

## Lipids :

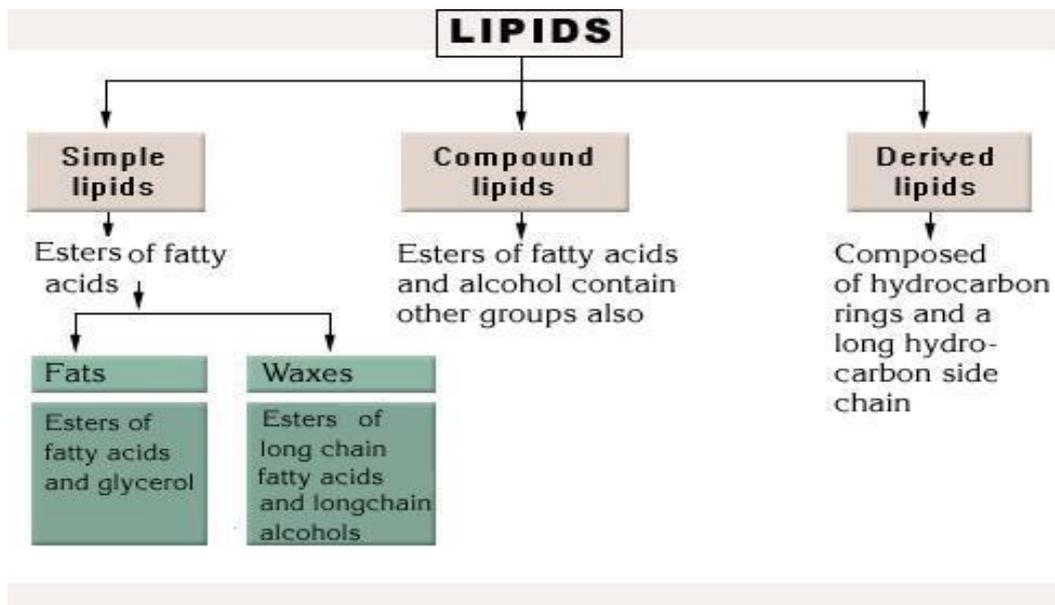
Lipids are a class of biological molecules defined by low solubility in water and high solubility in non-polar solvents like ether and chloroform.

## Function of Lipids :

- 1- Storage molecules for **energy (fats and oils)**
  - Can get lots of energy from a fat.
  - Stored in adipose tissue .
- 2- Structural components of cellular membranes.
- 3- Protective molecules (waxes).
- 4- Hormones and vitamins.
- 5- Intracellular messengers.
- 6- Pigments.
- 7- Insulation.

## Classes of Lipids :

In the year 1943 Bloor proposed the following classification of lipids based on their chemical composition.



### Types of lipids :

- **lipids** include fatty acids :-
- 1- Prostaglandins.
- 2- Waxes.
- 3- Triacylglycerol's.
- 4- Glycerophospholipids.
- 5- Sphingolipids.
- 6- Glycosphingolipids.
- 7- Steroids (cholesterol, bile salts and steroid hormones).

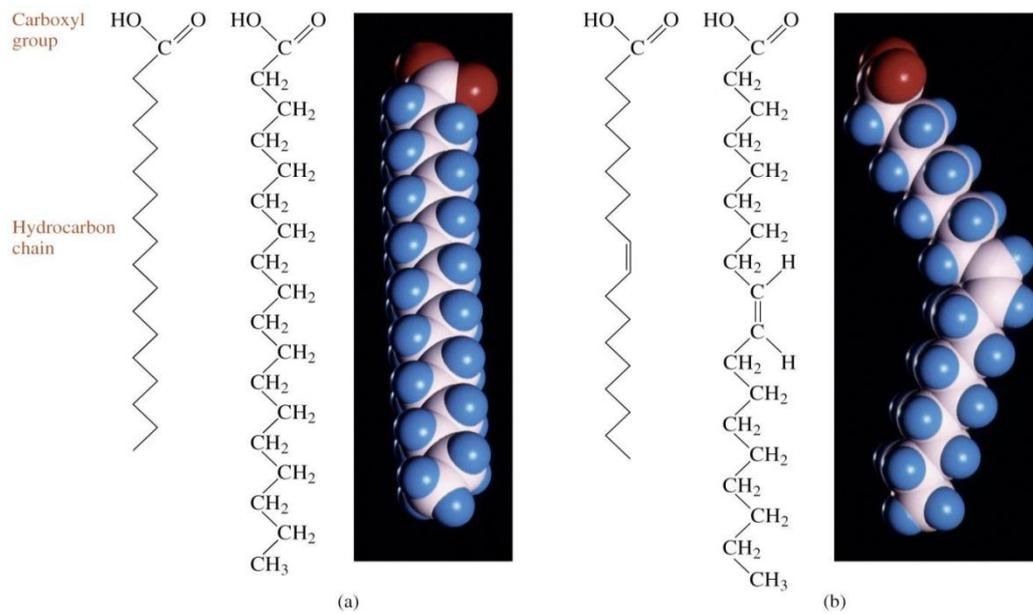
### Fatty Acid (FA) :

