

# **BIOCHEMISTRY AND CYTOGENETICS**

## **LIPIDS**

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# LIPIDS

- **Lipids** are a group of naturally occurring molecules that include fats, waxes, sterols, fat-soluble vitamins (such as vitamins A, D, E, and K), monoglycerides, diglycerides, triglycerides, phospholipids, and others.
- The main biological functions of lipids include storing energy, signaling, and acting as structural components of cell membranes.
- Lipids have applications in the cosmetic and food industries as well as in nanotechnology

- Lipids may be broadly defined as hydrophobic or amphiphilic small molecules; the amphiphilic nature of some lipids allows them to form structures such as vesicles, multilamellar/unilamellar liposomes, or membranes in an aqueous environment.
- Biological lipids originate entirely or in part from two distinct types of biochemical subunits or "building-blocks"

# CLASSIFICATION OF LIPIDS

- Simple lipids
- Compound lipids
- Derived lipids

# SIMPLE LIPIDS

## FATS

- Fat is one of the three main macronutrients, along with carbohydrate and protein.
- Fats, also known as triglycerides, are esters of three fatty acid chains and the alcohol glycerol.
- Fats that are saturated fats have no double bonds between the carbons in the chain
- Unsaturated fats have one or more double bonded carbons in the chain

- Fat is an important foodstuff for many forms of life, and fats serve both structural and metabolic functions.
- They are a necessary part of the diet of most heterotrophs (including humans). Some fatty acids that are set free by the digestion of fats are called essential because they cannot be synthesized in the body from simpler constituents.
- There are two essential fatty acids (EFAs) in human nutrition: alpha-linolenic acid and linoleic acid

- The properties of any specific fat molecule depend on the particular fatty acids that constitute it.
- Fatty acids form a family of compounds (are composed of increasing numbers of carbon atoms linked into a zig-zag chain).
- The more carbon atoms there are in any fatty acid, the longer its chain will be. Long chains are more susceptible to intermolecular forces of attraction and so the longer ones melt at a higher temperature



- There are many different kinds of fats, but each is a variation on the same chemical structure. All fats are derivatives of fatty acids and glycerol.
- Most fats are glycerides, particularly triglycerides. One chain of fatty acid is bonded to each of the three -OH groups of the glycerol by the reaction of the carboxyl end of the fatty acid (-COOH) with the alcohol
- Water is eliminated and the carbons are linked by an -O- bond through dehydration synthesis. This process is called esterification and fats are therefore esters.

## OIL

- Fat in the liquid state is known as oil.
- An oil is any neutral, non-polar chemical substance that is a viscous liquid at ambient temperatures and is both hydrophobic (immiscible with water, literally "water fearing") and lipophilic (fat loving).
- Oils have a high carbon and hydrogen content and are usually flammable and slippery.

- When oils are exposed to air, they react with the oxygen or water vapor to form short-chain carboxylic acids.
- The short-chain acids are volatile and have unpleasant smells and tastes.
- For example, the strong smell and sour taste of vinegar are due to acetic acid, a two-carbon carboxylic acid .
- The oxidation process is called rancidification and can make foods unpalatable.

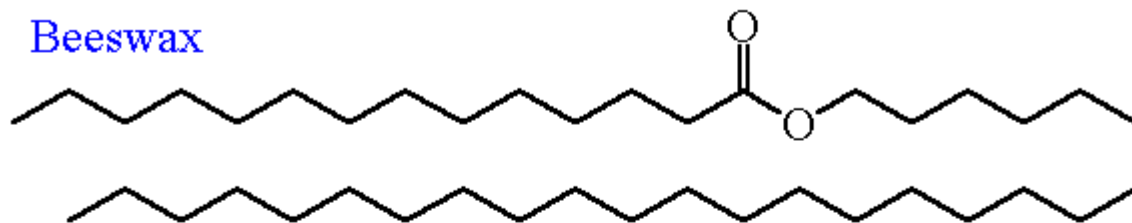
## WAXES

- Esters of fatty acids with any alcohol other than glycerol.
- Have high molecular weight
- Waxes are a type of long chain nonpolar lipid.
- Natural waxes are typically esters of fatty acids and long chain alcohols.
- Animal wax esters are derived from a variety of carboxylic acids and fatty alcohols.
- Plant waxes are derived from mixtures of long-chain hydrocarbons containing functional groups.

