

الكيمياء الحياتية
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chemical properties

1. **Saponification** : hydrolysis of fat by alkali is called saponification. Hydrolysis products are glycerol and alkali salts of fatty acids called soaps.



- Washing soaps contain high amount of Sodium or potassium salts of these fatty acids.

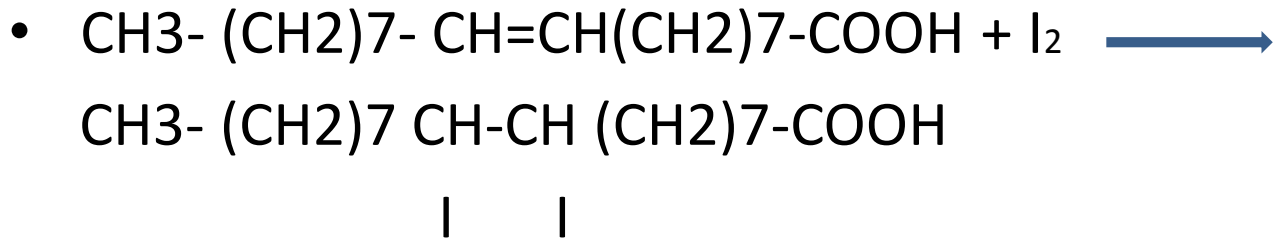
Saponification number:

the number of mgs of NaOH or KOH required to saponify the free fatty acid in 1gm of a given fat.

↑ saponification number → fat with shorter chain length of fatty acid.

- Ex : Butter contain large proportion of short chains of fatty acids, so it has high saponification number while margarine with more long fatty acids, so it has low saponification number.
- Hydrogenation: addition of hydrogen molecule to saturate the double bond of unsaturated fatty acids in the presence of catalyst like nickel.
- What is the importance of hydrogenation?

Iodine number: Number of grams of iodine taken up by 100 gms of fat. Uses : To know the degree of unsaturation of fatty acids and it is directly proportional to the content of unsaturated fatty acids ex: butter is low iodine number while sun flower is high iodine number.



3. **Acid number**: Number of mgm s of KOH required to neutralize the fatty acids in 1gram of fat

Uses: to indicate the degree of rancidity of fat.

4. **Rancidity**: hydrolytic or oxidative changes taking place at the double bond s of the unsaturated fatty acids resulting in short chain aldehydes or ketones, causes unpleasant odors and taste.

rancidity ocuring in fats from animal sources by the action of lipase enzyme, when the fats exposed to unsuitable condition like light , high temperature and moisture.

why vegetable fats is preserver for long periods than animal fats ?

Derived lipids

Fatty acids: define as organic acid , hydrolysis from fats(TG)
contain monocarboxylic acid , chain length
ranging from **C₄** to a bout **C₂₄**, divide in to :

1. saturated fatty acids: contain no double bonds.

general formula $C_n H_{2n+1} COOH$

ex : Acetic acid CH_3COOH

Propionic acid C_2H_5COOH

Butyric acid C_3H_7COOH

Caproic acid $C_5H_{11}COOH$

Palmitic acid $C_{15}H_{31}COOH$

Stearic acid $C_{17}H_{35}COOH$

milk contains significant amounts of lower fatty acids.

Unsaturated fatty acids: contain double bonds, divide in to

1. Monounsaturated fatty acids.

ex: oleic acid $C_{17}H_{33}COOH$ contain 1 double bond ,
found in all nearly fats.

(formula 18 : 1 ; 9)

2. Polyunsaturated fatty acids. There are three types

linoleic acid $C_{17}H_{31}COOH$ contain 2 double bonds ,

(formula 18 : 2 ; 9, 12)

present in sufficient amounts in peanut oil , corn oil , cotton seed oil , soybean oil and egg yolk.

linolenic acid $C_{17}H_{29}COOH$ contain 3 double bonds ,

(formula 18 : 3 ; 9 , 12 , 15)

Present in linseed oil, soy bean oil, fish visceras cod liver oil.