composed of a long hydrocarbon chain (“tail”) and a terminal carboxyl group (or “head”) The simplest lipids are the **fatty acids**, which rarely exist alone in nature, but instead are usually a component of more complex lipids Fatty acids are carboxylic acids with a long hydrocarbon chain attached Although the acid end is polar, the non-polar hydrocarbon tail makes fatty acids insoluble (or sparingly soluble) in water Fatty acids can be classified by how many double bonds are present in the hydrocarbon tail:

- **Saturated fatty acids** : have only single bonds
- **Monounsaturated fatty acids** : have one double bond
- **Polyunsaturated fatty acids** : have two or more double bonds

They are naturally occurring mono carboxylic acids that tend to have even numbers of carbon atoms, and may be classified as:

- Long – chain ( $C_{12}$  to  $C_{26}$  ).
- Medium – chain ( $C_8$  to  $C_{10}$  ).
- Short – chain ( $C_2$  to  $C_6$  ).



a- Saturated

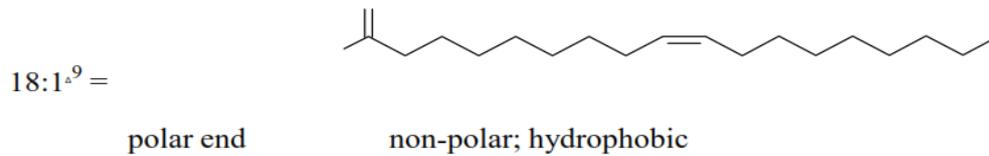
b- unsaturated

### NOMENCLATURE OF FA's :

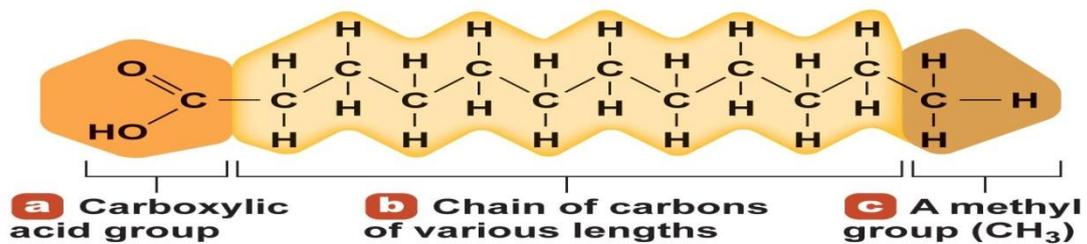
Referred to as a system of numbers.

- Of carbons: double bonds  $\Delta x, y, z$  (position of double bonds).