- Because of their hydrophobic nature, waxes prevent water from sticking on plants and animals.
- Synthetic waxes are derived from petroleum or polyethylene and consist of long-chain hydrocarbons that lack functional groups.
- Synthetic waxes are used in adhesives, cosmetics, food, and many other commercial products

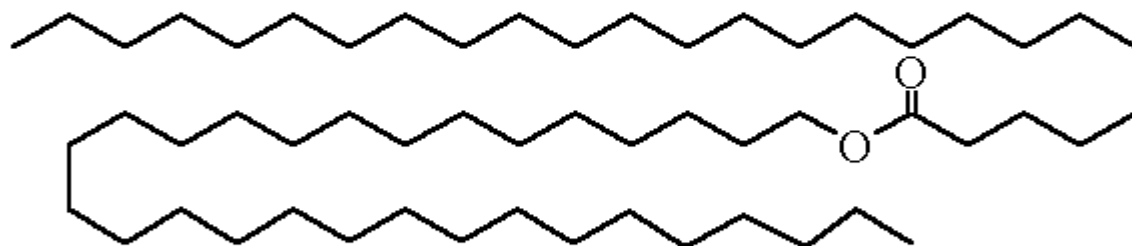
## Waxes

## Beeswax



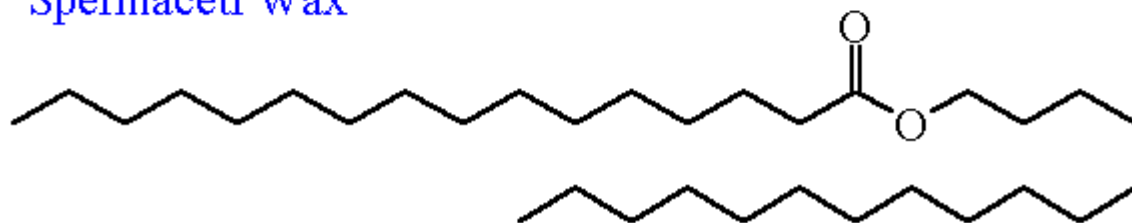
### Ceryl Myristate

## Carnauba Wax



## Myricyl Cerotate

## Spermaceti Wax

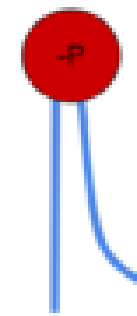
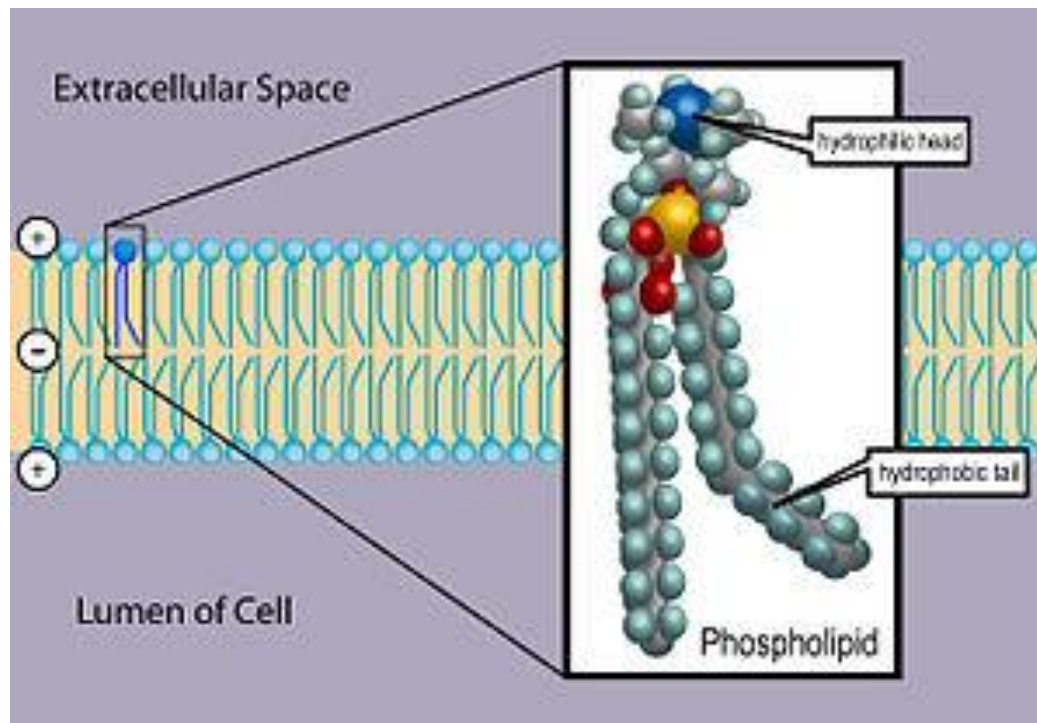


