

## II- Compound Lipids

Compound (conjugated) lipids are lipids conjugated with other substances. They include:

- 1- Phospholipids formed of lipid, phosphoric acid and nitrogenous base.
- 2- Glycolipids, formed of lipid part and carbohydrate part
- 3- Sulpholipids, lipids containing sulphate.
- 4- Lipoproteins formed of lipid part and protein part

### 1- Phospholipids

They are a group of compound lipids formed of alcohol, fatty acids, phosphoric acid and nitrogenous base. They are classified according to the alcohol present into:

- A)- Phosphoglycerides** in which nitrogen phosphorous ratio is 1 (N/P ratio = 1) i.e. they contain one nitrogen and one phosphate
- B)- Sphingomyelin** in which N/P ratio is 2 i.e. it contains 2 nitrogen and one phosphate

#### A- Phosphoglycerides

Phosphoglycerides are a group of phospholipids containing glycerol with N/P ratio = 1

They include phosphatidic, lecithin, cephalins, phosphatidyl inositol, plasmalogen and cardiolipin.

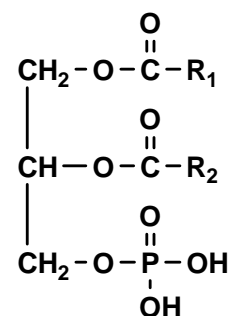
#### 1- phosphatidic acid

It is phosphoric acid ester of diglycerides

##### Structure

It is formed of:

- Glycerol
- Saturated fatty, attached to  $\alpha$  carbon of glycerol by ester bond.
- Unsaturated fatty acid, attached to  $\beta$  carbon of glycerol by ester bond.
- Phosphoric acid attached to  $\alpha$  carbon of glycerol by ester bond



Phosphatidic acid

#### Function of phosphatidic acid

It is an intermediate compound in biosynthesis of other phosphoglycerides and triglycerides

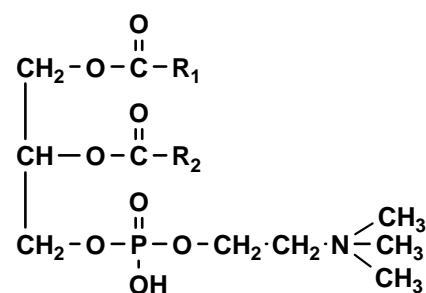
#### 2- Lecithin

It is phosphatidyl choline

##### Structure

It is formed of:

- Glycerol
- Saturated fatty acid, attached to  $\alpha$  carbon of glycerol by ester bond.
- Unsaturated fatty acid, attached to  $\beta$  carbon of glycerol by ester bond.
- Phosphoric acid attached to  $\alpha$  carbon of glycerol by ester bond
- Choline attached to phosphoric acid by ester bond



Lecithin (phosphatidyl choline)

#### Function of lecithin

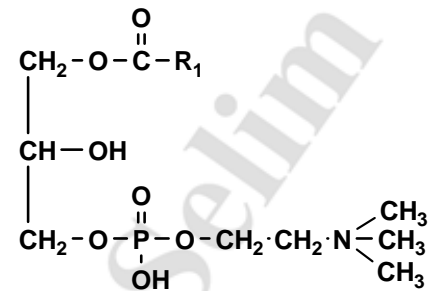
- 1- It is the most abundant phospholipid in the cell membrane
- 2- It acts as a lipotropic factor preventing accumulation of lipids in the liver.
- 3- Dipalmityl lecithin acts as a surfactant in the lung alveoli forming a layer at the interface of fluid lining the alveoli and air in side alveoli preventing lung collapse

In premature infants the lung alveoli do not secrete lecithin in sufficient amount so the lungs collapse this is called respiratory distress syndrome.

## Lysolecithin

Snake venom contains lecithinase enzyme, which removes the unsaturated fatty acid from lecithin forming lysolecithin.

Lysolecithin is a strong surface-active substance that has a marked haemolytic action causing haemolysis of the red blood cells.



