

Biochemistry
Lipids
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LIPIDS

Are non polar hydrophobic compounds insoluble or sparingly soluble in water, but readily soluble in non-polar organic solvents such alcohol, acetone etc.

- There are mainly three groups of lipids

1) Simple lipids (homolipids)

- **Waxes** : Esters of fatty acids and non-glycerol aliphatic alcohols
- **Neutral Fats**: Esters of fatty acids and glycerol

2) Compound lipids

- **Phospholipids**
 - i) **Phosphoglycerides** : Lecithin, Cephalin, Prostaglandins
 - ii) **Sphingolipids or Sphingomyelins**
- **Glycolipids**
- **Lipoproteins**
- **Sulpholipids**

3) Isoprenoids

- **Terpenes**

Simple lipids or Homolipids

- Are *alcohol esters of fatty acids* where lipid monomers are linked to alcohols through ester bonds or amide bonds

A) WAXES

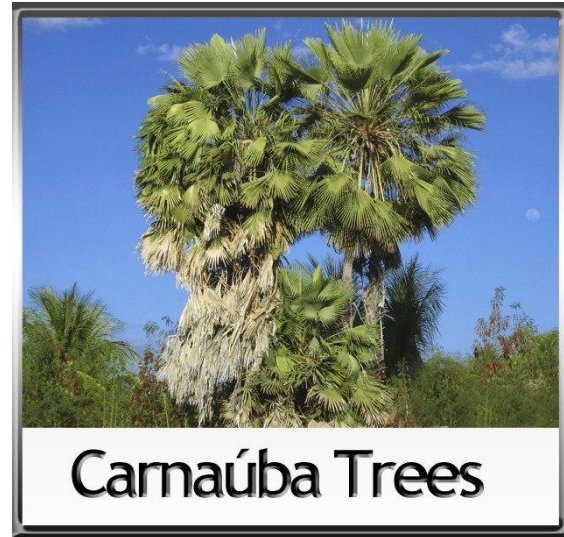
- Are esters of fatty acids and non-glycerol aliphatic alcohol (such as myricyl alcohol)
- Highly hydrophobic and resistant to oxidation

