**Lipids**

Lipids are a heterogeneous group of organic compounds that are related to fatty acids. They are insoluble in water and soluble in non-polar organic solvent like ethers, chloroform, benzene and acetone. The terms (fats) are solid and (oils) are liquid at room temperature.

**Food sources of Fat**

* Plants (nut, seeds, cottonseed, corn and olive oil.
* Animals (nervous system, blood, fatty tissues and Egg yolk).
* Dairy Fats and products (cream, butter, cheese.)

**Function of Lipid**

* Source of energy (9 kcal/g)
* Help carry fat soluble vitamins, absorption of vitamin A, D, E and K depend on the presence of lipids in the diet.
* Insulation- Lipids are excellent insulators.
* They combine with proteins forming different plasma lipoproteins which are the transport forms of lipids.
* Helps in the formation of cell membranes (Phospholipids)
* Supply Essential Fatty Acids (EFA) (Linoleic acid and linolenic acid)

**Classification of lipids**

Lipids are classified depending to chemical composition:-

1- Simple lipids

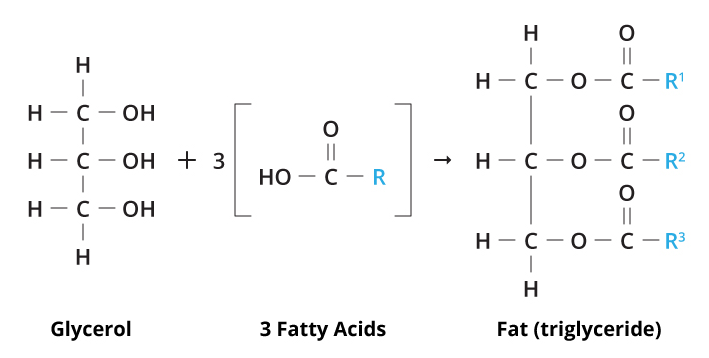
2- Compound lipids

3- Derived lipids

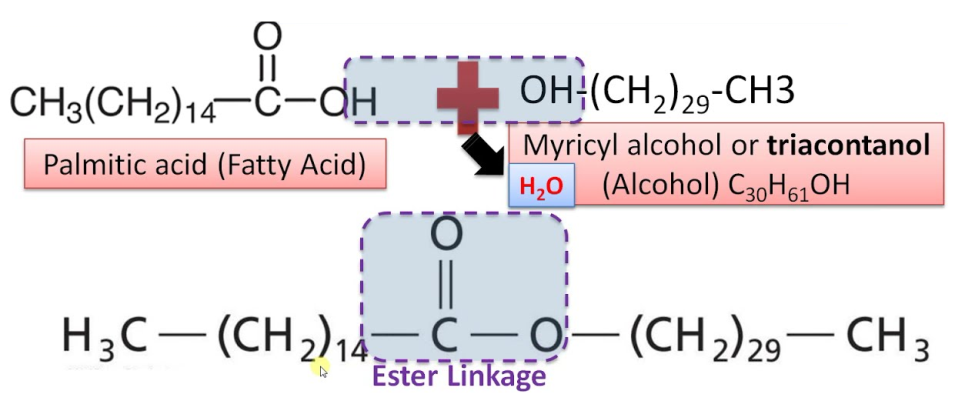
1. **Simple lipids**

Esters of fatty acids with alcohol

**(a)Fats**: They are esters of fatty acids and glycerol e.g.:- Triglycerides (T.G.)



**(b) Waxes**: They are esters of long chain fatty acids and higher molecular weight alcohols other than glycerol.



* Solid form at room temperature from animal sources (rich in saturated fatty acids) are called **fat.**
* Liquid form from plant source (rich in unsaturated fatty acids) are called **oil**.

