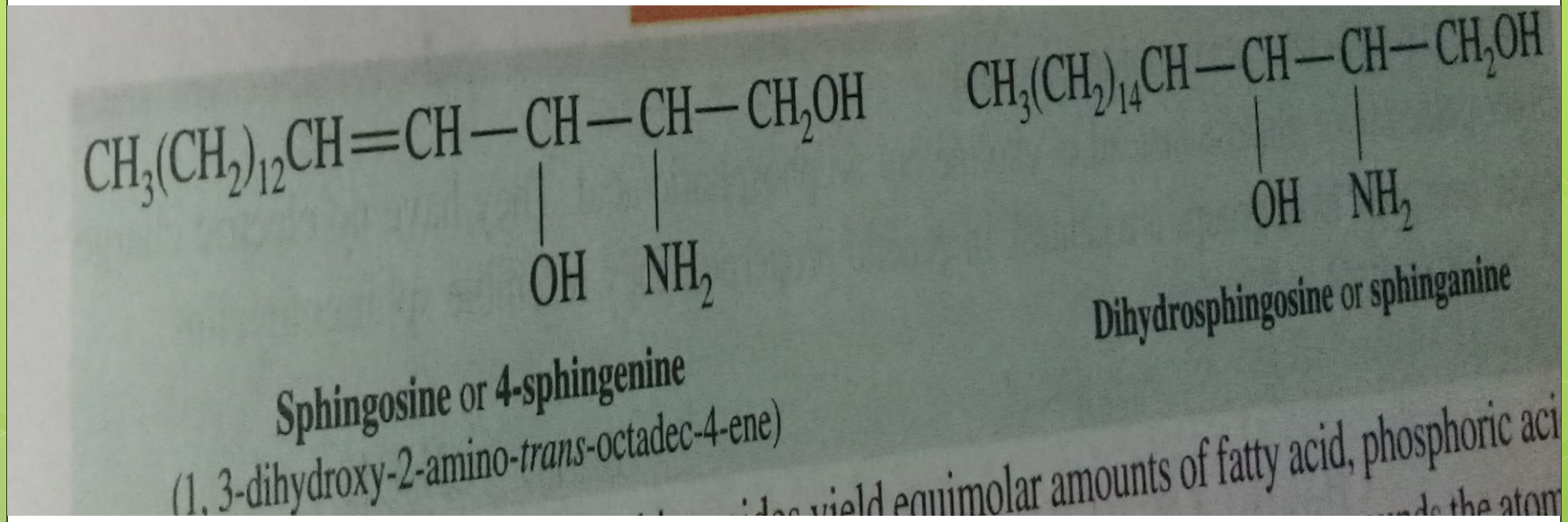
- Phosphatidyl inositol
- Brain cells, Soya bean
- Transport
- 1 Glycerol + 2 Fatty acids + 1 Phosphoric acid + Inositol

PHOSPHOINOSITIDES

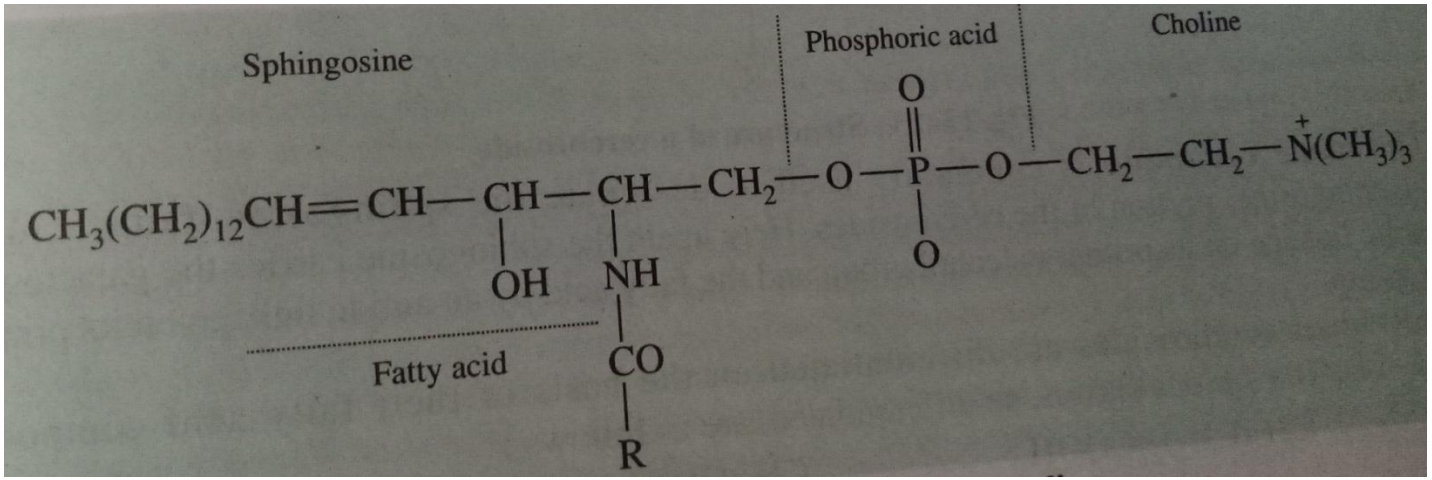


PHOSPHOSPHINGOSIDES

- 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


$CH_3(CH_2)_{12}CH=CH-CH-CH-CH_2OH$
OH NH_2
Sphingosine or 4-sphingenine
(1, 3-dihydroxy-2-amino-*trans*-octadec-4-ene)
$CH_3(CH_2)_{14}CH-CH-CH-CH_2OH$
OH NH_2
Dihydrosphingosine or sphinganine
yield equimolar amounts of fatty acid, phosphoric aci