- Form
anim: C20 acid nts and
 ester bond C24 alcohol

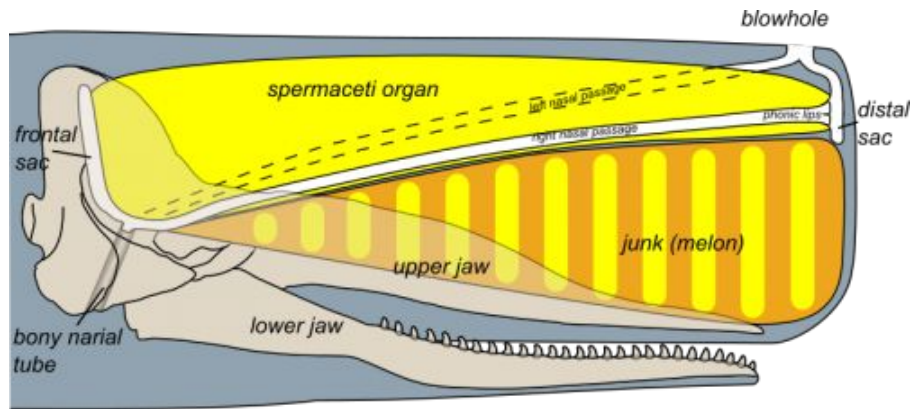




Bees wax - miricil alcohol and palmitic acid



Carnaúba Trees



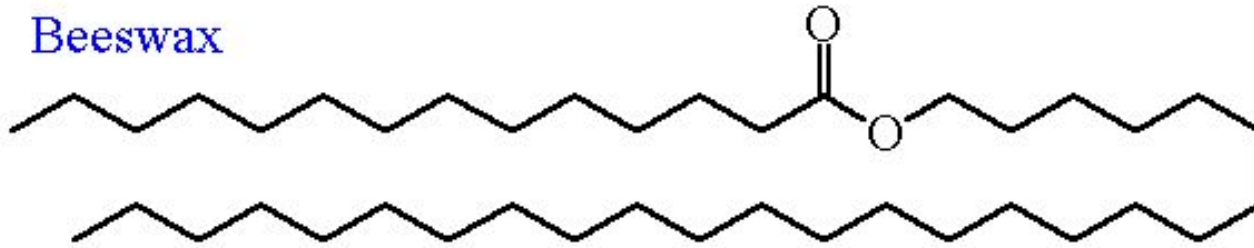
Sperm whale oil



Lanolin - wool fat – cholesterol, lanosterol and agnosterol

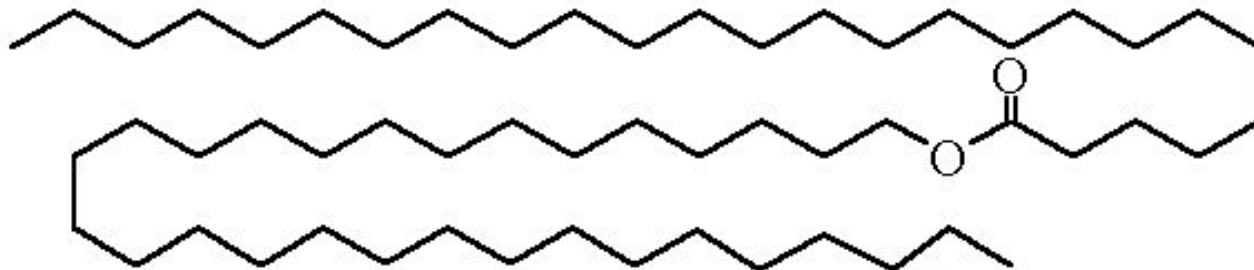
Waxes

Beeswax



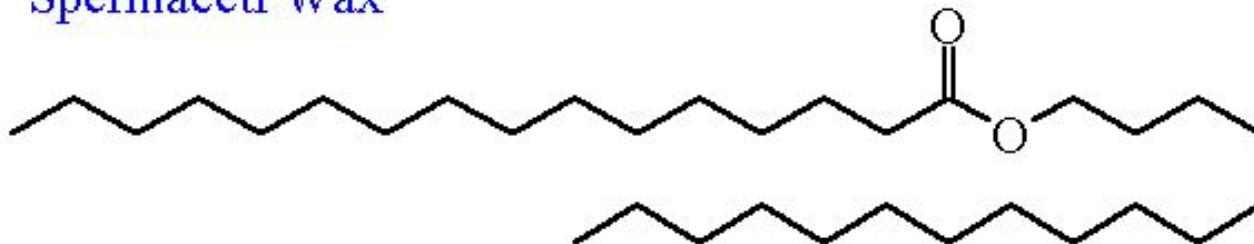
Ceryl Myristate

Carnauba Wax



Myricyl Cerotate

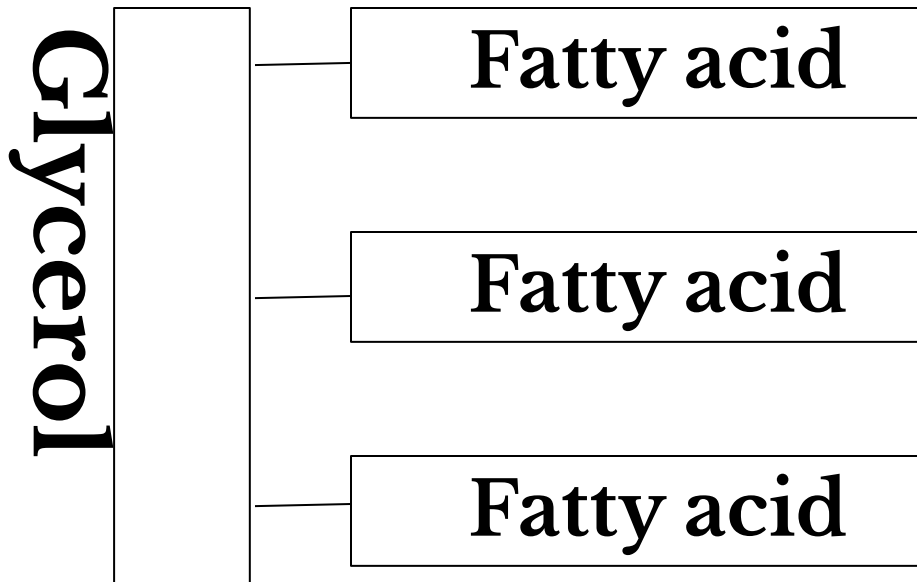
Spermaceti Wax



Cetyl Palmitate

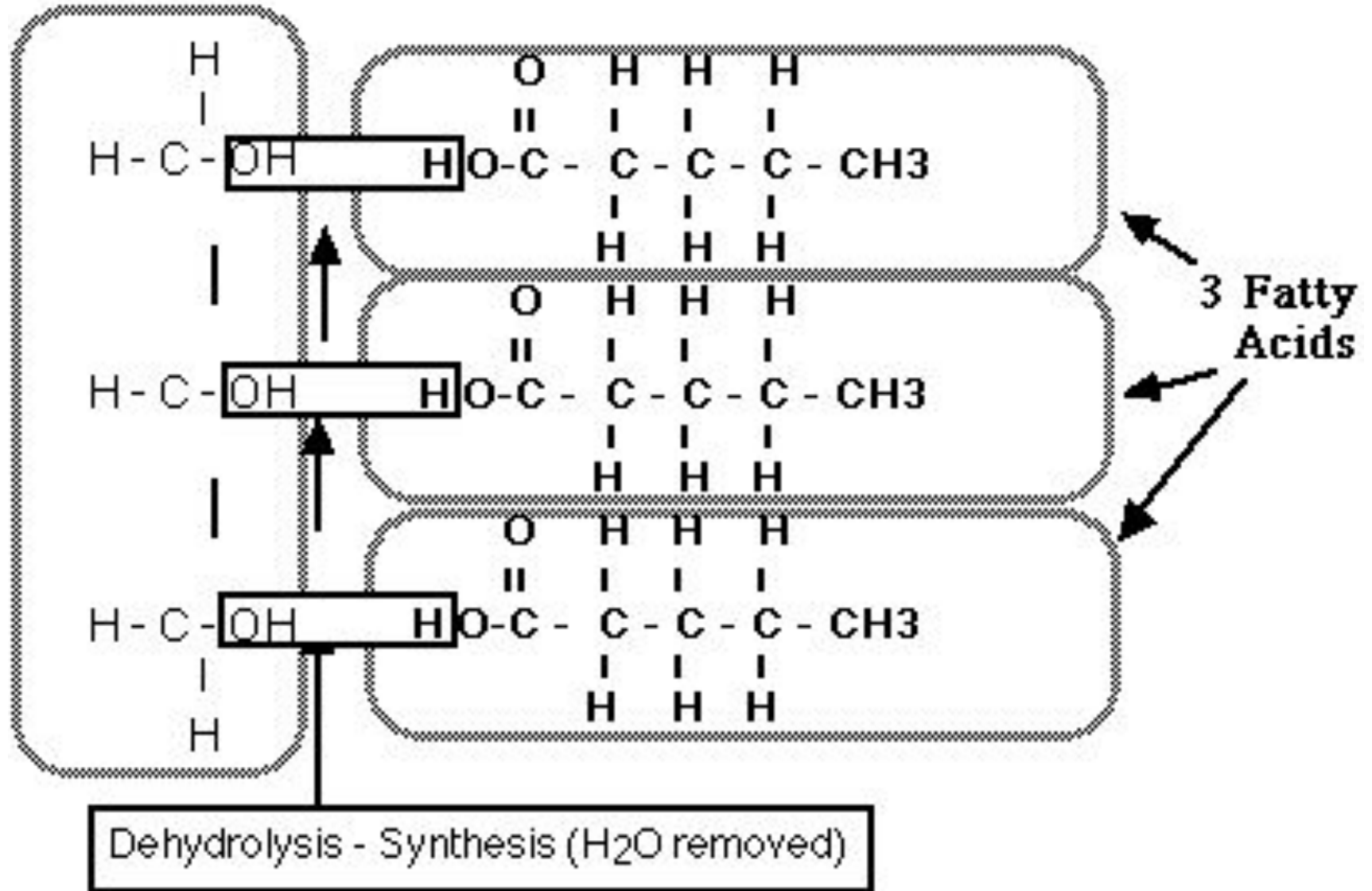
Neutral fat - are mixtures of triglycerides