### Cetyl Palmitate

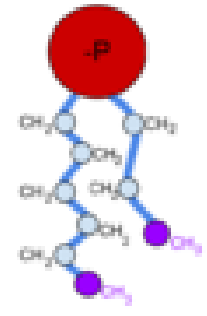
# COMPOUND LIPIDS

## PHOSPHOLIPIDS

- Phospholipids belong to the lipid family of biological polymers.
- A phospholipid is composed of two fatty acids, a glycerol unit, a phosphate group and a polar molecule.
- They frequently have N containing bases & other substituents.
- Eg: In glycerophospholipid, the alcohol is glycerol & in sphingo-phospholipid, the alcohol is sphingosine.



A phospholipid with a hydrophilic head and a hydrophobic tail



Chemical makeup of a single phospholipid

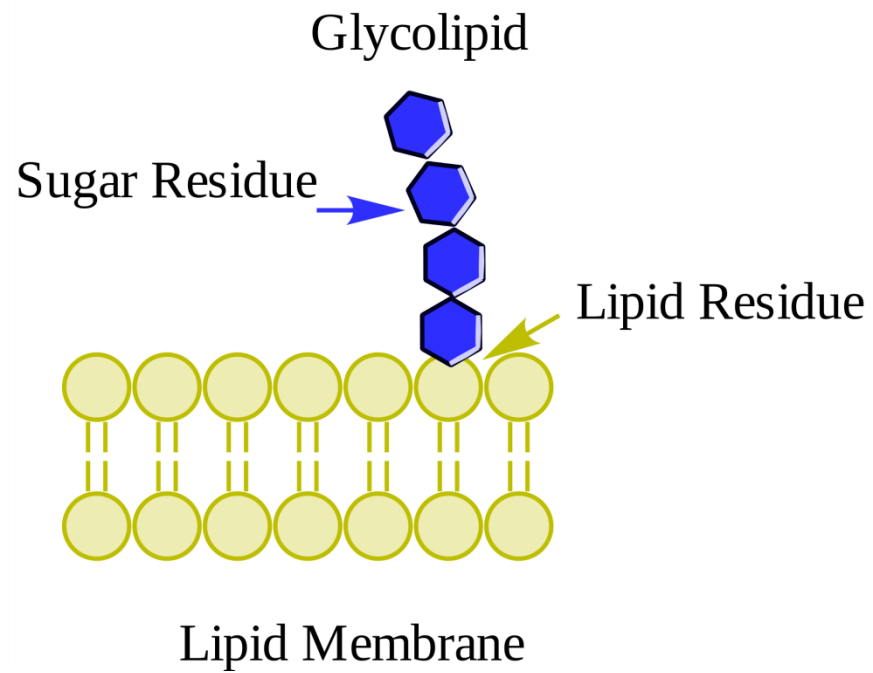


- The phosphate group and polar head region of the molecule is hydrophilic (attracted to water), while the fatty acid tail is hydrophobic (repelled by water). When placed in water, phospholipids will orient themselves into a bilayer in which the non-polar tail region faces the inner area of the bilayer
- The polar head region faces outward and interacts with the water.

- Phospholipids are a major component of cell membranes which enclose the cytoplasm and other contents of a cell.
- The lipid bilayer is semi-permeable, allowing only certain molecules to diffuse across the membrane.