SPHINGOMYELIN



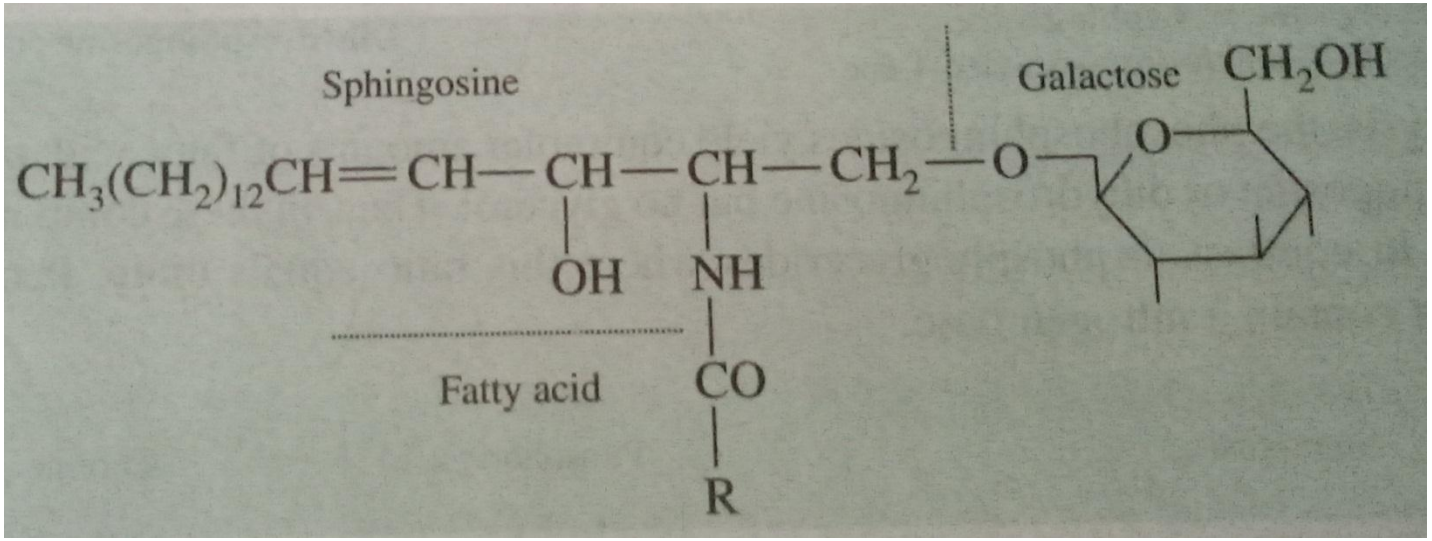
PHOSPHOSPHINGOSIDES

- Sphingosine + Fatty Acid + Phosphoric acid + Choline

GLYCOLIPIDS

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

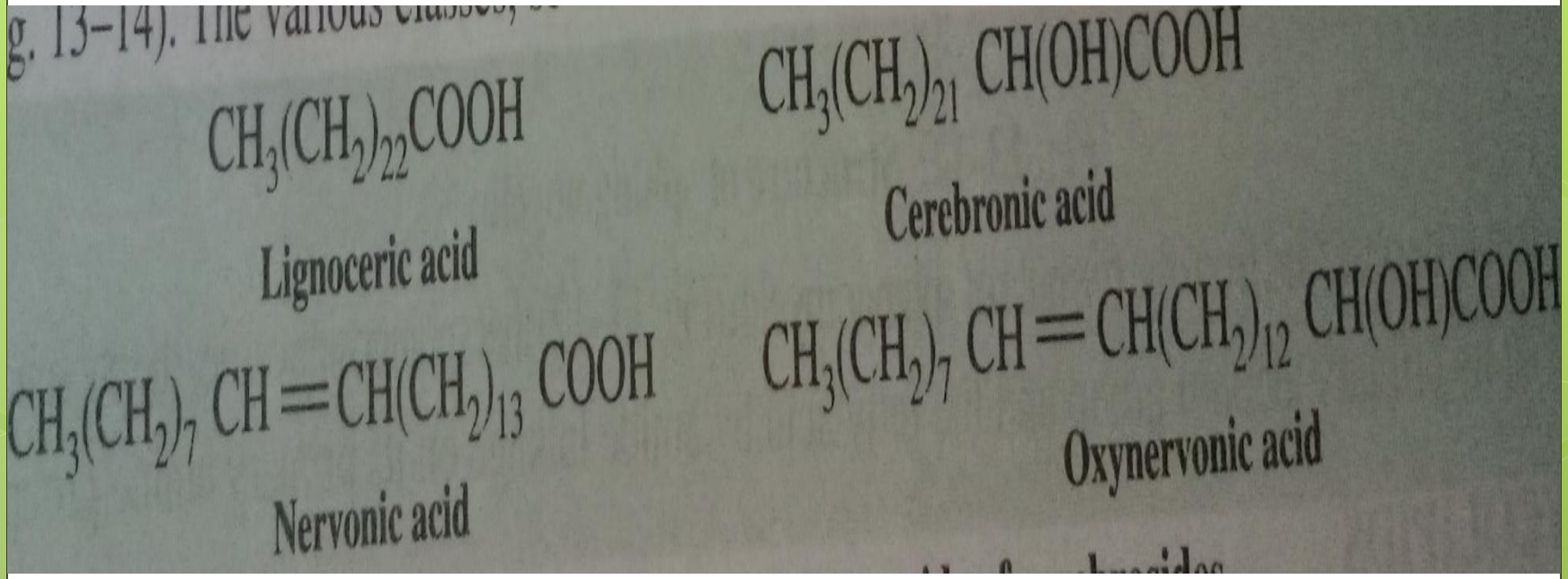
cerebrosides



GLYCOLIPIDS

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