Triglycerides are esters of fatty acids and glycerol



- In triglycerides free acidic or basic groups are absent

Glycerol



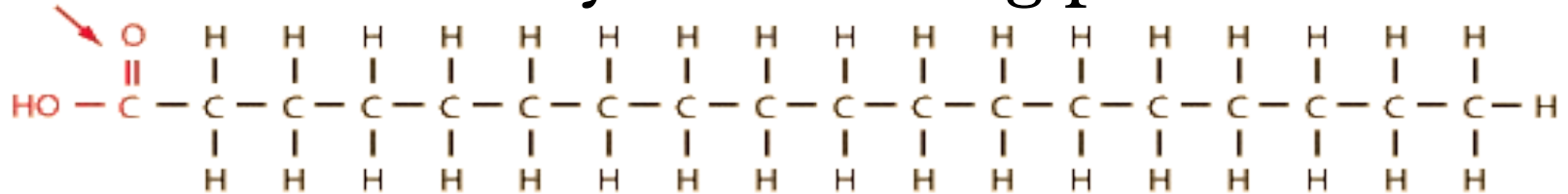
- Triglycerides containing the same kind of fatty acid in all three positions are known as homoglycerides eg:
 - Tristearin – Stearic acid
 - Tripalmitin – Palmitic acid
 - Triolein – Oleic acid
- Triglycerides containing two or three kinds of fatty acids are known as heteroglycerides eg: Most naturally occurring fatty acids

i) Fatty acids

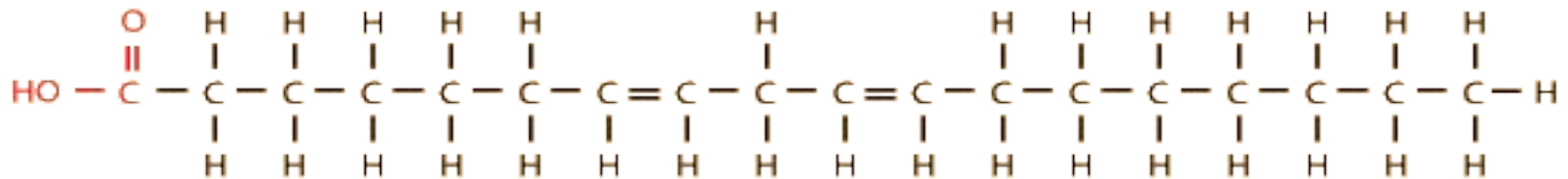
- Are straight – chain aliphatic hydrocarbons , with a carboxyl group at one end
- Amphipathic in nature since they contain both non-polar aliphatic chain and a polar ionisable carboxyl ($-\text{COOH}$) groups
- Carboxyl group forms the head and hydrocarbon chain forms its tail
- As fatty acids are synthesised from 2C units, most naturally occurring fatty acids are even numbered ranging between 12-26C
- There are two kinds of fatty acids:
 - i) Saturated fatty acids – where maximum possible number of hydrogen atoms remain attached to the C backbone forming single

ii) Unsaturated fatty acids – some C atoms will not have the full complement of attached hydrogen atoms and thus forms double bond between C atoms eg: Linoleic acid, Linolenic acid, erucic, acid, oleic acid, arachidnoic acid etc. Have very low melting point

Carboxylic acid group



Stearic acid, an example of a saturated fatty acid

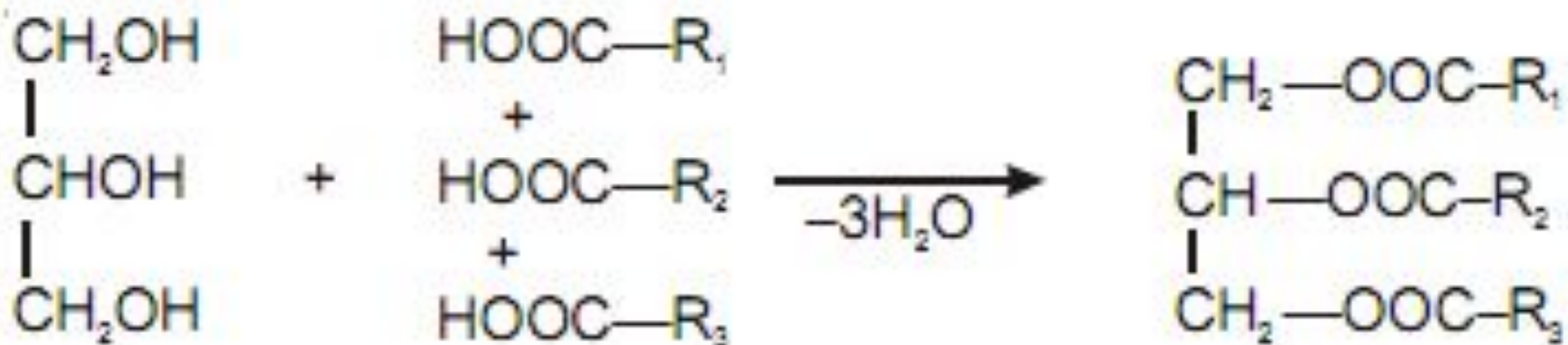


Linoleic acid, an example of an unsaturated fatty acid

ii) Glycerol

- Is a straight chain trihydroxy alcohol which can readily combine with weak acids
- Has three linkage site for esterifying three fatty acid molecules
- Linkage occurs between the acidic carboxyl group (-COOH) of fatty acid and alcoholic (-OH) group of the glycerol molecule with the elimination of one molecule of water. This kind of linkage between an acidic group and alcoholic group is known as *Ester linkage*

Glycerol (1 molecule) + fatty acid (3 molecules) $\xrightarrow{-3\text{H}_2\text{O}}$ fi Neutral fat (1 molecule)



Compound Lipids / hetero lipids

- Are the lipids which remain linked with non-lipid molecules such as proteins (lipoproteins), oligosachharides (glycolipids) and phosphates (phospholipid)
- They contain atoms like P S and N other than C, H and O

