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 α carbon of glycerol by ester bond.
- Unsaturated fatty acid, attached to β carbon of glycerol by ester bond.
- Phosphoric acid attached to α carbon of glycerol by ester bond

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 α carbon of glycerol by ester bond.
- Unsaturated fatty acid, attached to β carbon of glycerol by ester bond.
- Phosphoric acid attached to α carbon of glycerol by ester bond
- Choline attached to phosphoric acid by ester bond

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.

3- Cephalins
They are phosphatidyl ethanolamine and phosphatidyl serine

Structure
They are formed of:
- Glycerol
- Saturated fatty acid, attached to α carbon of glycerol by ester bond.
- Unsaturated fatty acid, attached to β carbon of glycerol by ester bond.
- Phosphoric acid attached to α carbon of glycerol by ester bond
- Ethanolamine or serine.

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

4- Phosphatidyl inositol
It is also called lipoinositol

Structure
It is formed of:
- Glycerol
- Saturated fatty, attached to α carbon of glycerol by ester bond.
- Unsaturated fatty acid, attached to β carbon of glycerol by ester bond.
- Phosphoric acid attached to α carbon of glycerol by ester bond
- Inositol, which is a cyclic alcohol derived from glucose.

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 α 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

Function of plasmalogens
They are present in cardiac muscle, skeletal muscles and brain.
6- Cardiolipin
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 cardiolipin
Cardiolipin 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 (-NH2).
- The third carbon contains hydroxyl group.
- There is a double bond between C4 and C5.

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.

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).

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\text{Sphingosin} \text{ –fatty acid –glucose –galactose –N acetyl galactosamine –galactose} \quad NANA
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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.