## GLYCOLIPIDS

- Carbohydrate attached lipids
- Contain fatty acid sphingosine and carbohydrate
- Plays an important role in providing energy and also serve as markers for cellular recognition



## LIPOPROTEINS

- Biochemical assembly that contains both proteins and lipids
- Transport water insoluble lipid in the water based blood stream
- Lipids/derivatives may be covalently or non covalently bound to the proteins

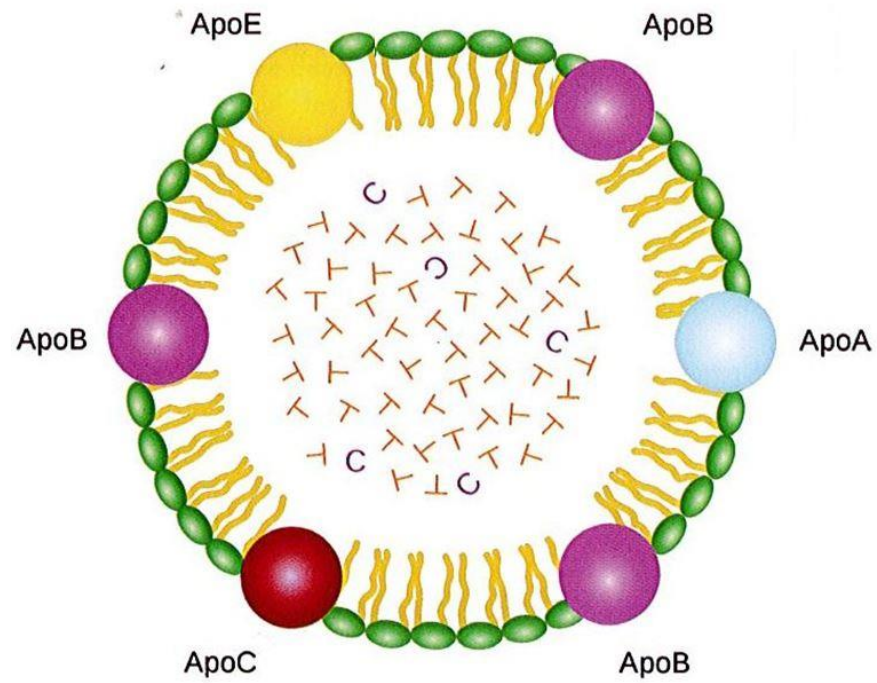
- Many enzymes, transporters and structural proteins are lipoproteins
- Eg:HDL,LDL

**Légende**

ApoA, ApoB, ApoC, ApoE : Apolipoprotéine (partie protéique)

T : Triglycérides

C : Cholestérol



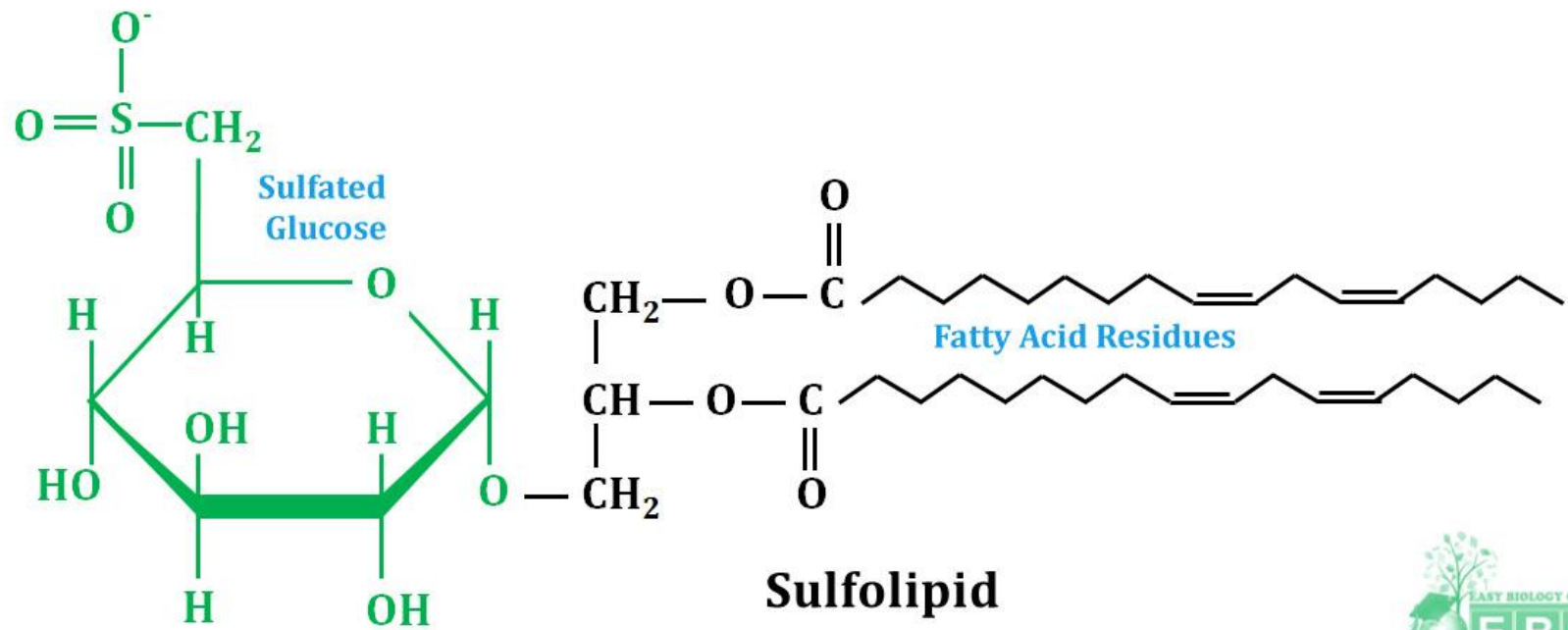
[DP by Xvazquez]