PHOSPHOLIPDS

- Are amphipathic molecules with a polar and hydrophilic head formed of -vely charged phosphate group and a +vely charged alcohol group and a non-polar and hydrophobic tail formed of fatty acids
- 2 types of phospholipids – phospho
glycerides and prosterolands

i) Phosphoglycerides

- fatty acid esters of glycerol phosph

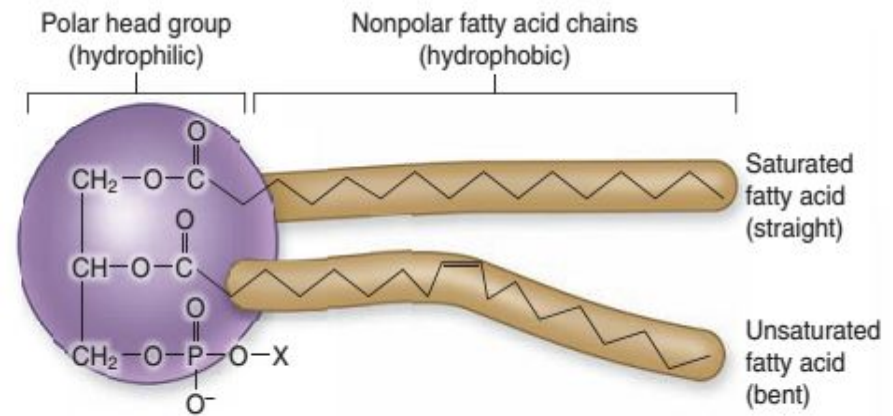
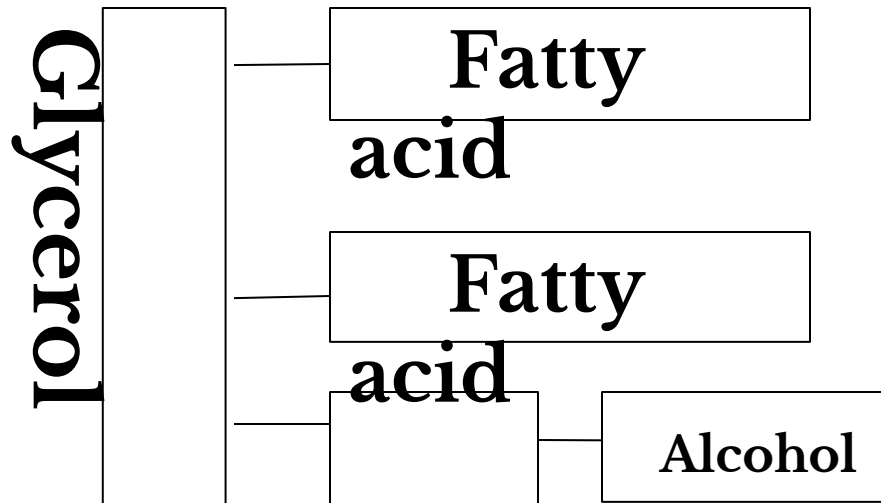
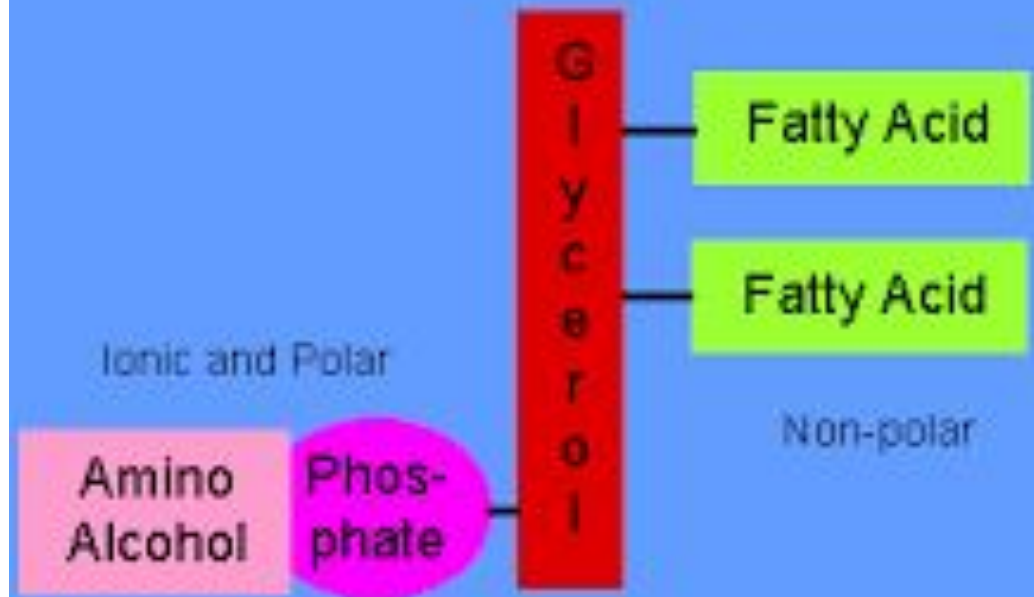


Figure 30: A Phospholipid Molecule



- Is a diglyceride formed of two fatty acid molecules, a glycerol molecule and a phosphate group complex with an attached alcohol unit (phosphatidic acid)