g. 13–14). The various classes,

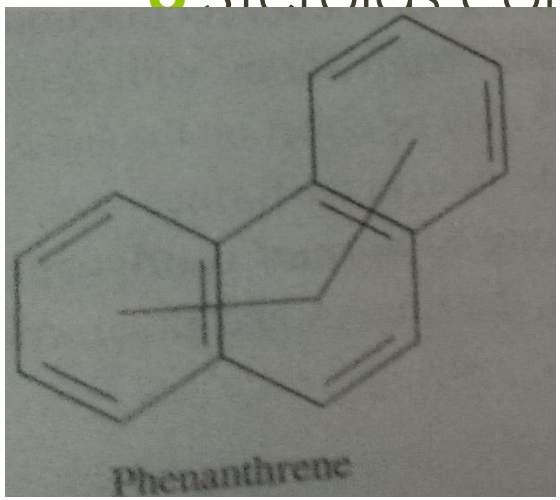


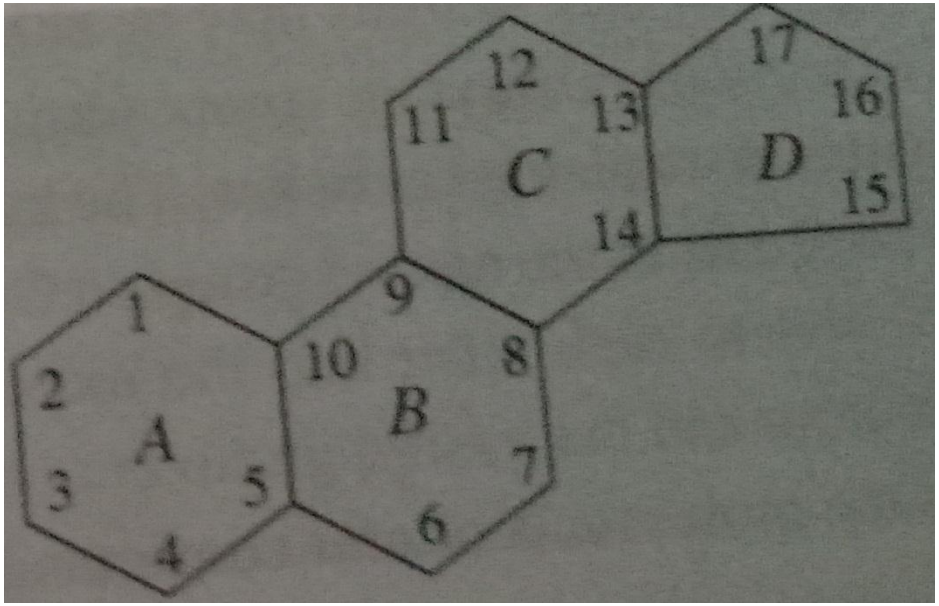
DERIVED LIPIDS

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

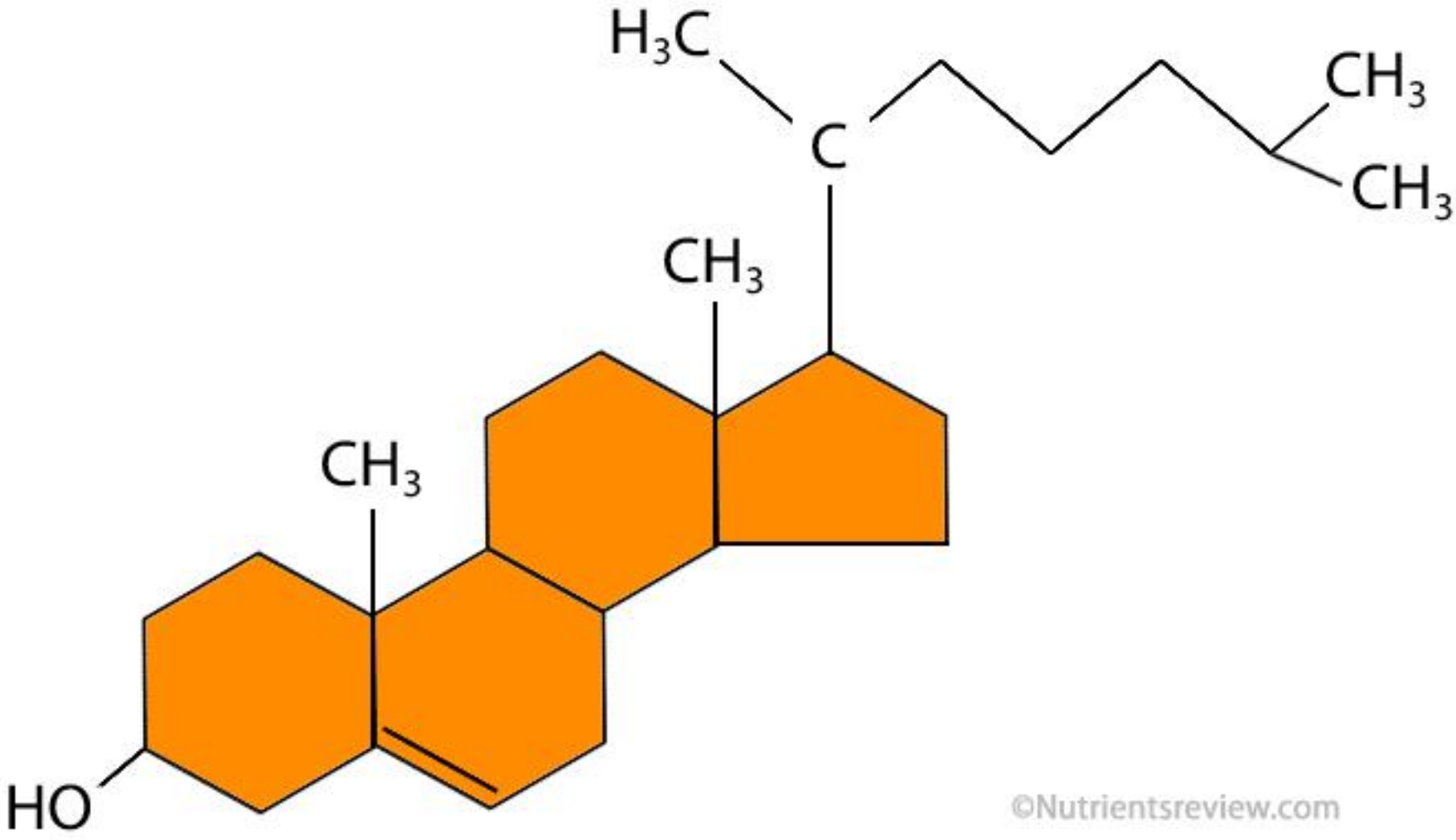
STEROIDS

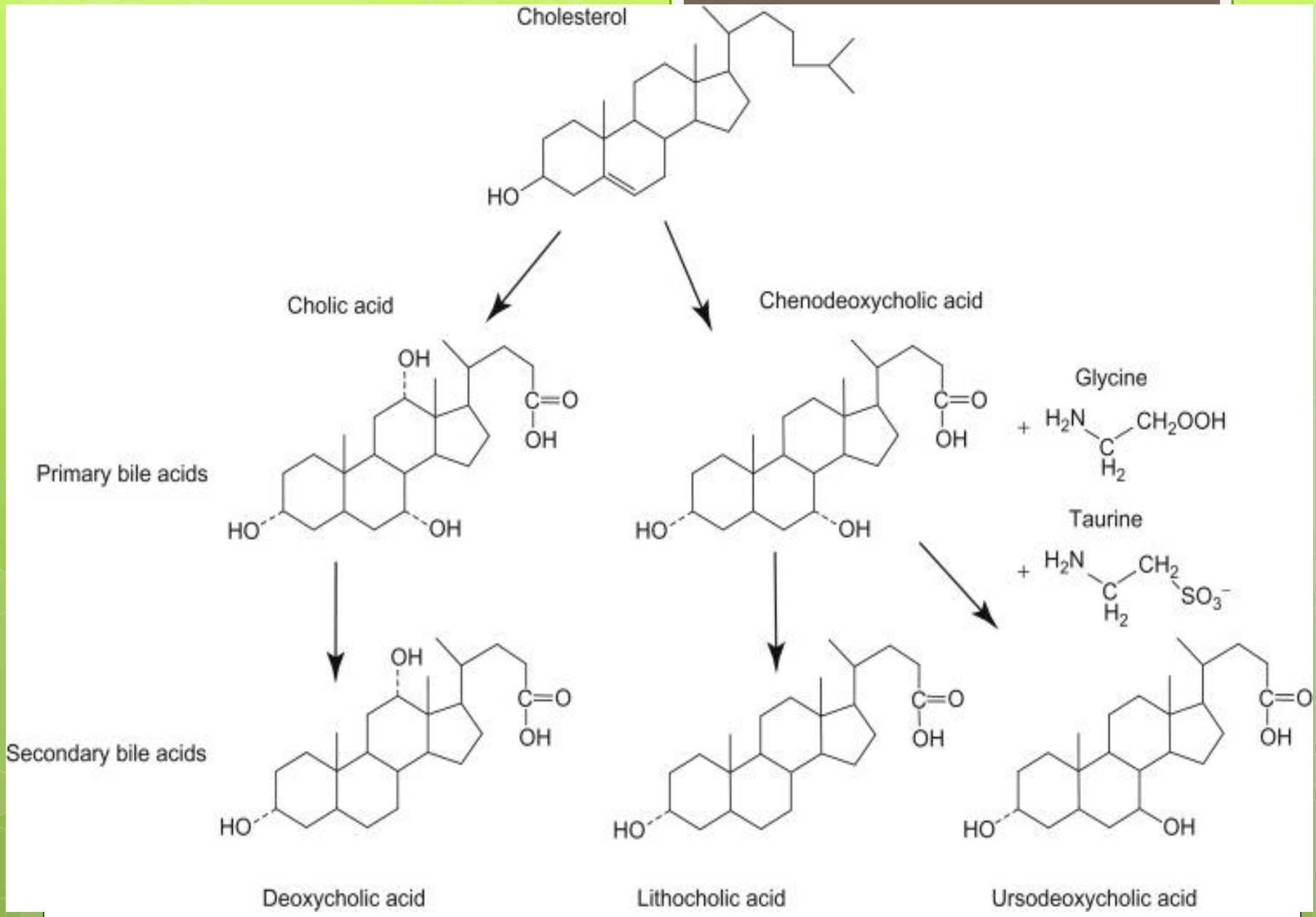
- Cyclopentanoperhydrophenantherene
- Sterane
- Steroids contai