## SULPHOLIPIDS

- Sulfolipids are a class of lipids which possess a sulfur-containing functional group.
- An abundant sulfolipid is sulfoquinovosyl diacylglycerol, which is composed of a glycoside of sulfoquinovose and diacylglycerol.



- In plants, sulfoquinovosyl diacylglycerides (SQDG) are important members of the sulfur cycle. Other important sulfolipids include sulfatide and seminolipid, each of which are sulfated glycolipids.



# DERIVED LIPIDS

- Derived lipids are the substances produced from simple and compound lipids through the process of hydrolysis.
- Include fatty acids, glycerol, steroids and alcohols.
- Carotenoids, terpenes and hormones also fall under this category.

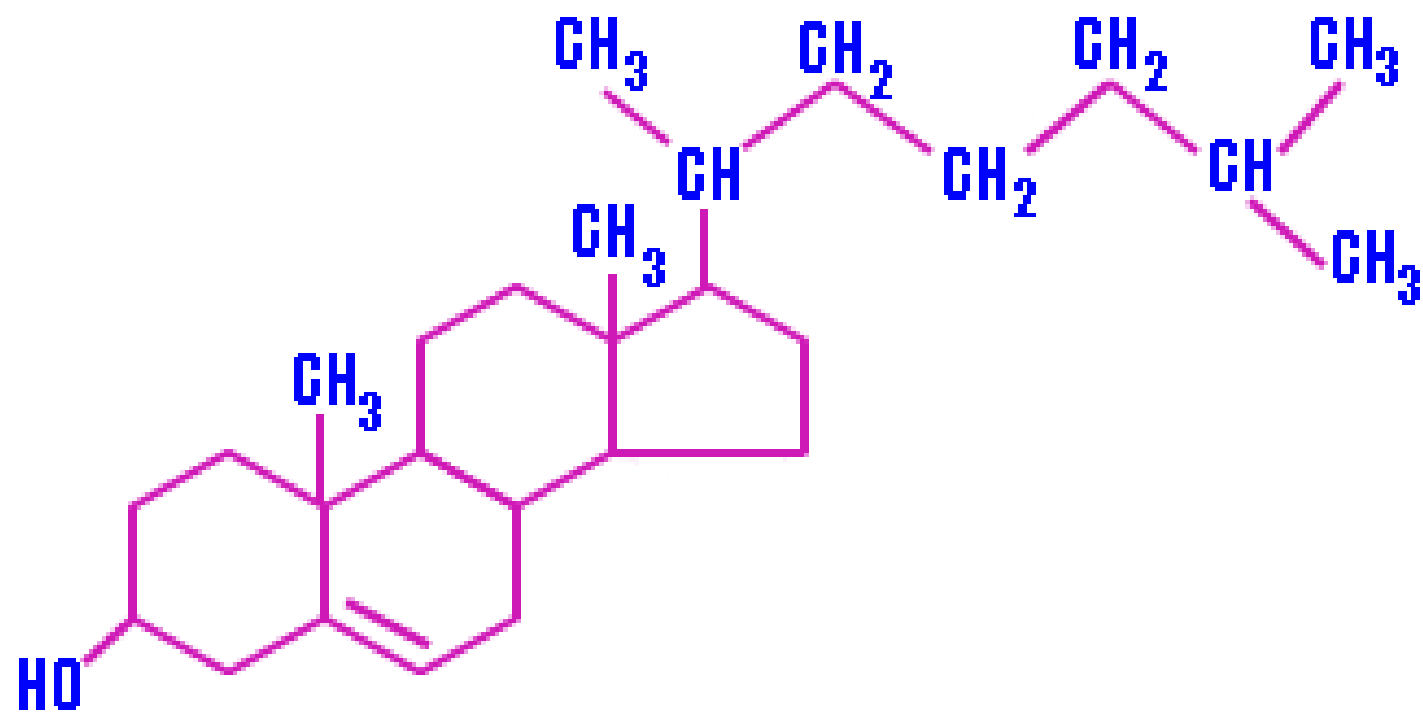
- Steroids are derived lipids that are found in almost every species of animal and do not contain fatty acids.
- Terpenes are found mainly in plants, and this group includes substances such as natural rubber and many essential oils.