Arachidonic acid $C_{20}H_{33}COOH$, contain 4 double bonds , (formula 20 : 4 ; 5 , 8 , 11 , 14).

Present in animal fats and in peanut oil.

linoleic , linolenic and arachidonic acids are called essential fatty acids (EFA).

Essential fatty acids: fatty acids cannot be synthesized in the body and must be provided in the diet.

Lack of (EFA) in the diet cause:

1. degenerative changes in arterial wall
2. produce fatty liver
3. increase serum cholesterol
4. necrosis of skin (Eczema like dermatitis
5. linoleic acid necessary for optimal vision.

Phospholipids

Define as compound lipids contain in addition to fatty acids and glycerol, phosphoric acid and nitrogen base.

Distributed in animals in liver, brain, tissues, sperm and egg yolk. In plants it is present in seeds and sprouts.

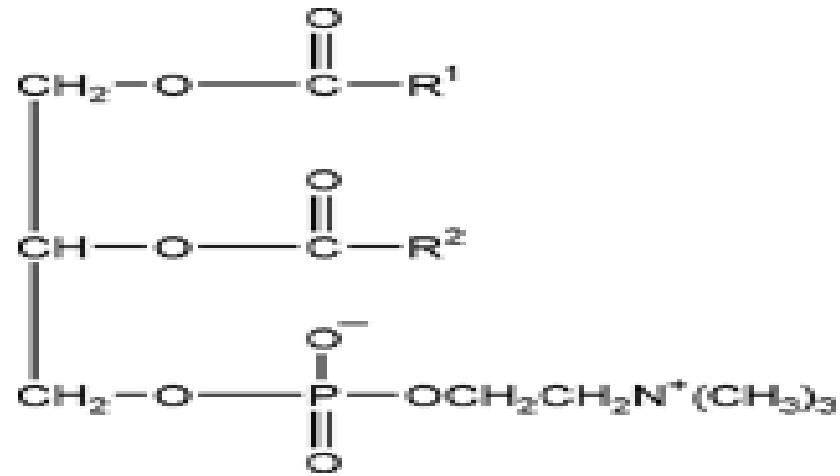
Classification:

1. Glycerophosphatides: alcohol is glycerol
 - a. Phosphatidyl choline(lecithin)
 - b. Phosphatidyl ethanol amine (cephalin)
 - c. Phosphatidyl serine ephalin) d. Plasmalogn
2. Phosphosphingosides: alcohol is sphingol

glycerophosphatides are divide in to:

a) **lecithin: consist of**

fatty acids + glycerol + phosphoric acid
+ nitrogen base (choline)



Functions:

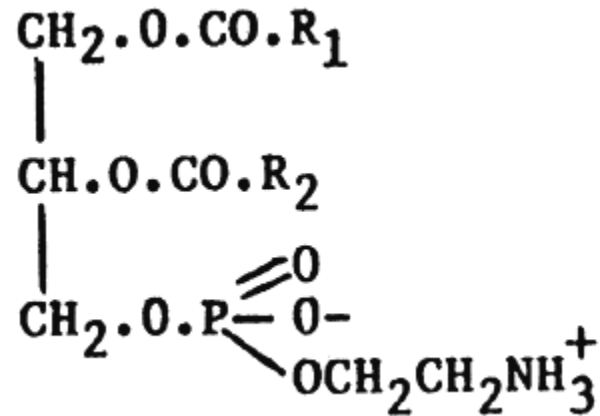
prevent accumulation of fat in the liver.

Absence of choline will block the synthesis of lecithin and cause fatty liver.

Choline: is define as lipotropic factor convert of fat(triglyceride) to phospholipid, therefore prevent the condition of fatty liver.