1. **Compound lipids**

They contain other groups in addition to fatty acids and alcohol and include:-

(Fatty acid + alcohol + other substances)

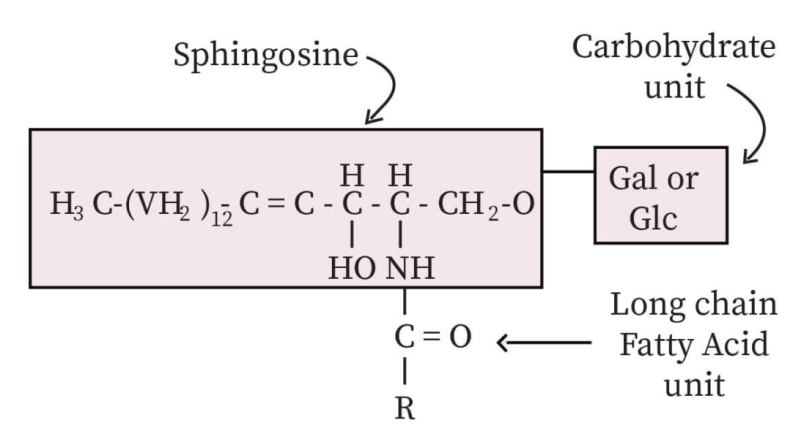
Phosphorus

Protein

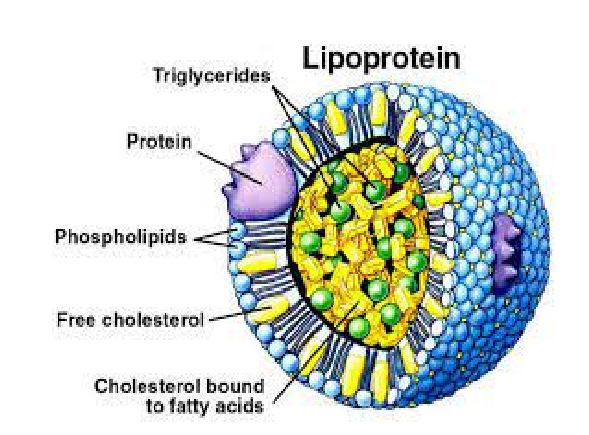
Sulphate

Sugar

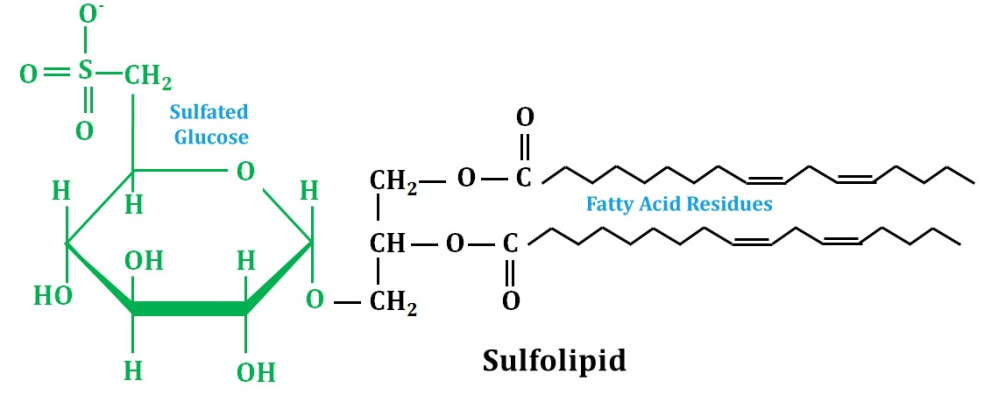
1. **Glycolipids (Glycosphingolipids):** These lipids contain fatty acids, sphingosines (nitrogenous) and carbohydrates.