- Carotenoids are a type of tetraterpene produced only by plants, although they are widespread in both plants and animals as they remain in the body after carotenoid producing plants are eaten.

# CHEMISTRY OF STEROLS, TERPENES AND CAROTENOIDS

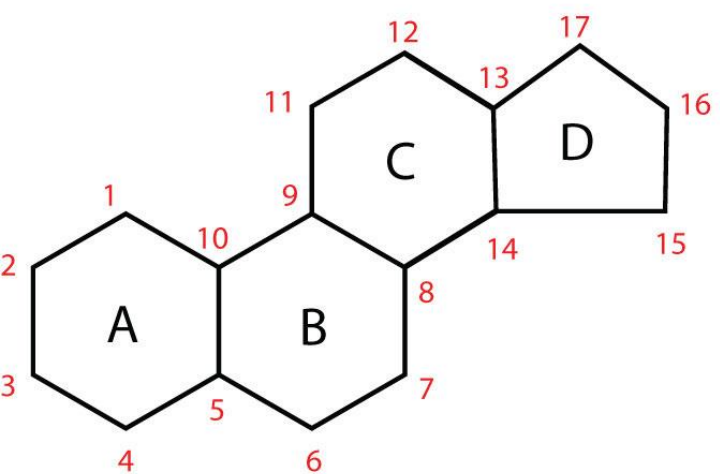
## STEROLS

- Sterol refers to a sub group of steroids that contain an alcohol functional group .
- Found predominantly in eukaryotic cells
- Most abundant steroid-cholesterol
- Cholesterol has 27 C atoms, an OH group at C3, a methyl group at C13 and a branched aliphatic hydrocarbon (8 C) unit at C17.
- It is the basic building block for all other steroids