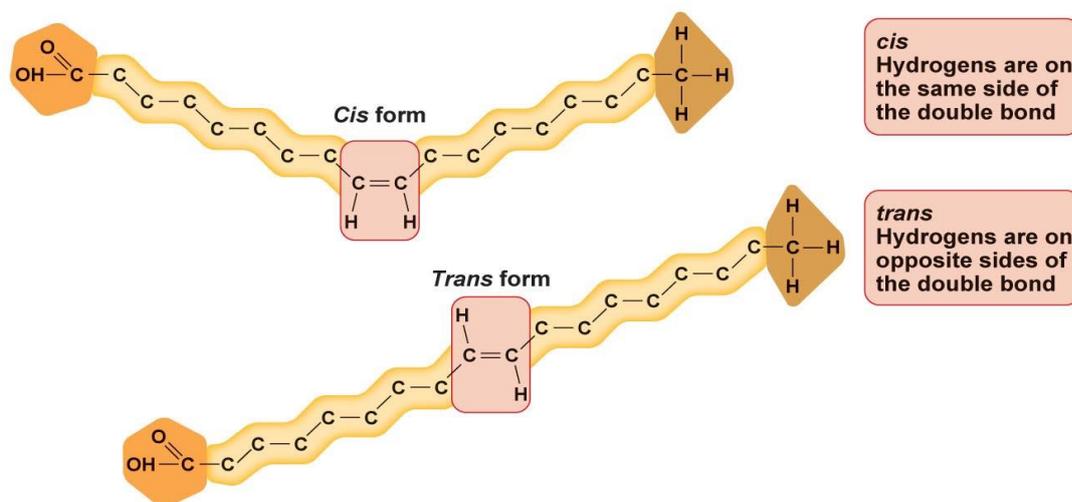
— - For example: oleic acid 18:1 $\Delta$ 9.



- Palmitic acid (26% of human fat)
- Oleic Acid (45% of human fat)



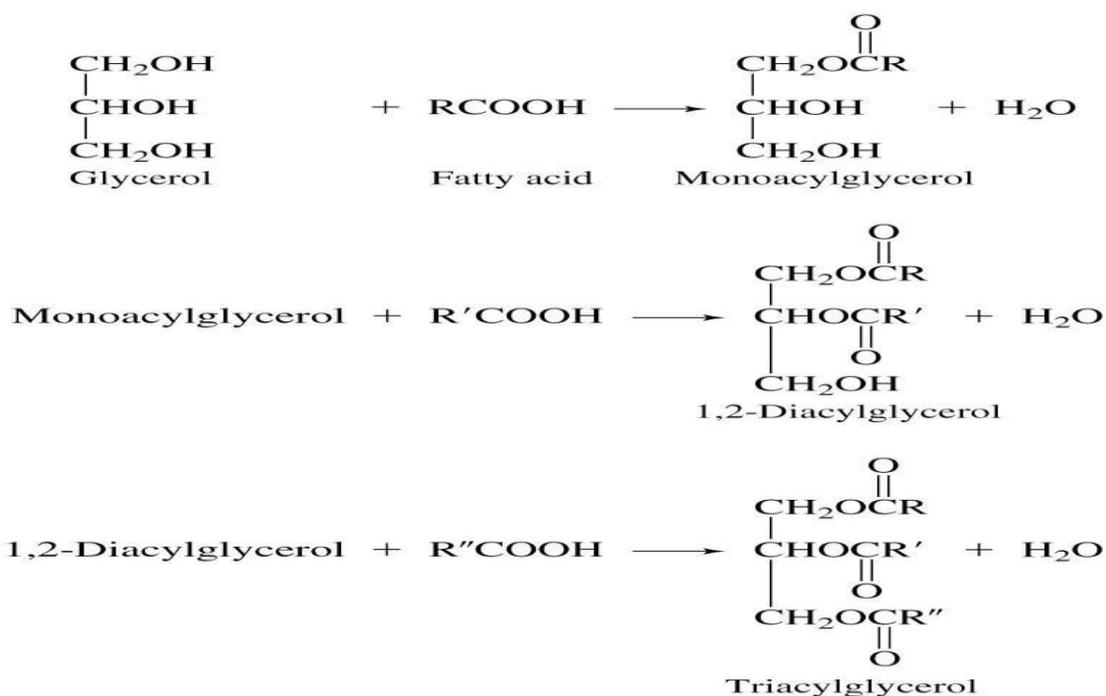
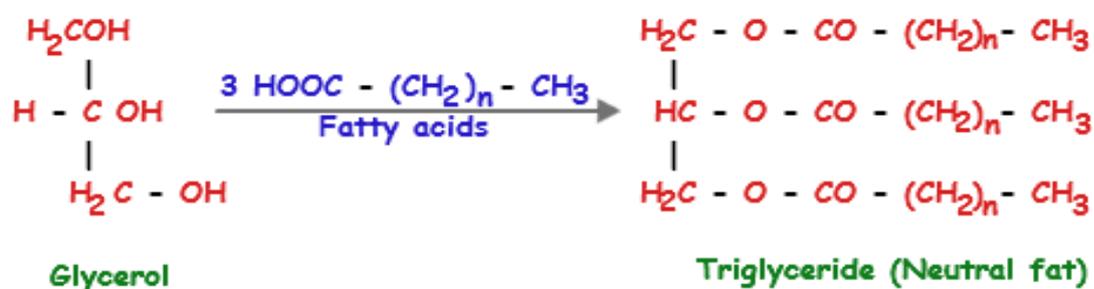
## Chemistry - College of Dental - Lec -12