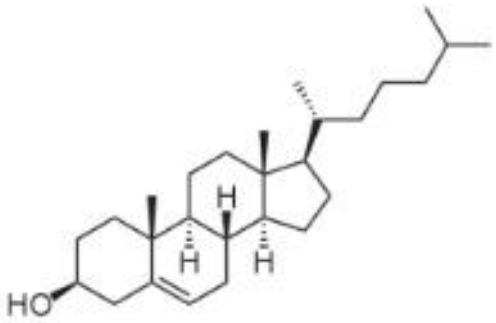
CHOLESTEROL



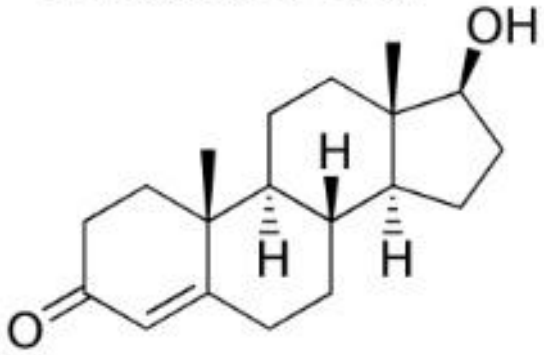

Cholesterol
HO
Cholic acid
Chenodeoxycholic acid
Primary bile acids
OH
C=O
OH
HO
OH
Glycine
+
H_2N
CH_2OOH
C
H_2
Taurine
+
H_2N
CH_2
SO_3^-
C
H_2
Secondary bile acids
Deoxycholic acid
Lithocholic acid
Ursodeoxycholic acid

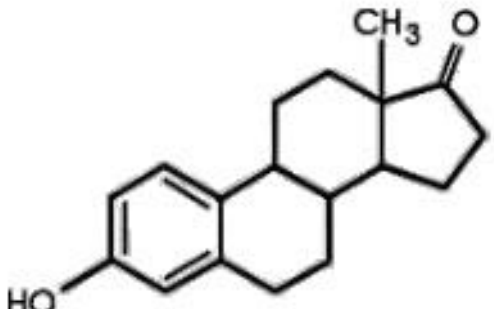
Steroid

Cholesterol



Testosterone

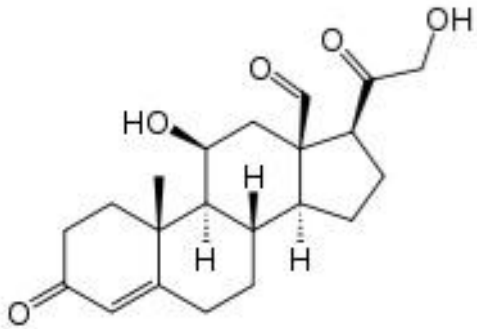


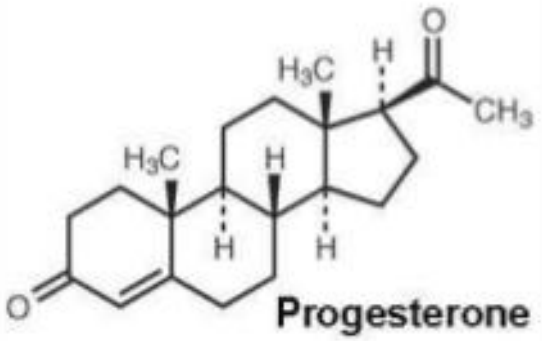


Estrogen

Cortisone

Aldoesterone

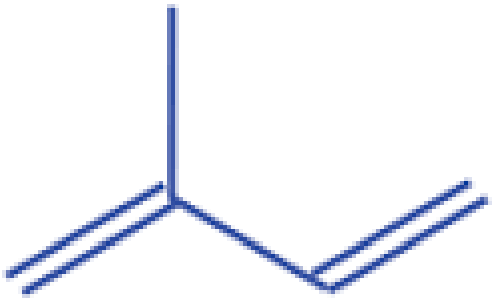




Progesterone

TERI

$$CH_2 = \underset{\displaystyle CH_3}{\overset{\displaystyle |}{C}} - CH = CH_2$$