Lysolecithin

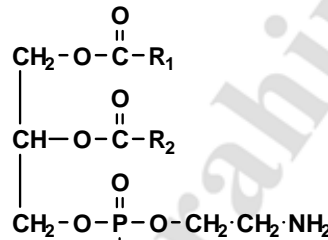
## 3- Cephalins

They are phosphatidyl ethanolamine and phosphatidyl serine

### Structure

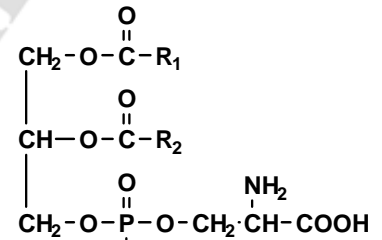
They are formed of:

- Glycerol
- Saturated fatty acid, attached to  $\alpha$  carbon of glycerol by ester bond.
- Unsaturated fatty acid, attached to  $\beta$  carbon of glycerol by ester bond.
- Phosphoric acid attached to  $\alpha$  carbon of glycerol by ester bond
- Ethanolamine or serine.



Cephalin

(Phosphatidyl ethanolamine)



Cephalin

(Phosphatidyl serine)

### Function of cephalins

- They have a role in blood coagulation.
- They accelerate blood clotting because they enter in the structure of thromboplastin, which is essential for blood clotting.

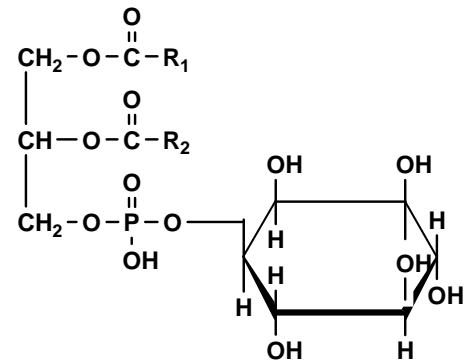
## 4- Phosphatidyl inositol

It is also called lipoinositol

### Structure

It is formed of:

- Glycerol
- Saturated fatty, attached to  $\alpha$  carbon of glycerol by ester bond.
- Unsaturated fatty acid, attached to  $\beta$  carbon of glycerol by ester bond.
- Phosphoric acid attached to  $\alpha$  carbon of glycerol by ester bond
- Inositol, which is a cyclic alcohol derived from glucose.



Phosphatidyl inositol

### Function of phosphatidyl inositol

It is found in brain tissue.

It has a role in mechanism of hormone action. On hydrolysis by phospholipase C enzyme, it gives compounds, which act as second messengers in hormone action e.g. diacyl glycerol (DAG) and inositol triphosphate (IP3).

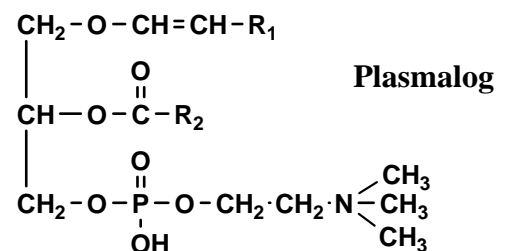
## 5- Plasmalogens

They are lecithin or cephalin in which the fatty acid attached to  $\alpha$  carbon is replaced by fatty aldehyde in the enol form.

### Structure

It is formed of:

- Glycerol
- Fatty aldehyde, enol form (unsaturated alcohol)
- Unsaturated fatty acid
- Phosphoric acid
- Nitrogenous base, which may be choline, ethanolamine or serine



Plasmalog

### Function of plasmalogens

They are present in cardiac muscle, skeletal muscles and brain.

## 6- Cardioliipin

It is a diphosphatidyl glycerol formed of 2 phosphatidic acids attached together by glycerol.

### Structure

It is formed of:

- 3 glycerol molecules.
- 2 saturated fatty acids.
- 2 unsaturated fatty acids.
- 2 molecules of phosphoric acid.

### Functions of cardioliipin

Cardioliipin is present in heart muscle.

It is used as antigen for detection of syphilis.

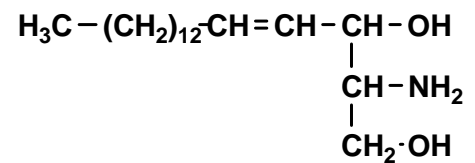
## B- Sphingomyelins

Sphingomyelin is a phospholipid with N/P ratio = 2.

In this type of phospholipids the alcohol is sphingol alcohol which is also called sphingosine base i.e. sphingomyelin contains sphingosine base instead of glycerol.