Common name	Chemical structure	C:D	=
Myristoleic acid	$\text{CH}_3(\text{CH}_2)_3\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$	14:1	<i>cis</i> - $\Delta^9$
Palmitoleic acid	$\text{CH}_3(\text{CH}_2)_5\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$	16:1	<i>cis</i> - $\Delta^9$
Sapienic acid	$\text{CH}_3(\text{CH}_2)_6\text{CH}=\text{CH}(\text{CH}_2)_4\text{COOH}$	16:1	<i>cis</i> - $\Delta^6$
Oleic acid	$\text{CH}_3(\text{CH}_2)_7\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$	18:1	<i>cis</i> - $\Delta^9$
Elaidic acid	$\text{CH}_3(\text{CH}_2)_7\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$	18:1	<i>trans</i> - $\Delta^9$
Vaccenic acid	$\text{CH}_3(\text{CH}_2)_5\text{CH}=\text{CH}(\text{CH}_2)_9\text{COOH}$	18:1	<i>trans</i> - $\Delta^{11}$
Linoleic acid	$\text{CH}_3(\text{CH}_2)_4\text{CH}=\text{CHCH}_2\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$	18:2	<i>cis, cis</i> - $\Delta^9, \Delta^{12}$
Linoelaidic acid	$\text{CH}_3(\text{CH}_2)_4\text{CH}=\text{CHCH}_2\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$	18:2	<i>trans, trans</i> - $\Delta^9, \Delta^{12}$
$\alpha$ -Linolenic acid	$\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_2\text{CH}=\text{CHCH}_2\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$	18:3	<i>cis, cis, cis</i> - $\Delta^9, \Delta^{12}, \Delta^{15}$
Arachidonic acid	$\text{CH}_3(\text{CH}_2)_4\text{CH}=\text{CHCH}_2\text{CH}=\text{CHCH}_2\text{CH}=\text{CHCH}_2\text{CH}=\text{CH}(\text{CH}_2)_3\text{COOH}^{\text{NIS}}$	20:4	<i>cis, cis, cis, cis</i> - $\Delta^5, \Delta^8, \Delta^{11}, \Delta^{14}$

### Simple Lipids :

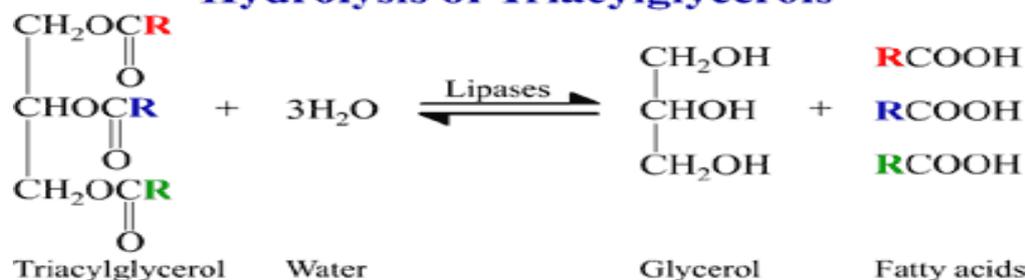
- **Simple lipids** are the esters of fatty acids with various alcohols. Fats and Oils (triglycerides and triacylglycerol's) . These are esters of fatty acids with a tri-hydroxy alcohol, glycerol. A fat is solid at ordinary room temperature and usually from animals and do not contain unsaturated fatty acids, an oil is liquid and usually from plants and Contain more unsaturated fatty acids.
- **Simple Triglycerides:** Simple triglycerides are one in which three fatty acids are similar or are of the same type.
- Example: Tristearin, Triolein.
- **Mixed Triglycerides** are one in which the three fatty acids radicles are different from each other.
- Example: distearo- olein, dioleo - palmitin.