Isoprene

C_5H_8

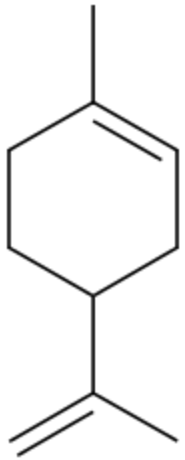
MONOTERPENE

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

OIL OF BAY

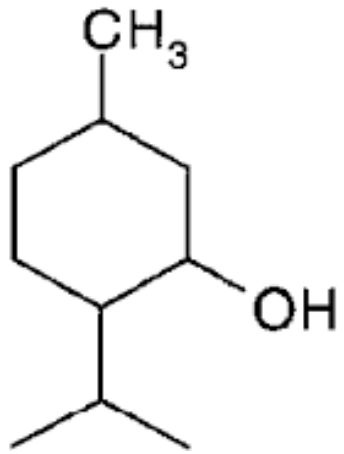
MONOTERPENE

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



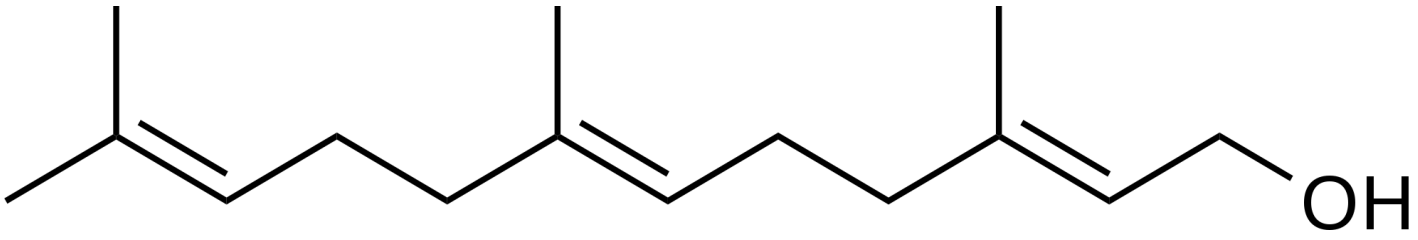
MONOTERPENES

Menthol



$C_{10}H_{20}O$

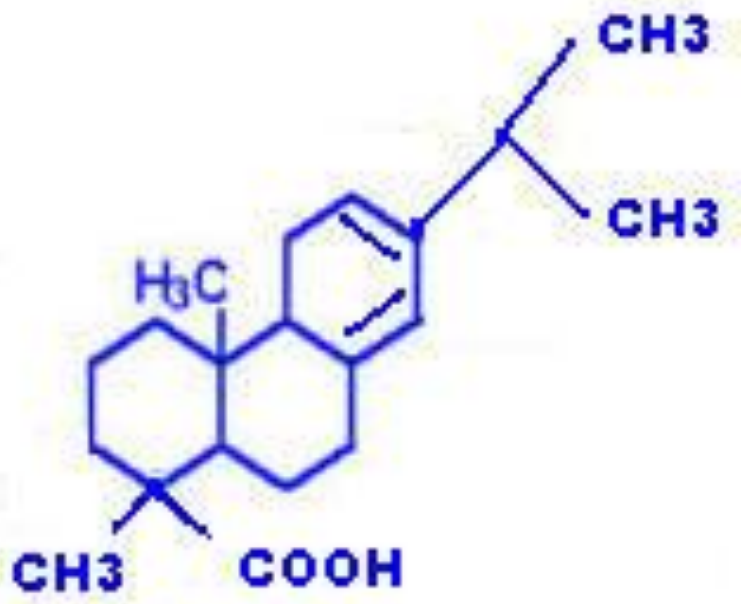
SESQUITERPENES
$C_{15}H_{24}$



FARNESOL

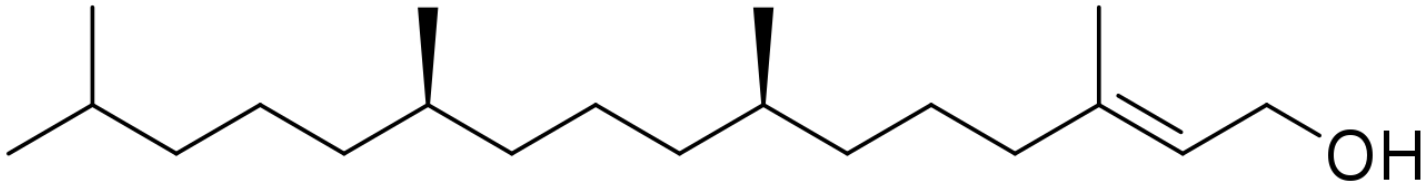
DITERPENES (RESINS)
$C_{20}H_{32}$