1. **Lipoproteins**: Lipids attached to proteins, they are present in plasma and tissues



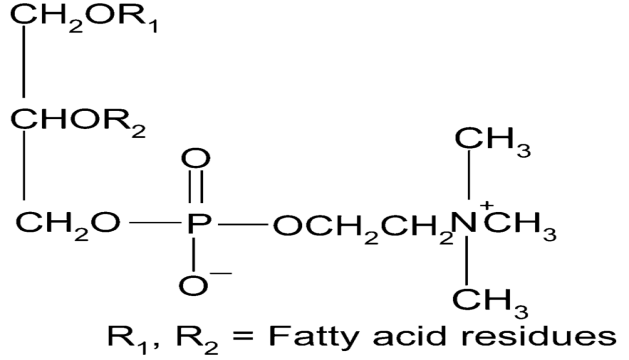
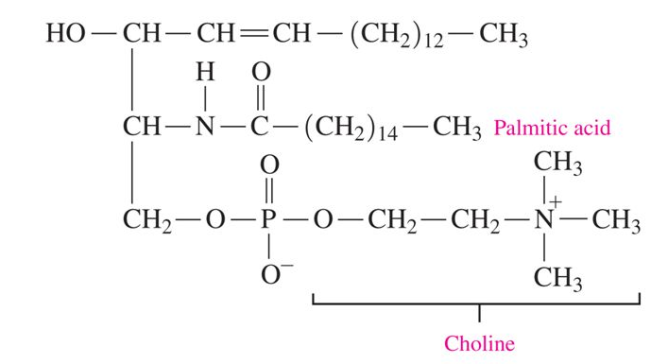
1. **Sulpho-lipids**: Lipids containing carbohydrates and sulphate group.



**D. Phospholipids:** They contain fatty acids, glycerol, phosphoric acid, and nitrogenous compound

Phospholipids found in cell membrane. Such as:-

1. Lecithin: found in the cell membrane.
2. Sphingomyeline: contain saphingosine, found in large amount in brain and nerve tissues

**Lecithin structure Sphingomyeline structure**

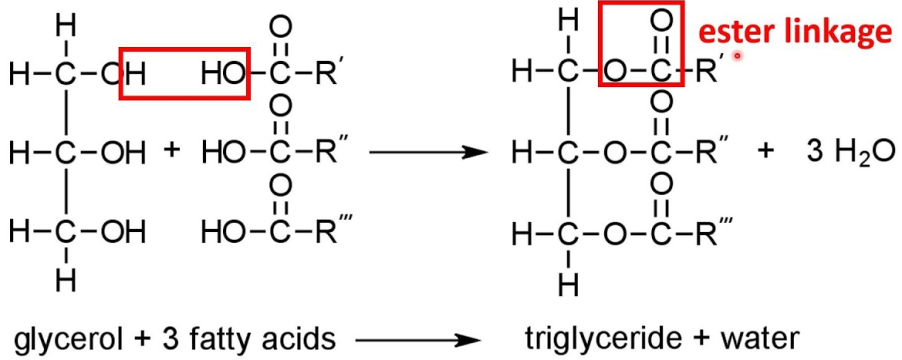
1. **Derived lipids:** They are derived from hydrolysis of simple lipids or compound lipids such as: Fatty acids, Glycerol, Sphingosine, and steroids (cholesterol).

**Triglycerides (**Simple lipid**)**

* Most abundant dietary fat.
* Compose 95% of all fat stored in adipose tissue (storage form of lipids).
* TG represents the most common class of lipids in nature.
* Found in both animal and plant tissues.
* Chemically they are esters of fatty acids and glycerol.