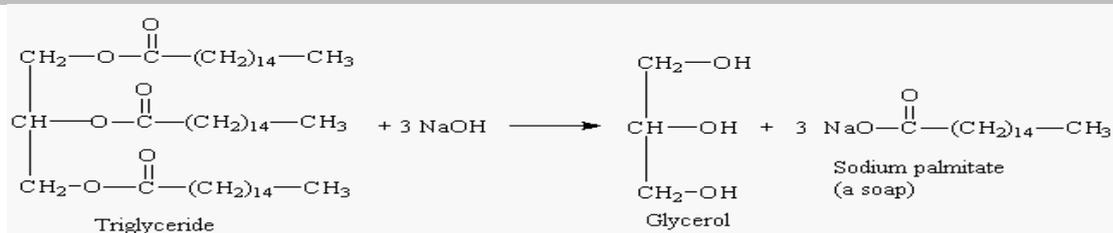
**Reactions of triglyceride :**

**1- Hydrolysis :**

**Hydrolysis of Triacylglycerols**



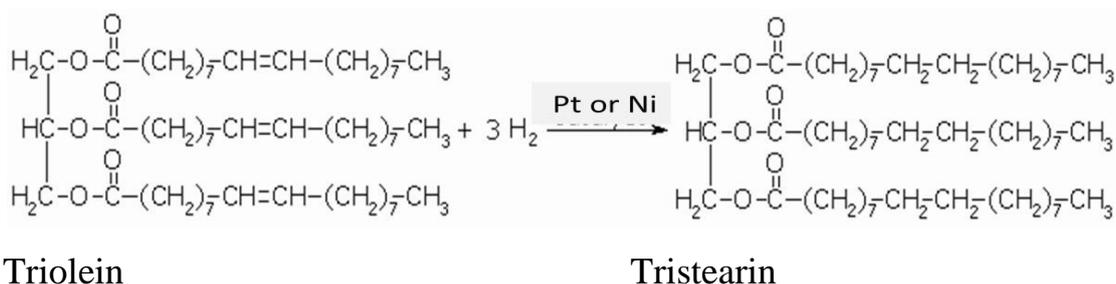
**2- Saponification :**



**Saponification number :** is the number of milligrams of potassium hydroxide required for the complete saponification of one gram of substance - called also **saponification value**.

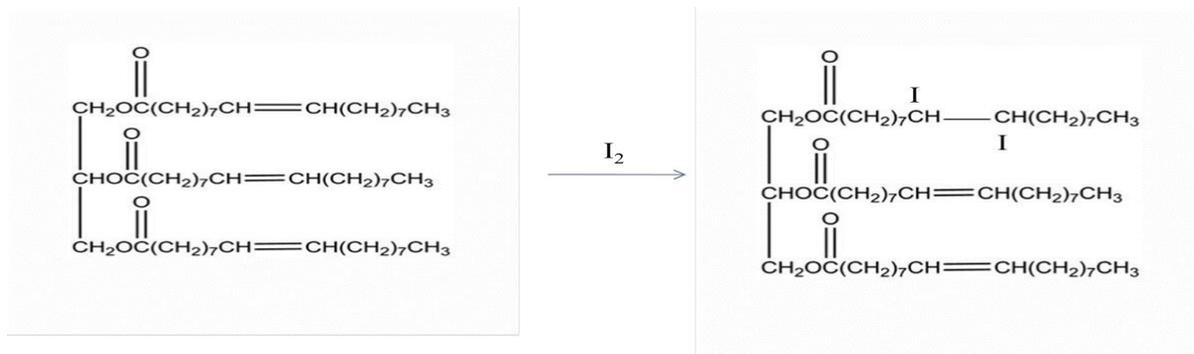
**3- Hydrogenation :**

It is the reaction by which the oil is converted to fat (unsaturated fatty acids are converted to saturated).