ABIETIC ACID



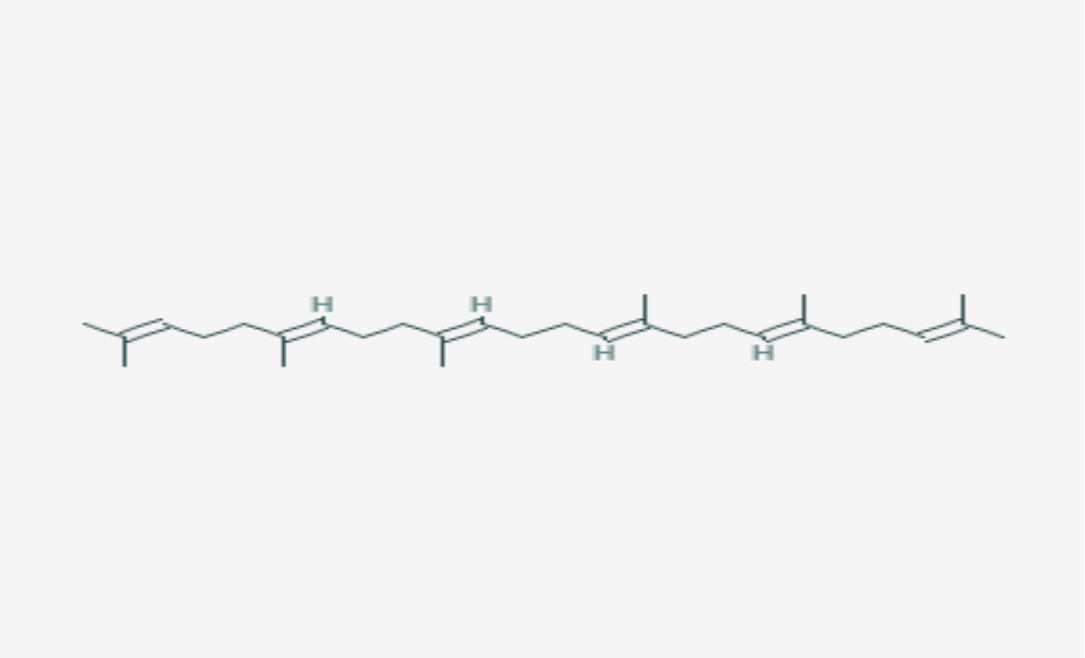
SAPIETIC ACID

DITERPENE



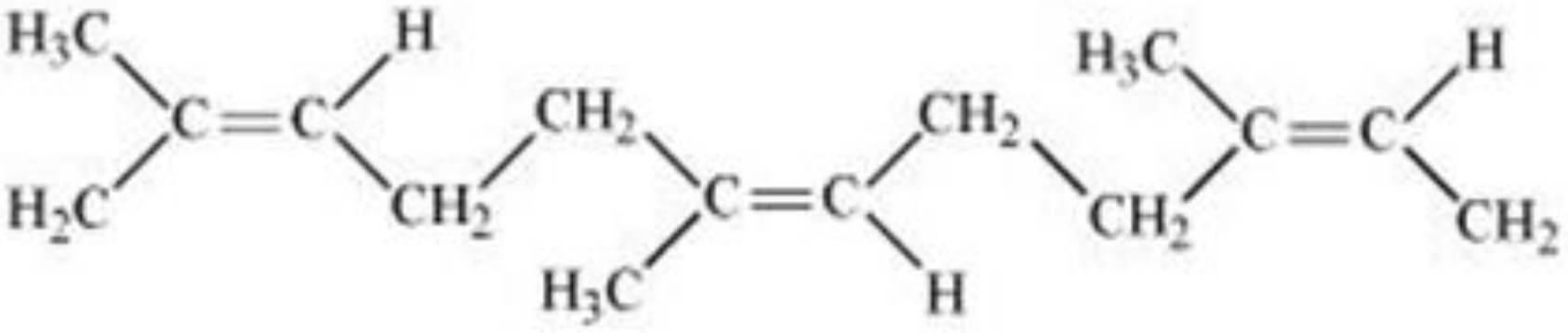
PHYTOL
ACYCLIC DITERPENE
HYDROLYSIS OF CHLOROPHYLL

TRITERPENE
$C_{30}H_{48}$



SQUALENE
$C_{30}H_{50}$

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

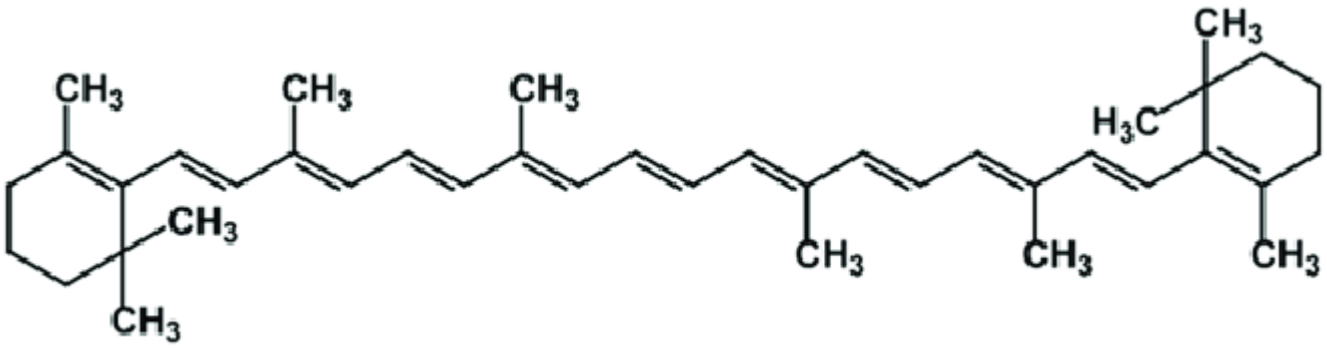
Lycopene

Molecular weight: 536.89

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

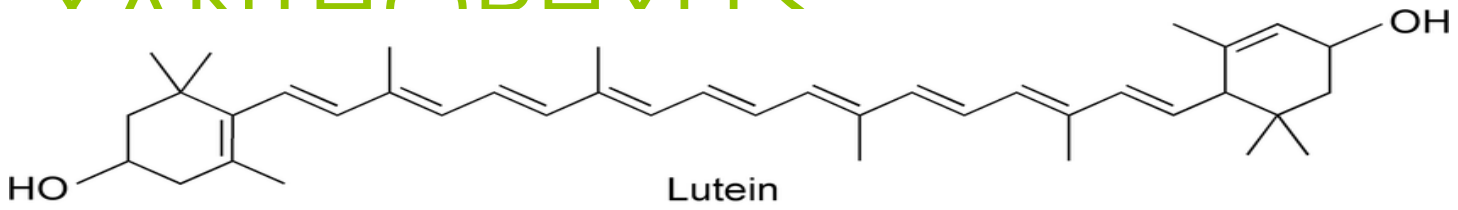
Molecular composition: C: 9.49%; H: 10.51%