Sphingosine base contains 18 carbon atoms:

- The first carbon contains hydroxyl group (-OH).
- The second carbon contains amino group (-NH<sub>2</sub>).
- The third carbon contains hydroxyl group.
- There is a double bond between C4 and C5

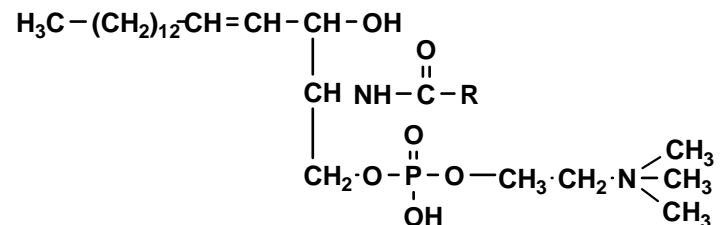


Sphingosine base

### Structure of sphingomyelin

Sphingomyelin is formed of:

- Sphingosine base
- Unsaturated fatty acid attached to the amino group of sphingosine
- Phosphoric acid attached to the first carbon of sphingosine.
- Choline base attached to phosphoric acid.



Sphingomyelin

### Function of sphingomyelin

It is abundant in the nervous system in the myelin sheath also it is present to lesser extent in liver, spleen and bone marrow.

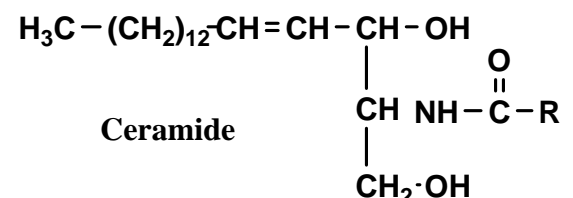
### N.B: Ceramide

It is formed of sphingosine base to which fatty acid is attached by amide linkage.

It differs from sphingomyelin, as it does not contain phosphoric acid or choline.

### N.B: Nimann Pick disease

It is a disease caused by deficiency of sphingomyelinase enzyme, which catabolizes sphingomyelin. This leads to accumulation of large amounts of sphingomyelin in liver, spleen and brain.



## 2- Glycolipids

They are compound lipids that contain carbohydrates. They also contain sphingosine base  
They include cerebrosides and gangliosides

### 1- Cerebrosides

These are compound lipids formed of lipids and carbohydrates. They are called cerebrosides because they are present mainly in the brain and nerves.

#### **Structure**

It is formed of:

- Sphingosine base.
- Long chain fatty acid attached to the amino group of the sphingosine base by amide linkage.
- Carbohydrate usually galactose but may be glucose.

According to the type of fatty acid present, cerebrosides are classified into:

- 1- **Kerasin** that contains lignoceric acid, which is a saturated fatty acid containing 24 carbon atoms
- 2- **Nervon** that contains nervonic acid, which is an unsaturated fatty acid containing 24 carbon atoms
- 3- **Oxynervon** that contains oxynervonic acid, which is an unsaturated fatty acid containing 24 carbon atoms and hydroxyl group.
- 4- **Cerebron** that contains cerebronic acid, which is a saturated fatty acid containing 24 carbon atoms and hydroxyl group.

#### **Functions of cerebrosides**

They are present mainly in the nervous tissues i.e. brain and nerves. They act as electric insulators of nerve impulses.

Also, they are present in spleen, liver, adrenal gland, kidney and lungs

### 2- Gangliosides

These are the most complex glycolipids .

#### **Structure**

- Sphingosine base.
- Long chain fatty acid
- One glucose molecule.
- 2 galactose molecules.
- N-acetyl galactosamine.
- \*- N-acetyl neuraminic acid (sialic acid; NANA).

**Sphingosin –fatty acid –glucose –galactose –N acetyl galactosamine –galactose**



#### **Function**

Gangliosides are present in high concentration in brain. They act as receptors at cell membrane.

## 3- Sulpholipids

They are cerebrosides containing sulphate group attached to C3 of galactose.

**Structure of sulpholipids**

It is formed of:

- Sphingosine base.
- Long chain fatty acid attached to the amino group of the sphingosine base by amide linkage.
- Carbohydrate usually galactose but may be glucose.
- Sulphate group attached to carbon number 3 of galactose.

**Function of sulpholipids**

They are present in brain and nervous tissues.

Prof. Mohammad Ibrahim Selim