Triglyceride(TG) $\xrightarrow{\text{cholin}}$ Phospholipid

b) Phosphatidyl ethanolamine(Cephalin)

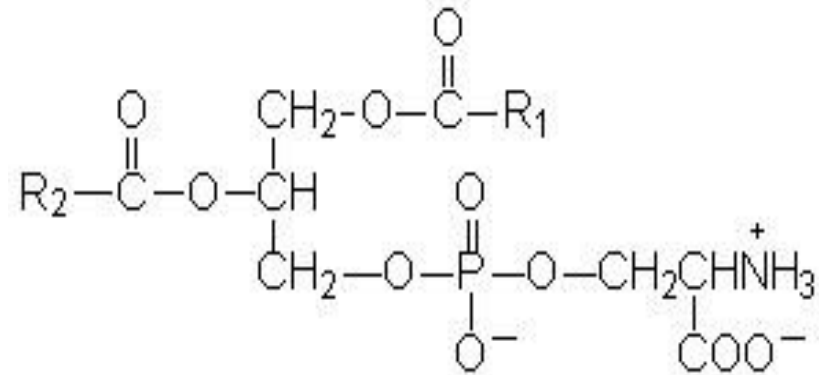


Structurally identical to lecithin except that base ethanolamine replaces cholin. It is rich in brain and nervous tissues.

Functions:

- a. Important in the clotting of blood.
- b. sources of phosphoric acid for formation of new tissues.

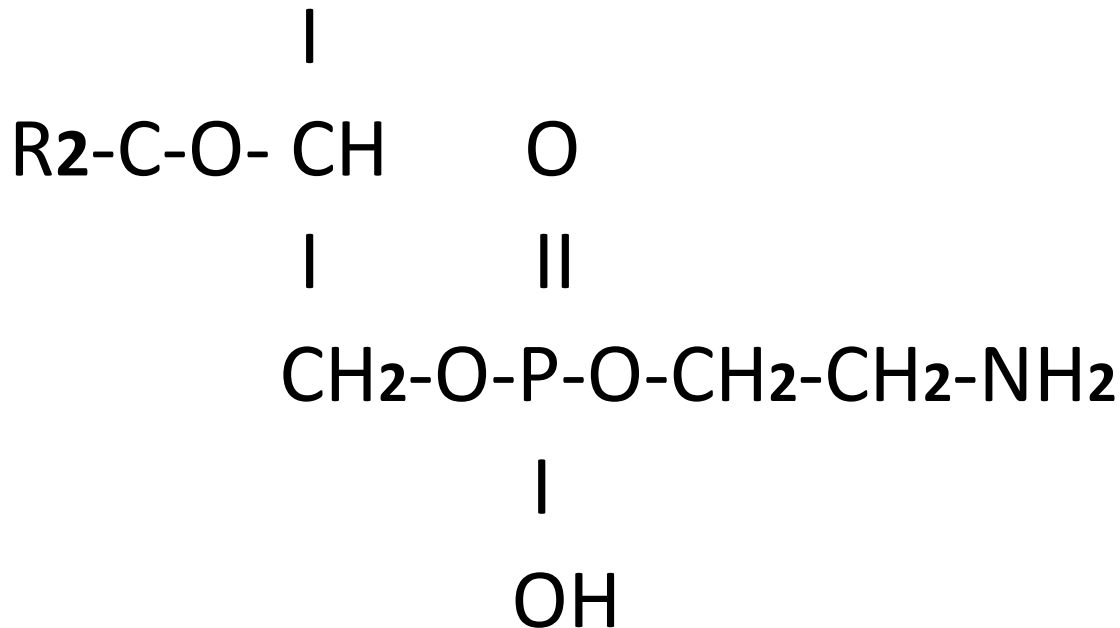
c) Phosphatidyl serine: phospholipid contain amino acid serine in place of ethanol amine.



d) Plasmalogen: 10% of total phospholipids are concentrated in brain, nervous tissues, muscle and mitochondria.