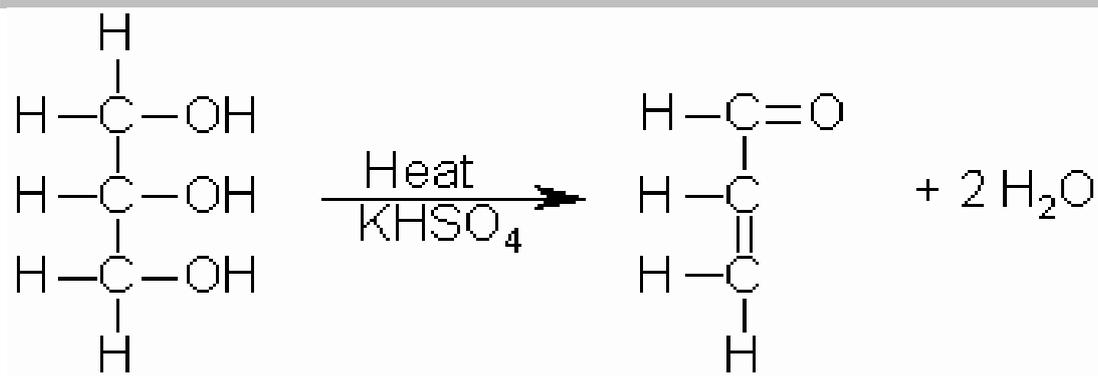
### 4- Halogenation :

— Unsaturated fatty acids in triglyceride accept halogen such as  $I_2$  at the double bonds.



— **Iodine Number:** is the number of grams of iodine or equivalent halogen consumed by 100 grams of the substance .

### 5- Formation of Acrolein (heat reaction) :



### 6- Rancidity :

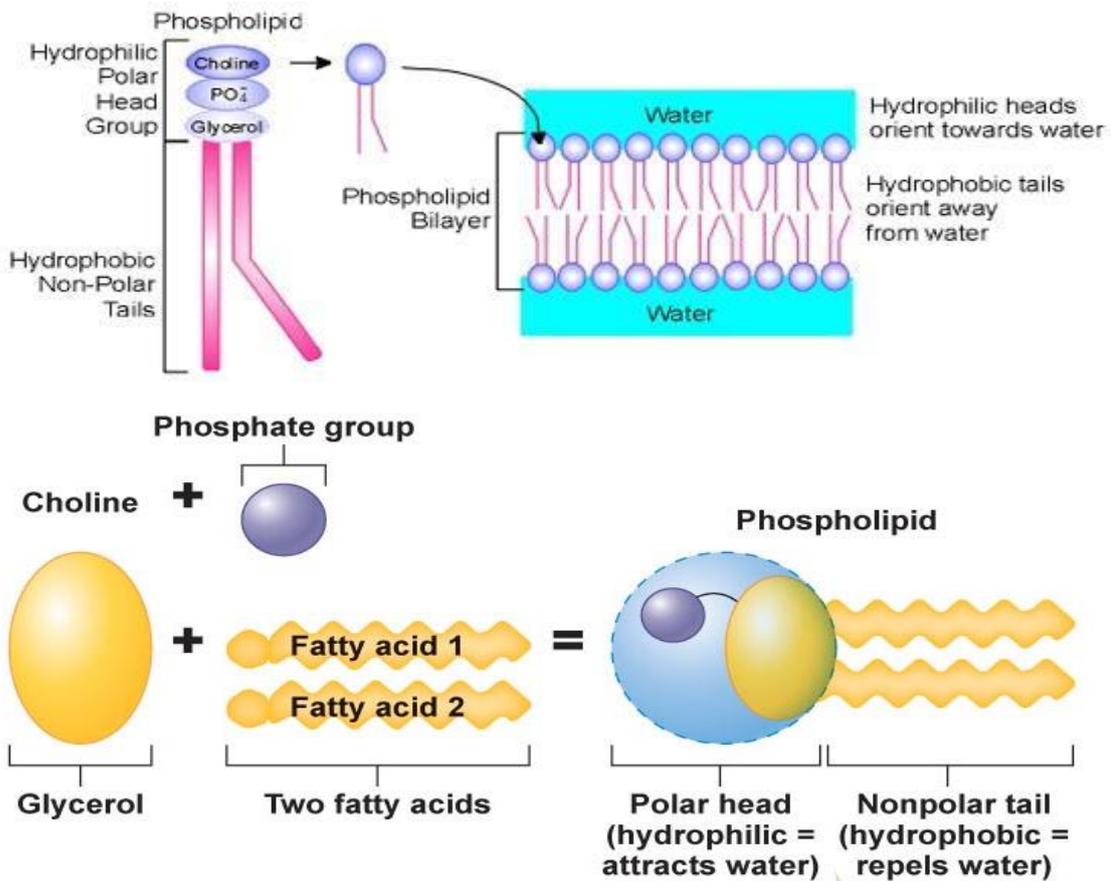
— rancidity, is the chemical decomposition of fats, oils and other lipids. When this process occurs in food, undesirable odors and flavors can result. In some cases, however, the flavors can be desirable (as in aged cheeses):