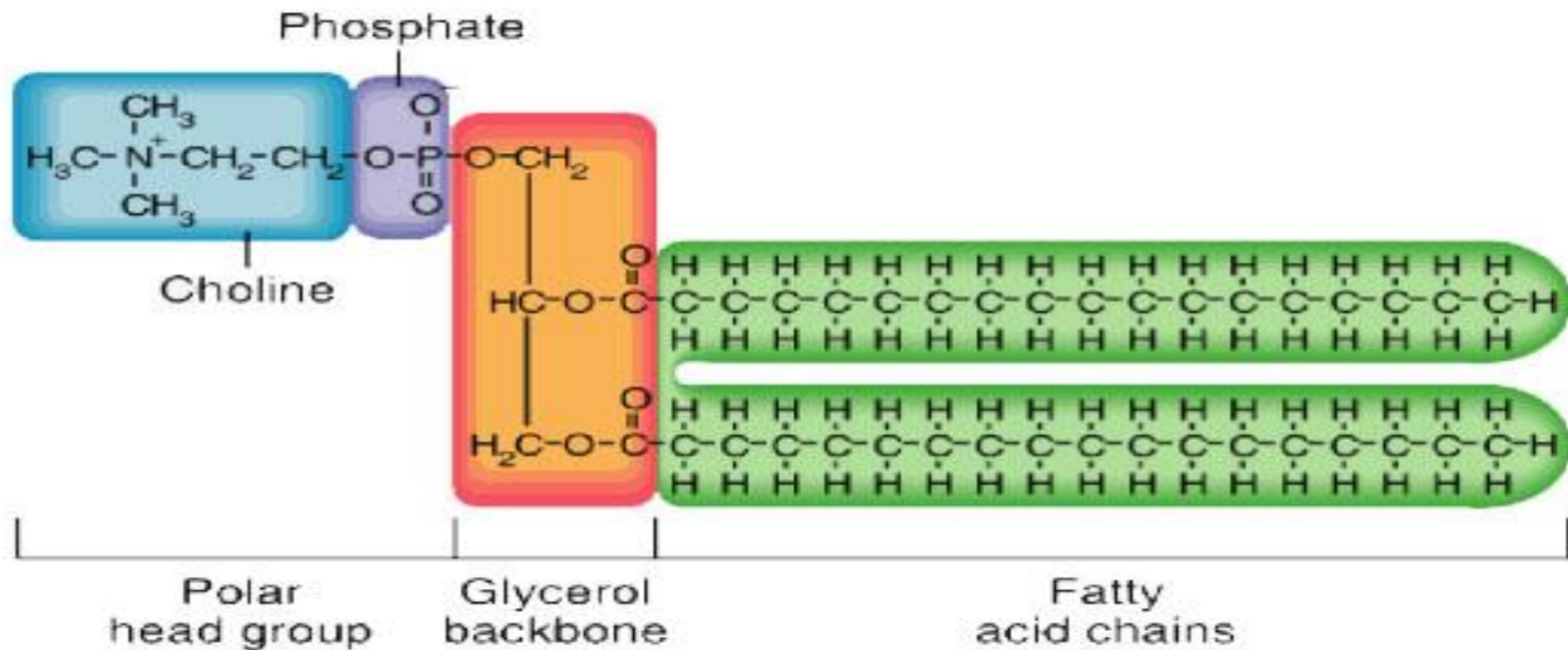
General Structure of a Phosphoglyceride



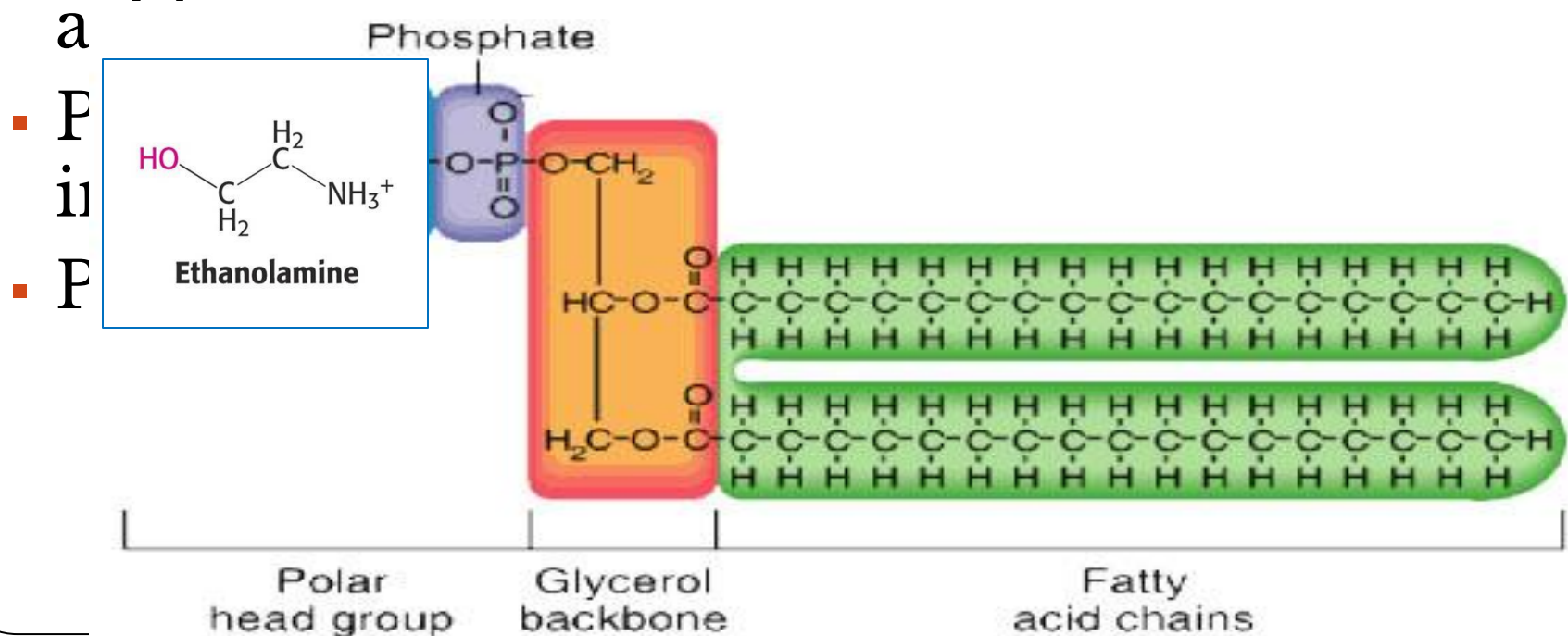
- Based on attached alcohol several kinds of phosphoglycerides can be recognised

Eg 1: Phosphatidyl choline – Lecithin

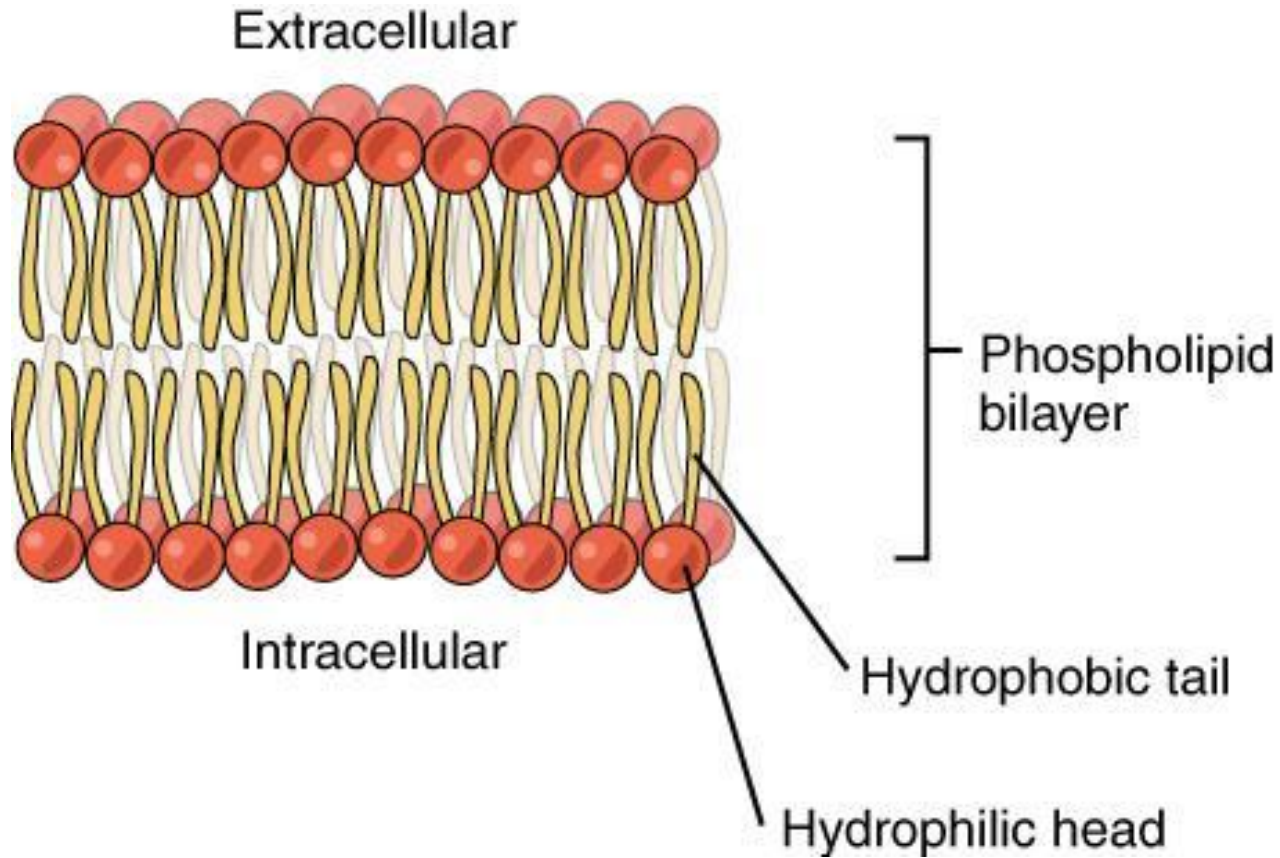
- Are choline derivatives of phosphatidic acid
- Exist as zwitterions having acidic $-\text{COOH}$ group of phosphoric acid and basic $-\text{OH}$ group of choline