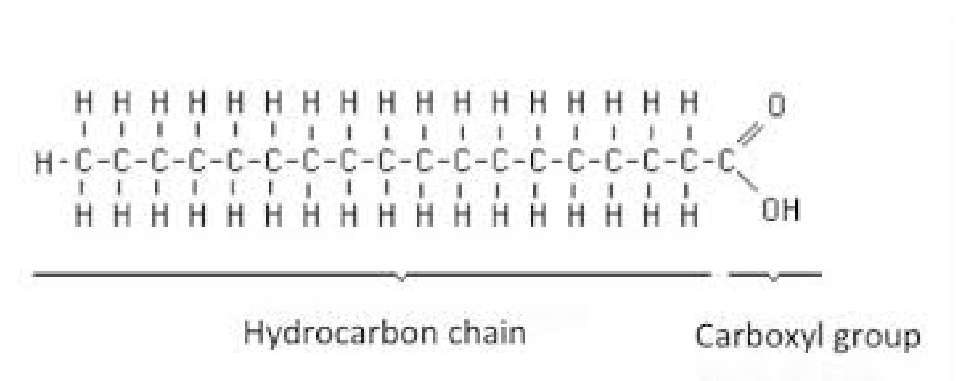
**Formation of Triglycerides**

They are esters of 3 molecules of fatty acids and glycerol



**Fatty acids**

* Fatty acids are organic acids that occur in the natural triglycerides.
* Long-chain carboxylic acids, Insoluble in water
* Have the general formula R-(CH2) n-COOH
* Fatty acids that occur in natural fats are usually straight-chain derivatives containing an even number of carbon atoms.
* The chain may be saturated (containing no double bonds) or unsaturated (containing one or more double bonds)



**Classification of Fatty acids**

Fatty acids can be classified depending on:

1. **Double bonds are present or not into:**

* Saturated fatty acids: They have no double bond (s)
* Unsaturated fatty acids: They have double bond (s).

1. **According to chain length:**

* Short chain FA: 2-4 carbon atoms
* Medium chain FA: 6 –10 carbon atoms
* Long chain FA: 12 – 26 carbon atoms.

1. **Nutritionally classified into:**

* Non-essential fatty acids (NEFAs)
* Essential fatty acids (EFAs)

**Nomeclature of fatty acids**

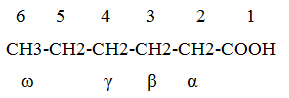
* The systematic name of fatty acids is derived from the name of the hydrocarbon. The term oic being substituted for the final –e in the name of hydrocarbon.

Examples:

Butane = Butanoic (4 carbon atoms).

Octane = Octanoic (8 carbon atoms).

* Carbon atoms are numbered from –COOH group, where –COOH takes number 1. the next is C2 (alpha **α**) and terminal carbon atom is called omega **ω**



* To indicate the number and position of double bonds the symbol ∆ is placed.

Example:

If we have oleic acid C17H33COOH, so it is expressed 18:1; ∆9

Generally fatty acids are expressed by a formula to indicate:

* Number of carbon atoms.
* Number of double bonds.
* Position of double bonds

**Saturated Fatty acids**

* They have no double bond (s)
* Genral formula CnH2n+COOH.

Examples for saturated fatty acid:

n = 4: butyric acid

n = 6: caproic acid

n = 8: caprylic acid

n = 10: capric acid

n = 12: lauric acid

n = 14: myristic acid

n = 16: palmitic acid

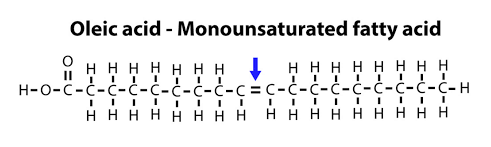
n = 18: stearic acid

**Unsaturated fatty acids:**

They have double bond (s). Subdivided into:

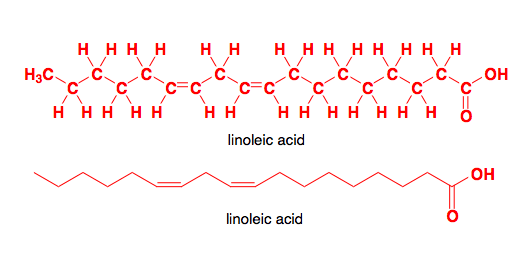
**Mono unsaturated fatty acids**:

* contain only one double bond
* Example Oleic acid (C17H33COOH) which was found nearly in all fats.

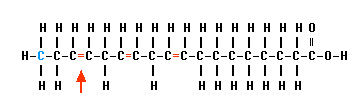


**Poly unsaturated fatty acids:**

* They contain two or more double bond.
* Linoleic acid (18:2;9,12): It contains two double bonds between C9 and C10 and between C12 and C13.



* Linolenic acid (18:3;9,12,15): It contains 3 double bonds between C9 and C10 and between C12 and C13 and between C15 and C16.