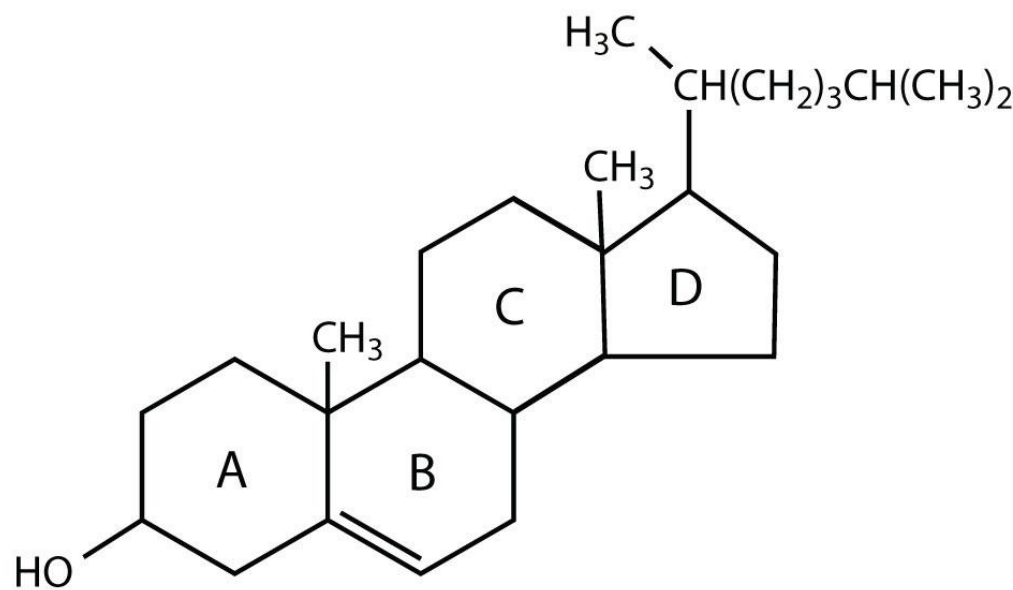


- Steroids are important as it is the precursor of bile acids,adreno cortical & sex hormones and Vit D
- These amphipathic molecules are derived from 2 C acetyl Co-A units whose combination leads to the formation of isoprenoids(5 C isoprene) and finally to the formation of a 17 C tetracyclic hydrocarbon,the steroid skeleton





(a) Steroid skeleton

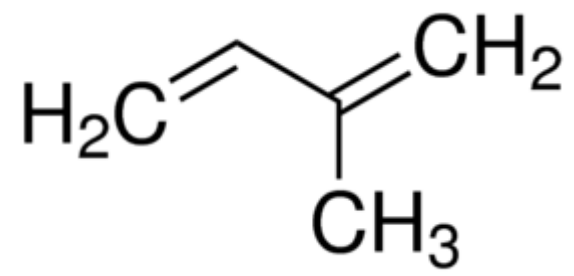


(b) Cholesterol

## TERPENES

- These are unsaturated hydrocarbons with the formula  $C_{10}H_{16}$
- Common in higher plants
- Responsible for flavour and fragrance of essential oils and resins
- Essential constituents of gibberlins, natural rubber etc

- Universally present in small amounts in all living organisms where they have role in physiology as well as important functions in all cellular membranes
- Can be cyclic or acyclic form made of repeating isoprene units. An isoprene is a 5C unit ( $C_5H_8$ ) and do not have attached fatty acid.



ISOPRENE

CLASSIFICATION OF TERPENES BASED ON NO.OF ISOPRENE UNITS  
INCORPORATED IN THE BASIC MOLECULAR SKELETON

NO	TERPENES	ISOPRENE UNITS	CARBON ATOMS
1	Monoterpenes	2	10
2	Sesquiterpenes	3	15
3	Diterpenes	4	20
4	Sesterpenes	5	25
5	Triterpenes	6	30
6	Carotenoids	8	40
7	Rubber	>100	>500