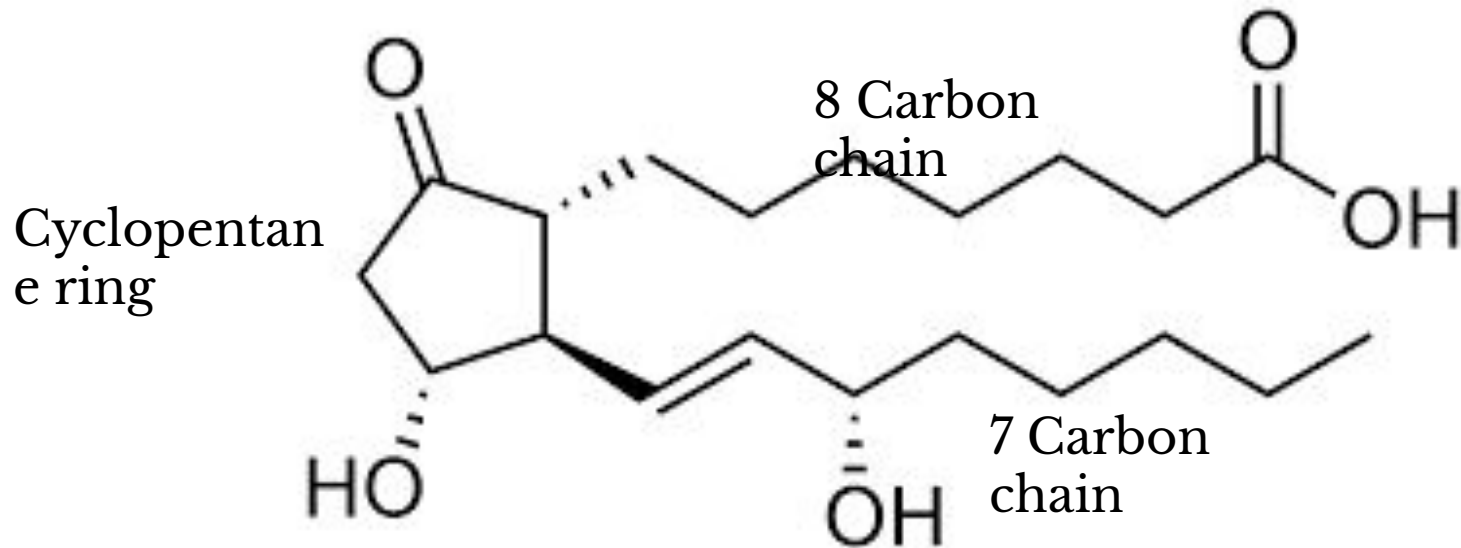
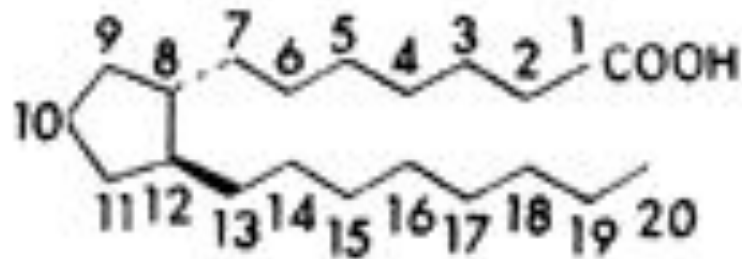
- They are highly polar molecules capable of orienting themselves in a definite fashion. This orderly orientation enables them to play a major role in keeping the structural integrity of protoplasm
- Eg 2: Phosphatidyl ethanolamines – Cephalins
- Are ethanolamine derivatives of phosphatidic