CAROTENOIDS

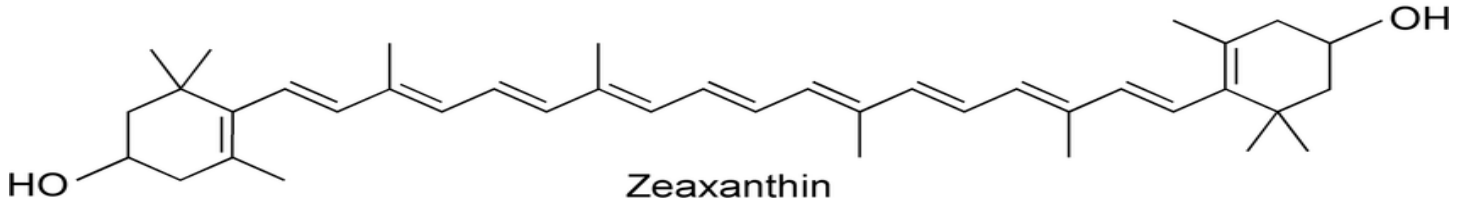


β CAROTENE

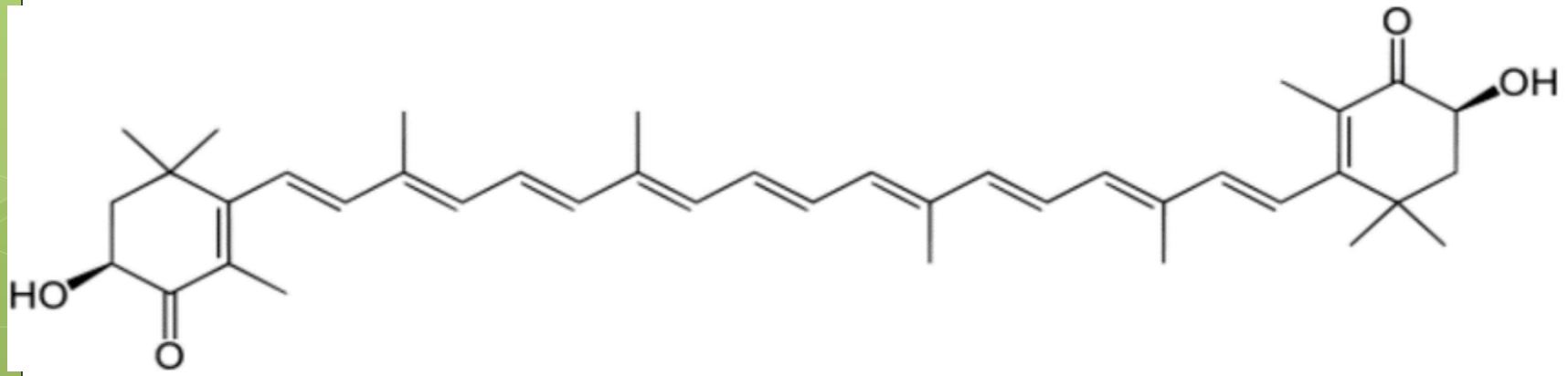
XANTHOPHYLLS



Lutein



Zeaxanthin

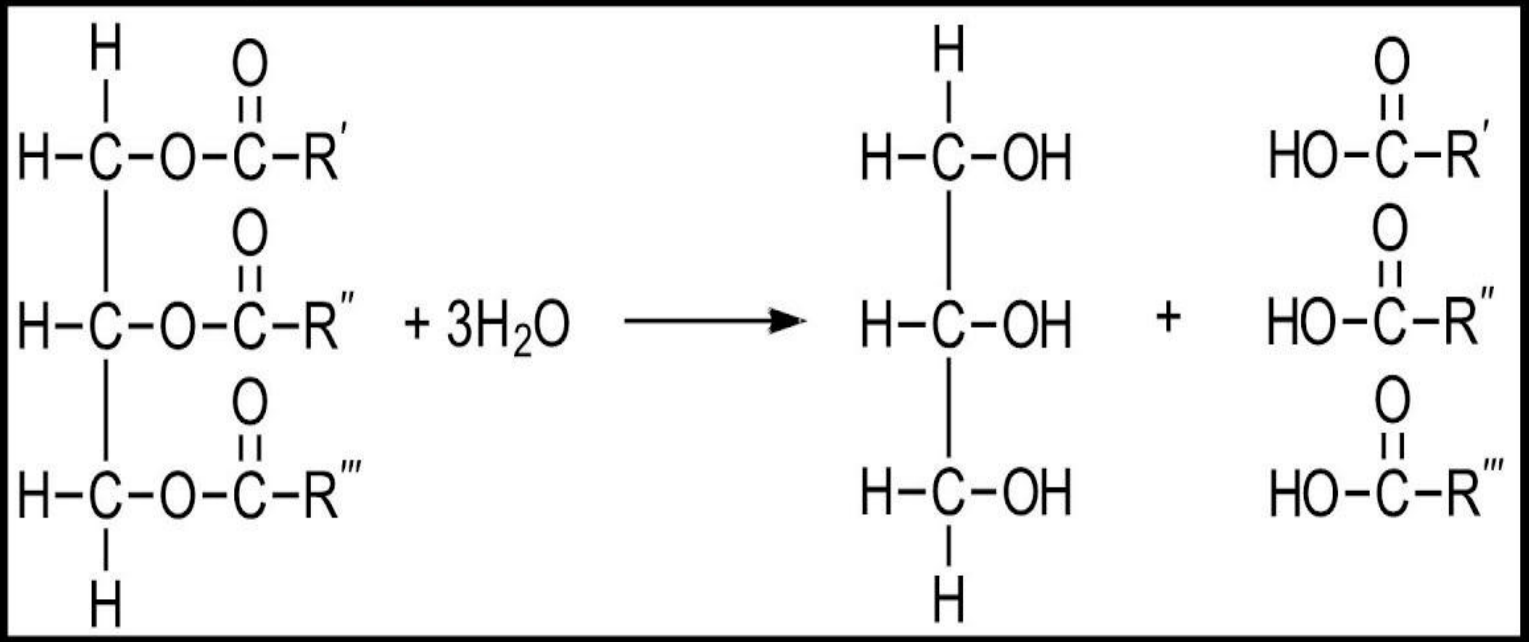


ASTAXANTHINE

MSJChem
Tutorials for IB Chemistry

Hydrolysis

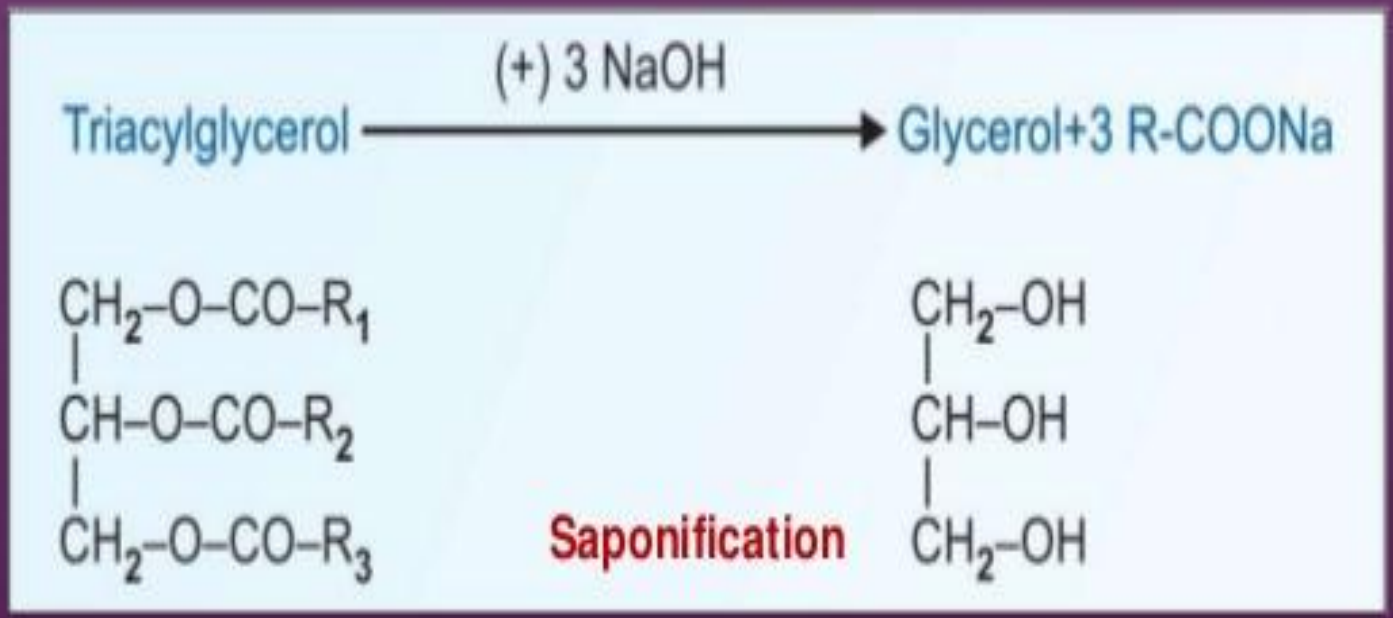
Fats and oils are hydrolysed in the human body by the enzyme **lipase**.



triglyceride + water ⟶ 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?

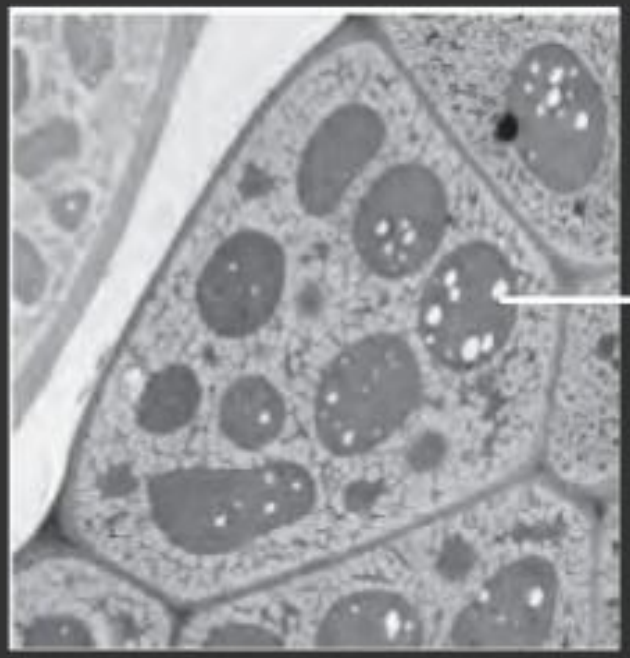
- Rancidity is the development of unpleasant smells in fats and oils, which are often accompanied by changes in their texture and appearance.
- Two types of rancidity:

  Hydrolytic rancidity

  Oxidative rancidity (auto-oxidation)