Structurally like lecithin and cephalin except that the normal ester is replaced by the ether linkage on the carbon atom C1.

The nitrogen base is choline or ethanolamine.

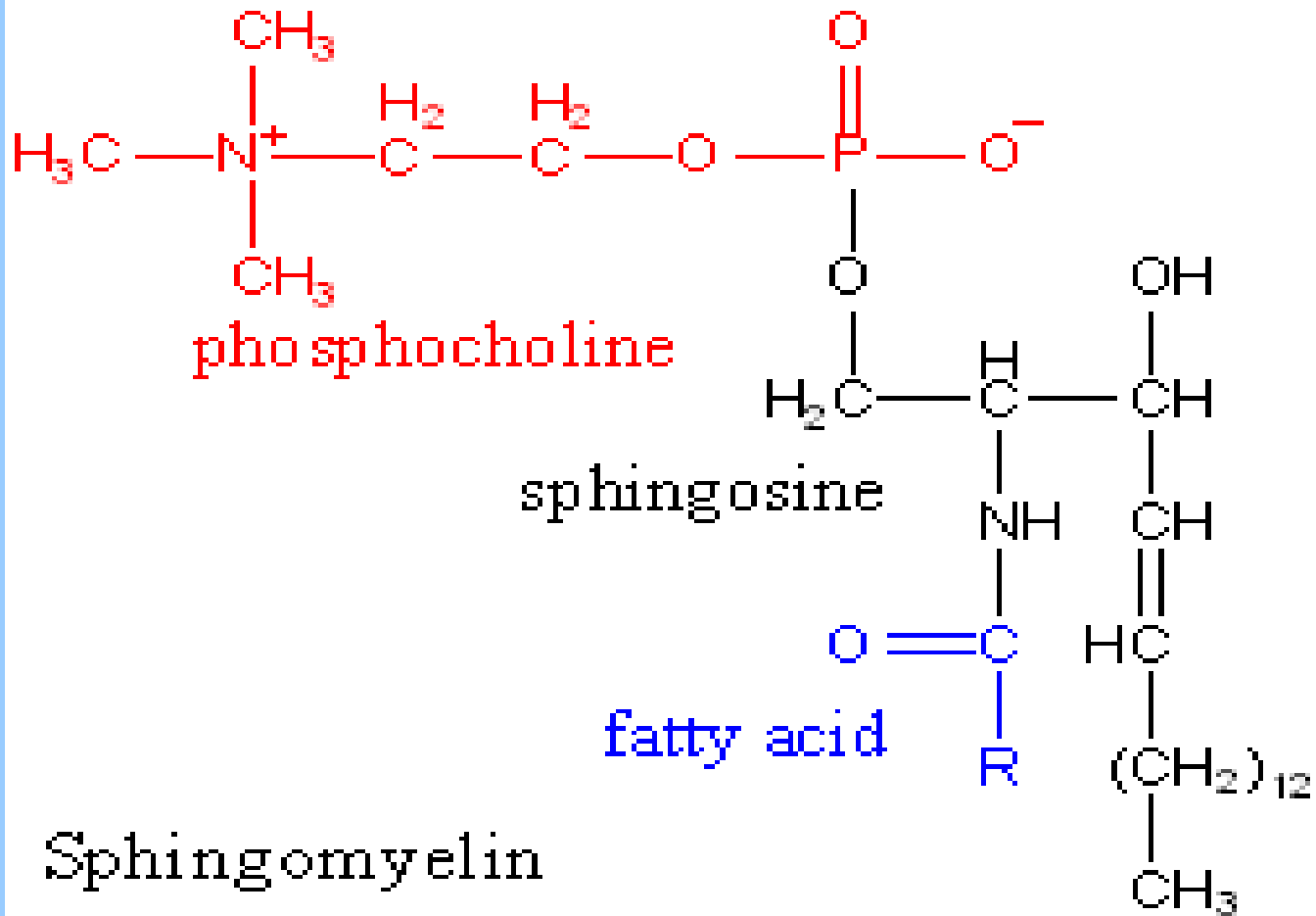


2. phosphosphingosides: ex: sphingomyelin

found in large quantities in brain and nervous tissues.