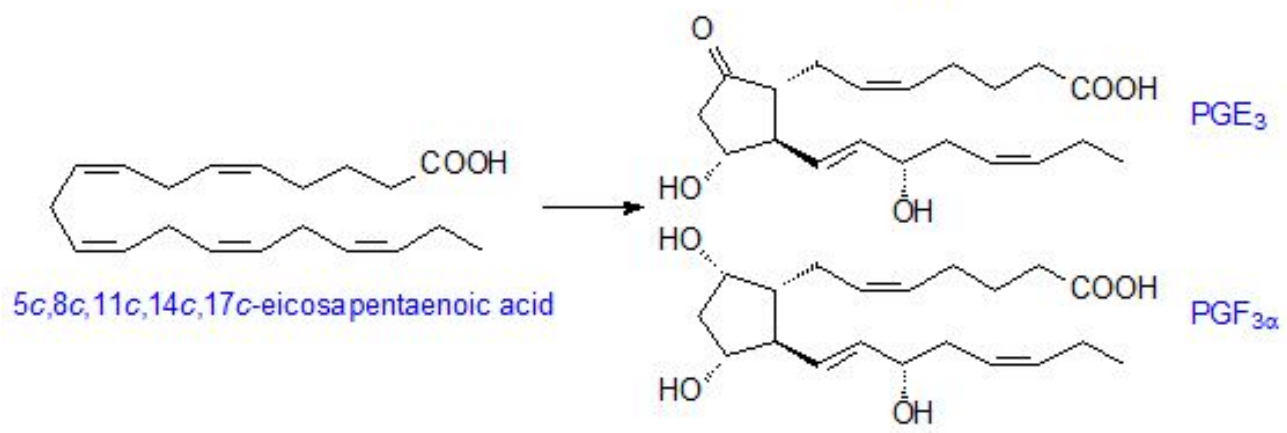
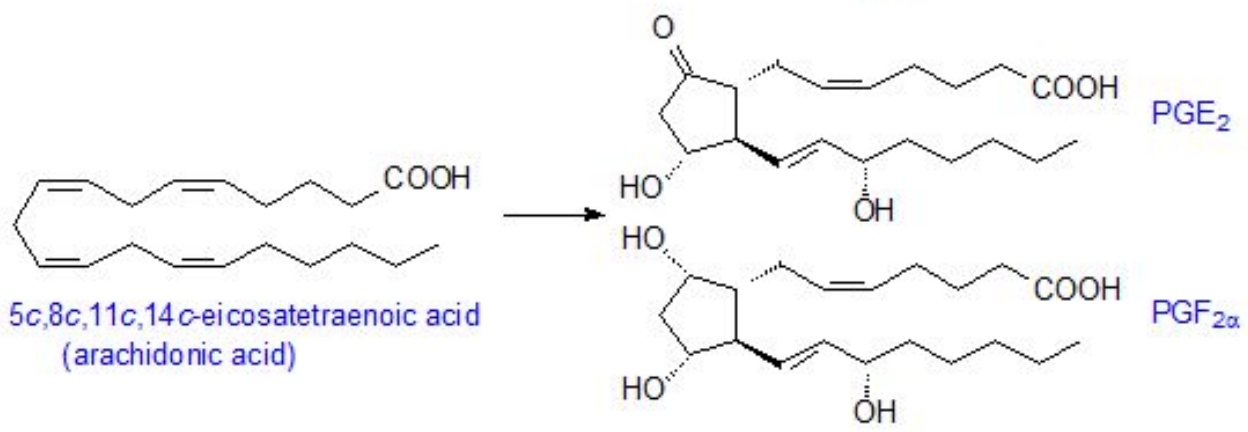
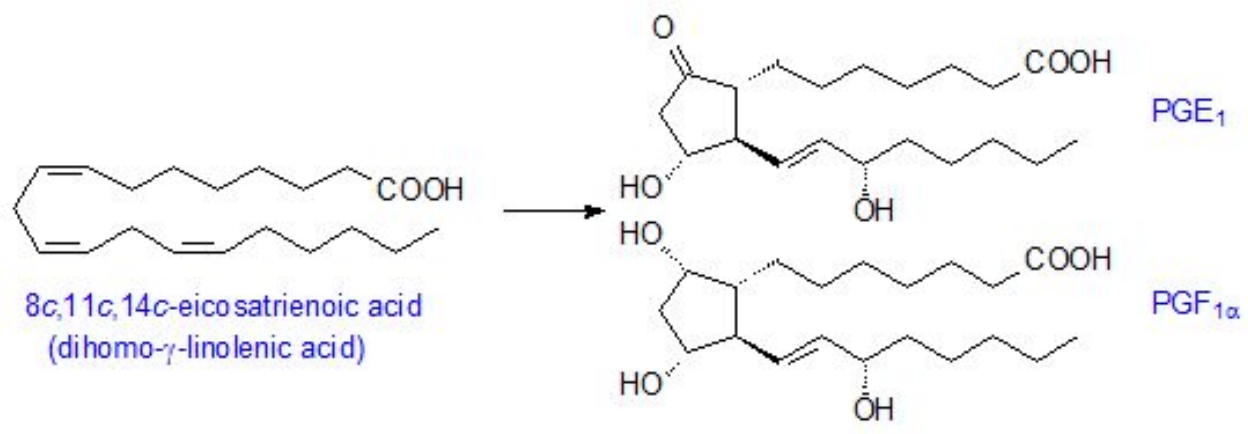