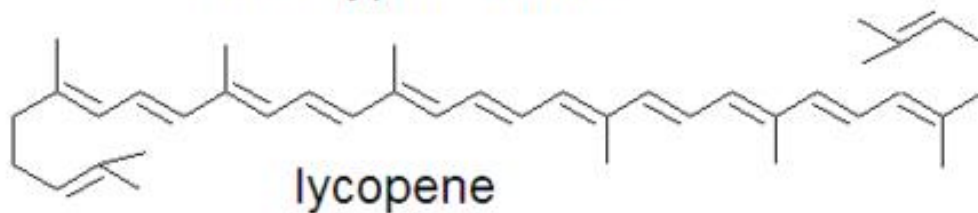
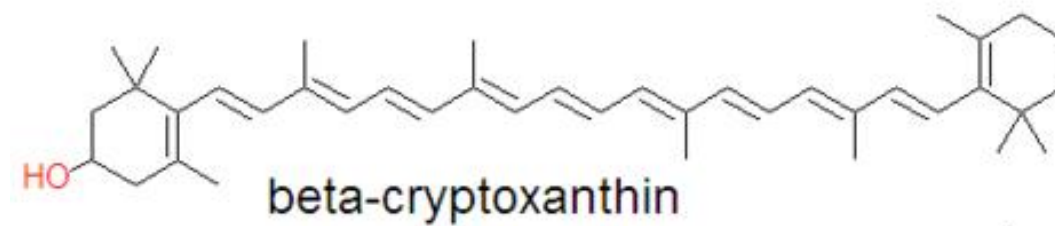
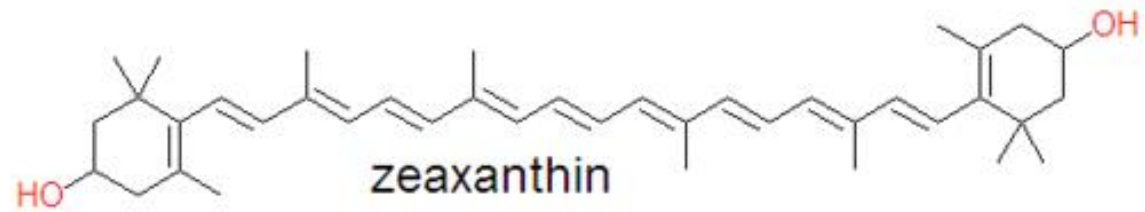
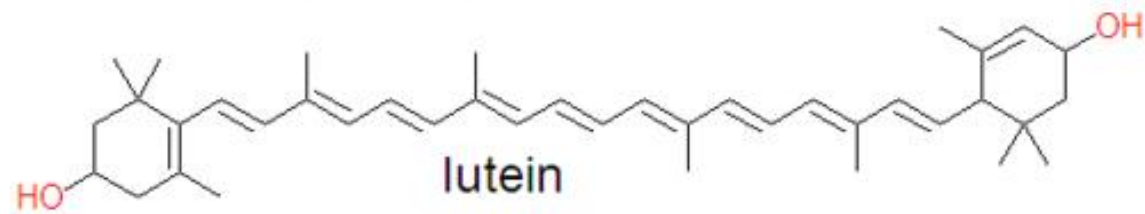
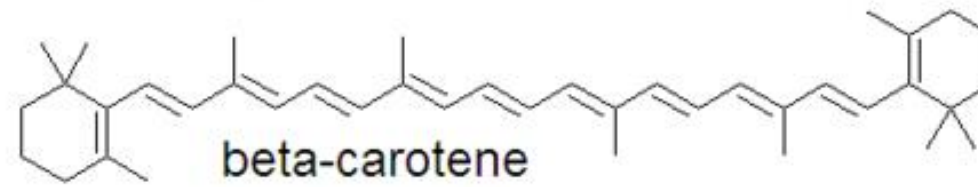
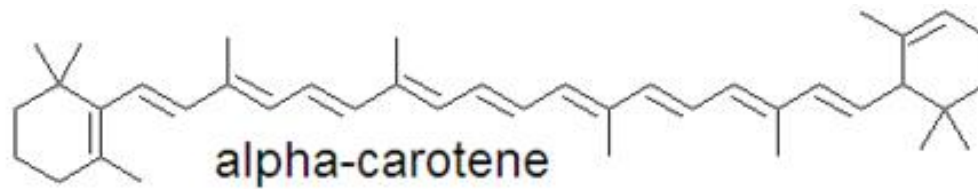
## CAROTENOIDS

- Formula  $C_{40}H_{56}$
- Carotenoids, also called tetraterpenoids, are organic pigments that are found in the chloroplasts and chromoplasts of plants and some other photosynthetic organisms, including some bacteria and some fungi.
- Carotenoids can be produced from fats and other basic organic metabolic building blocks by all these organisms.

- They are produced from 8 isoprene molecules and contain 40 carbon atoms.
- Carotenoids absorb wavelengths ranging from 400-550 nanometers (violet to green light). This causes the compounds to be deeply colored yellow, orange, or red. Carotenoids are the dominant pigment in autumn leaf coloration of about 15-30% of tree species,

- They absorb light energy for use in photosynthesis, and they protect chlorophyll from photodamage.
- Carotenoids can also act as antioxidants.
- In the eye, certain other carotenoids (lutein, astaxanthin,<sup>l</sup>and zeaxanthin) apparently act directly to absorb damaging blue and near-ultraviolet light.





THANK YOU...