* Arachidonic acid (20:4;5,8,11,14): It contains 4double bonds between C5 and C6 and between C8 and C9 and between C11 and C12 and between C14 and C15.



**Non-essential fatty acids:**

* Cannot be made (synthesized) in the body
* Examples: palmitic acid, stearic acid ….etc

**Essential fatty acids (EFAs) :**

* Cannot be made (synthesized) in the body.
* They have to be provided in diet
* Example: Linolenic acid

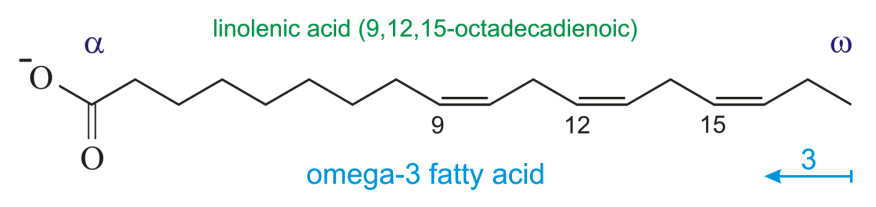
**Omega(ω) Fatty acids**

1. **Omega-3 Fatty acids**

* Omega-3 Fatty acids are a family of unsaturated fatty acid
* That has in common a carbon-carbon double bond in the position n-3, which is the third bond from the methyl end of the fatty acid.

Examples:

* Linolenic acid C18:3 (9,12,15)
* Stearidonic acid C18:4 (6,9,12,15)

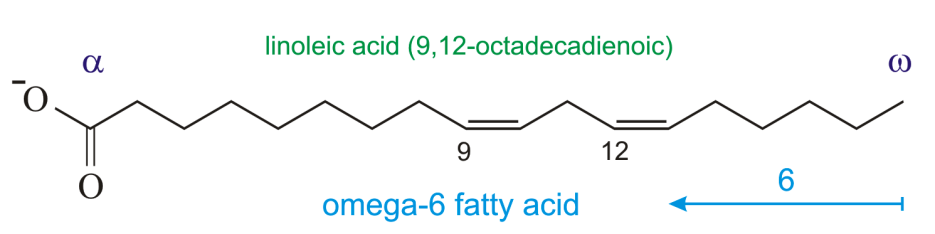


**The function of Omega-3 Fatty acids:**

* Anti-inflamatory and anti-coagluant properties
* Can provide against cardiovascular disease, arthritis, skin conditions, depression, and other disorders.

1. **Omega-6 Fatty acids**

* Omega -6 Fatty acids are a family of unsaturated fatty acid
* That have in common a carbon-carbon double bond in the position n-6, which is the sixth bond from the methyl end of the fatty acid



Examples:

* Linoleic acid C18:2 (9,12)
* Eicosadienoic acid C20:2 (11,14)

**The function of Omega-6 Fatty acids:**

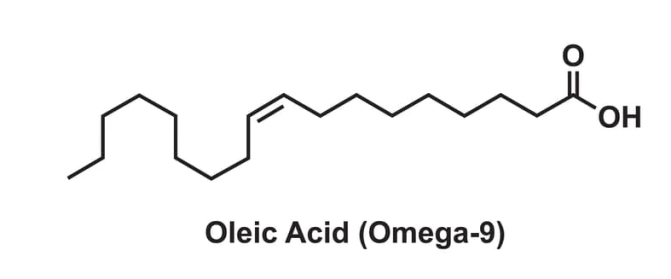
* **Omega-6** have anti-inflammatory properties.
* It maintains healthy skin, hair and nails, and helps to bring hormonal and emotional balance.

1. **Omega-9 Fatty acids**

* Omega-9 Fatty acids are a family of unsaturated fatty acid
* That has in common a carbon-carbon double bond in the position n-9, which is the ninth bond from the methyl end of the fatty acid.

Examples:

* Oleic acid C18:1 (9)
* Erucic acid C22:1 (13)



**Omega-9 Fatty acids function**

* Help to reduce the risk of cardiovascular disease, artherosclerosis, and stroke.