Plasmamembrane



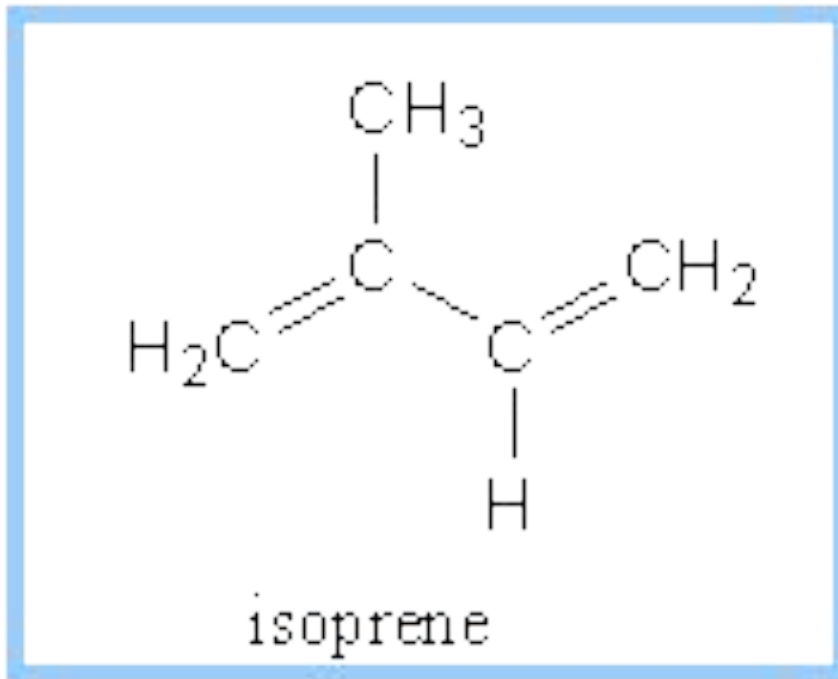
Prostaglandins





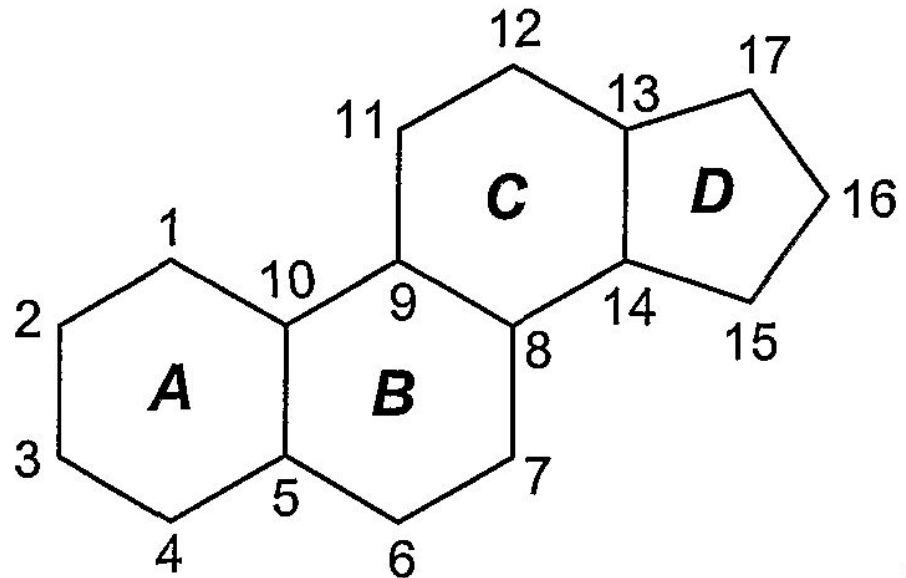
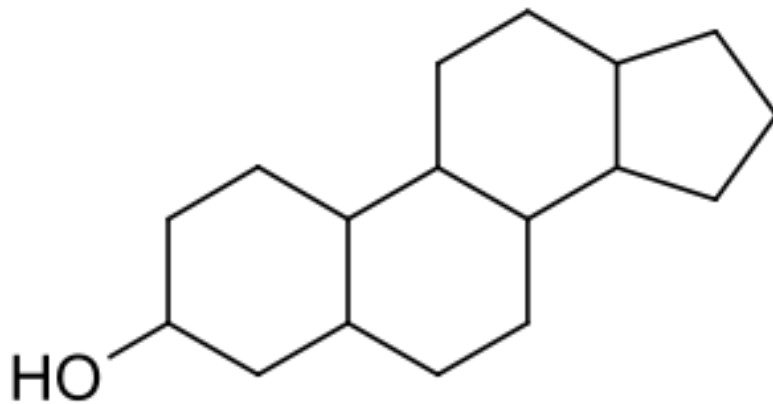
Isoprenoid

- 5 Carbon structural units called isoprenes



Steroids

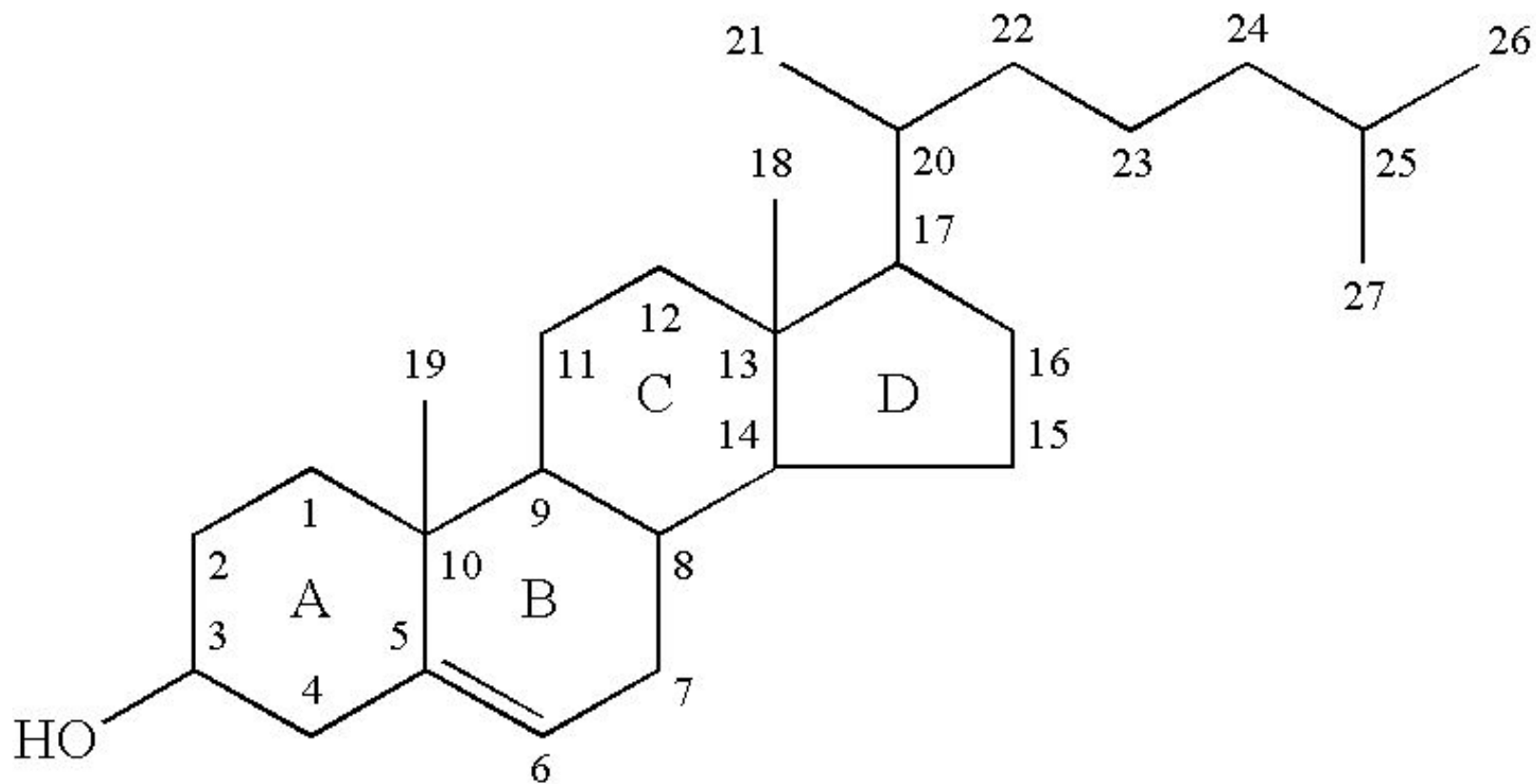
- -OH containing tetracyclic alcohol, Sterol (four fused rings with 17 Carbon atoms)



(I)

Cholesterol, $C_{27}H_{45}OH$

1



Cholesterol