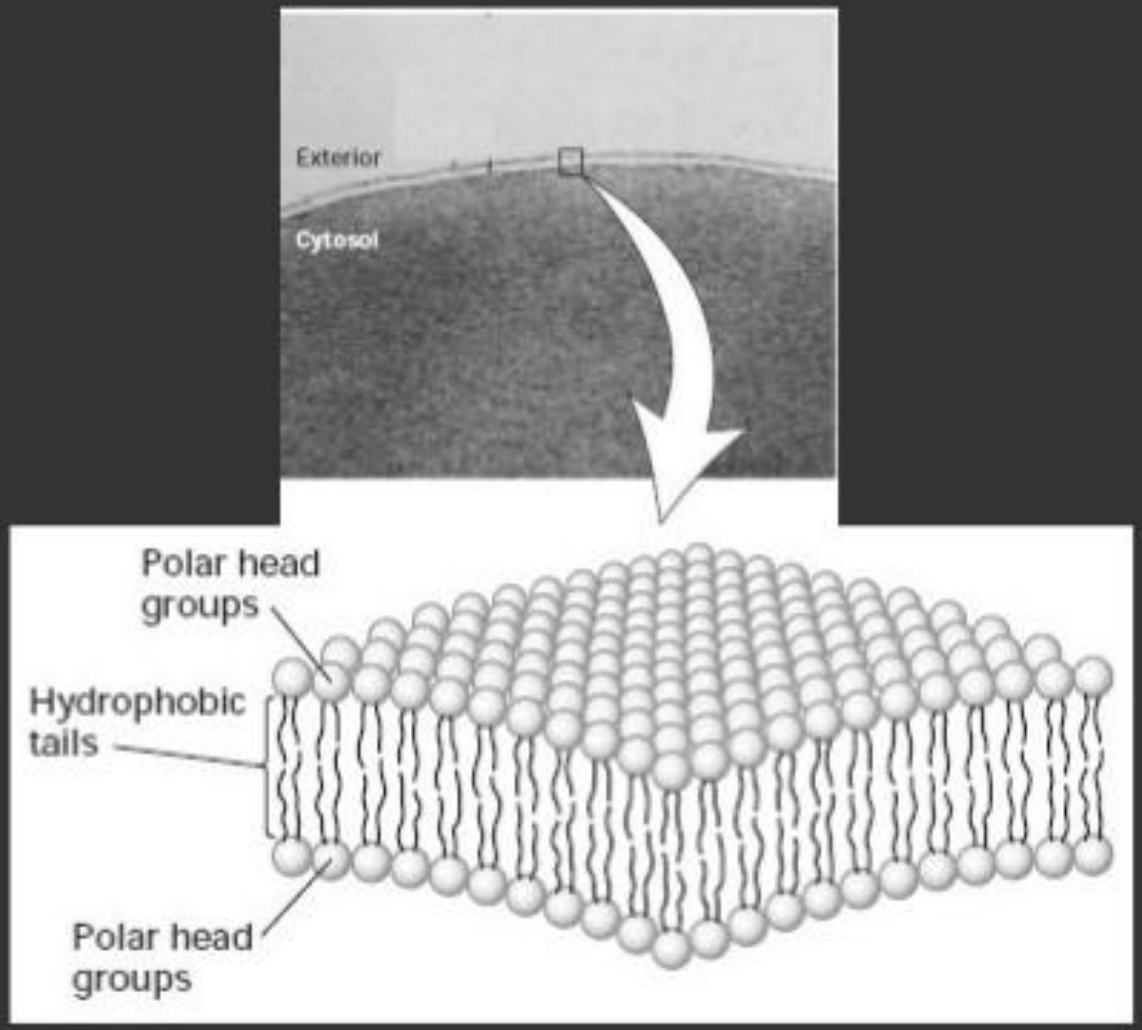
BIOMEDICAL IMPORTANCE

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

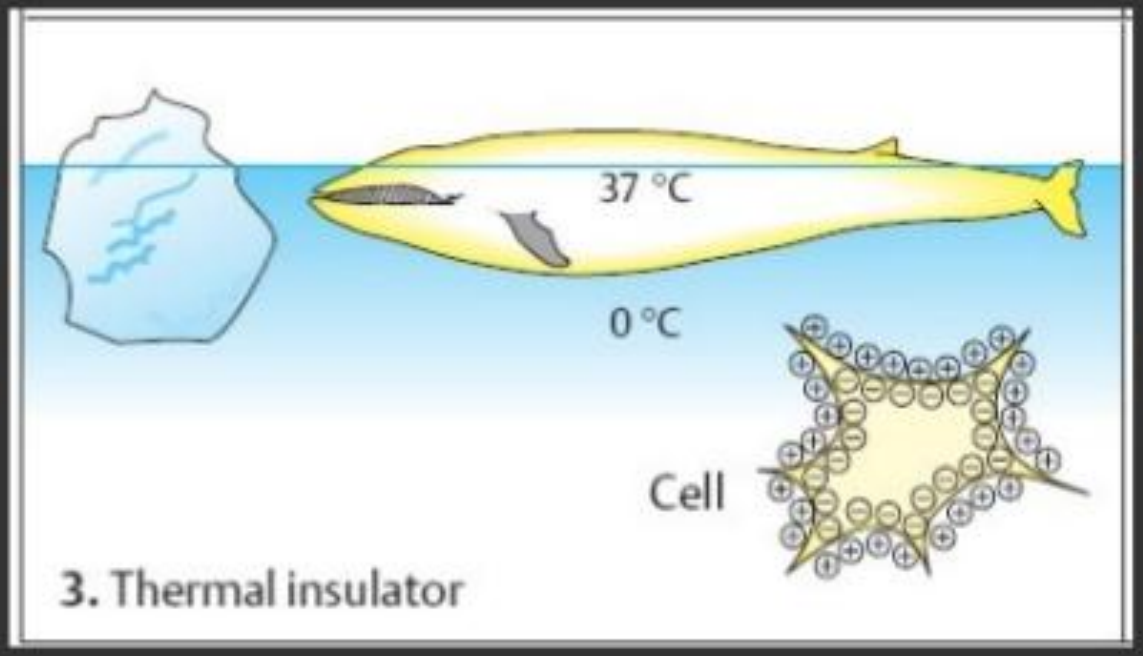


Lipid (TGL) Droplets In Adipose tissue

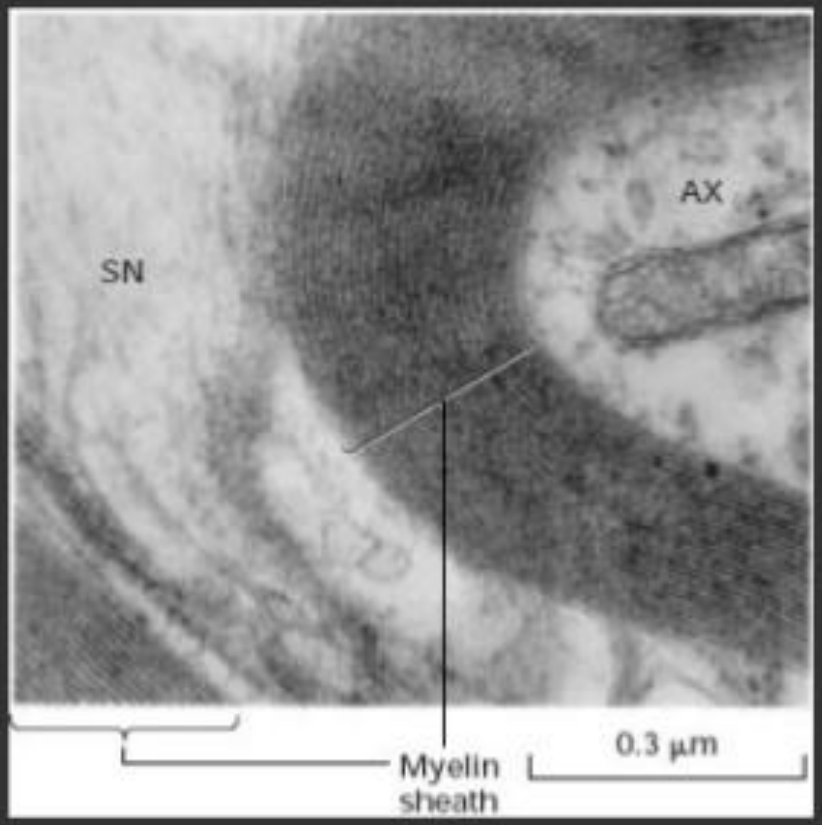
2. Structural components of biomembranes.



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, mitochodiria 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.