### Compound Lipids :

#### Heterolipids

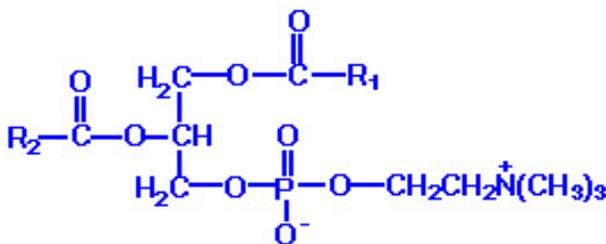
are esters of fatty acids with alcohol and possess additional groups also.

**Phospholipids** : are much more amphiphilic than triacylglycerols due to charged groups at neutral pH. Has both hydrophilic and hydrophobic regions phospholipids have one polar head and two non-polar tails .

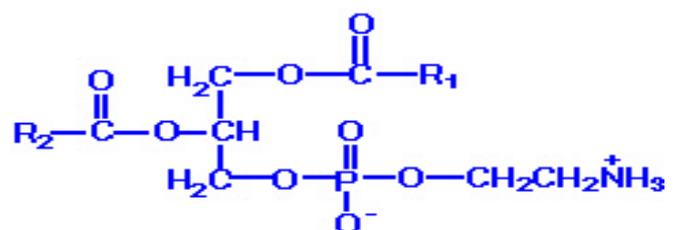


**Phosphoglycerides** : are major phospholipids, they are found in membranes. It contains fatty acid molecules which are esterified to hydroxyl groups of glycerol. The glycerol group also forms an ester linkage with phosphoric acid.

Example: Lecithin , Cephalins.



Lecithin(Phosphotidyl Cholin)



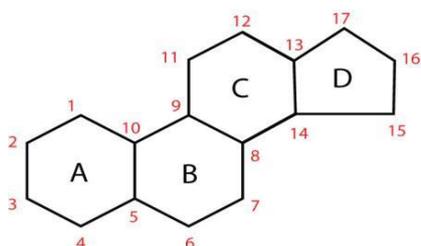
Cephalins (Phosphotidyl ethanol amine)

### Derived Lipids :

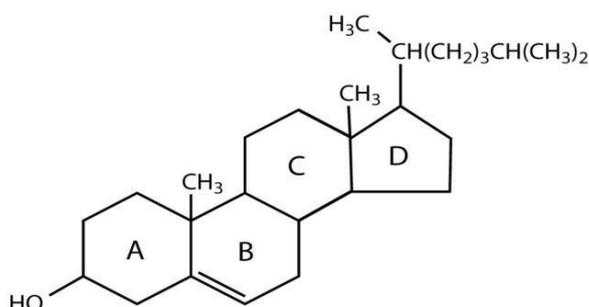
- Derived lipids are the substances derived from simple and compound lipids by hydrolysis.
- These includes fatty acids, alcohols, monoglycerides and diglycerides, steroids, terpenes, carotenoids. The most common derived lipids are steroids, terpenes and carotenoids.
- Steroids do not contain fatty acids, they are nonsaponifiable, and are not hydrolyzed on heating. They are widely distributed in animals, where they are associated with physiological processes.

### Function of Steroids

- 1- Source of some important biological molecules (Cholesterol, bile salts, vit. D, and sex hormones).
- 2- components of cell membranes.
- 3- Energy storage.



(a) Steroid skeleton



(b) Cholesterol

**β -oxidation reaction**