Consist of : fatty acid+ phosphoric acid+ nitrogen base choline + one molecule of complex amino alcohol called sphingosine (sphingol).

Clinical aspect of sphingomyelin is Niemann-Pick disease, inherited disorder of sphingomyelin metabolism lead to accumulation of sphingomyelin in liver, spleen and brain. It called lipid storage disease(lipidosis).



Functions of phospholipids

1. Role in enzyme action: Mitochondrial enzyme system involved in oxidative phosphorylation.

2.Role in blood coagulation.

Conversion of prothrombin to thrombin by active factor.

3.Role in lipid absorption in intestine.

Lecithine lowers the surfac tention of water and aids in emulsification of lipid water mixtures which help in absorption of lipids from gastrointestinal (GI) tract.

4. Role in transport of lipids from intestine.

Exogenous T.G is carried as lipoprotein complex chylomicrons,in which P.L takes an active part.

5.Role in transport of lipids from liver.

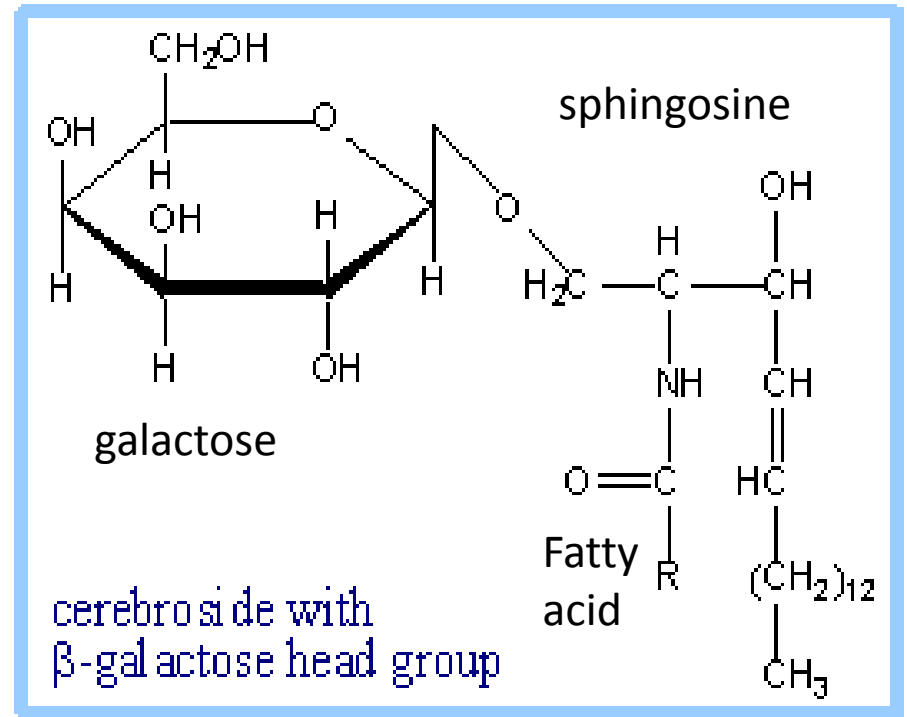
Endogenous TG is carried from liver to various tissues as lipoprotein complex called very low density lipoprotein (VLDL).

6. Lipotropic action of lecithin.

Cholin in lecithin act as lipotropic agent prevent fatty liver formation.

- **Glycolipids:**

Cerebrosides



- **Consist of:** fatty acid , alcohol (sphingosine) and sugar galactose.
- It is present in large quantities in brain especially in white matter and in the myelin sheath of nerve.