Lipids are the biomolecules of structural and functional importance. They are the important component of membrane composition and function with a role in long-term energy storage. One gram of fat stores more than twice as much energy as one gram of carbohydrate. Lipids have multiple functions within the body. Phospholipids are important part of cell membranes, which encase each and every cell.

The triglycerides are very important for fat metabolism and energy production. There is recent evidence that lipids are also important as signalling molecules within the body, sometimes serving as a marker for programmed cell death. Finally, some lipids take the form of vitamins, which can be important for mitochondria and creating other compounds. Chemically, they are made up of long chain hydrocarbons and are non-polar in nature; hence they are insoluble in water but soluble in non-polar solvents. This group of molecules include fats and oils, waxes, phospholipids, steroids (like cholesterol), and some other related compounds.

The following points highlight the top three types of lipid.

The types are:

1. Simple Lipids
2. Compound Lipids
3. Steroids.

Simple Lipids:

They contain only carbon, hydrogen and oxygen. Triglycerides (fats and oils) and waxes are simple lipids. The hydrolysis to triglycerides yields fatty acids and glycerol, while the hydrolysis of wax (e.g., Bees wax) yields fatty acids and long-chain alcohols.

Compound Lipids:

Compound lipids contain other elements such as sulphur, phosphorus or nitrogen, in addition to the carbon, hydrogen, and oxygen of the simple lipids.

Some compound lipids are described as follows:

PHOSPHOLIPIDS:

These are compound lipids, containing two fatty acids (diglycerides) attached to the glycerol molecule. Instead of the third fatty acid, they have a phosphate molecule, usually with an additional water-soluble molecule attached to it. Hence, they are also called glycerophosphates.

This chemical constitution makes the phosphlipid molecule amphipathic, with a non-polar, water-insoluble part (the fatty acids) and a highly polar, water-soluble part (the rest of the molecule) as shown below:

<u>Glycerol + two fatty acids + phosphate + water soluble molecule</u>

Thus, phospholipids are all phosphate esters of glycerol, with the following general formula:

R_1 and R_2 are fatty acids; R_3 represents a variety of residues attached to phosphoric acid.

The phosphorus-containing portion of the phospholipid molecule carries one or more electric charges, so this portion is hydrophilic (water-loving). The two fatty acid regions, however, are hydrophobic (water-fearing).

Thus, in a biological membrane, phospholipids line up in such a way that non polar hydrophobic **"tails"** pack tightly together to form the interior of the membrane, and the phosphorus containing **"heads** "face outward where they interact with water, which is excluded from the interior of the membrane. The phospholipids form a bilayer, i.e., a sheet two molecules thick.

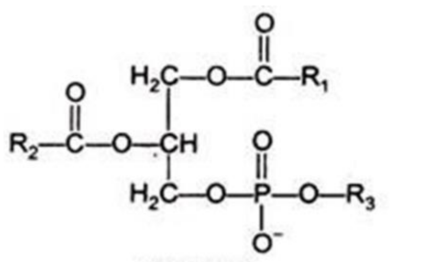
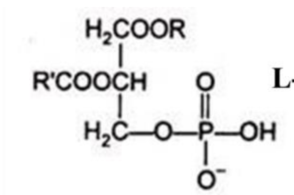
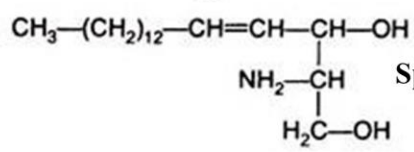


Fig: Phospholipid

In cell membranes there are five main phospholipids which differ according to the type of water-soluble molecule attached to the phosphate. The most abundant form is lecithin in which this additional molecule is choline, a vitamin B. Therefore lecithin is called choline phosphoglyceride. The phospholipids are bound into the structure of the cell membrane.



L-Phosphatidic acid



Sphingosine

When the phosphate group has no attached molecules, the phospholipid is slightly less polar. This group of phospholipids includes the phosphoglycerides derived from phosphatidic acid. It has been suggested that it functions as a movable molecule within the cell membrane, acting as a carrier for ions.

SPHINGOLIPIDS:

These are derivatives of sphingosine, an amino alcohol possessing a long unsaturated hydrocarbon chain.

Thus, the structure common to all sphingolipids is a sphingosine residue, on which two other residues (R_1 and R_2) are substituted as shown here. (R_1 may be a fatty acid whileR_2Can vary widely).

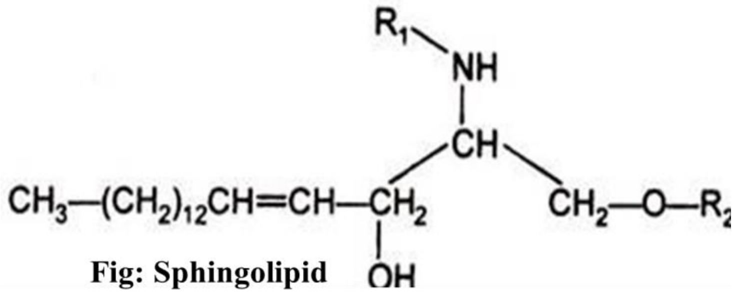


Fig: Sphingolipid

The myelin sheath surrounding many nerve cells is particularly rich in the sphingolipid sphingomyelin. In sphingomyelin, the amino group of the sphingosine skeleton is linked to a fatty acid and the hydroxyl group is esterified to phosphorylcholine.

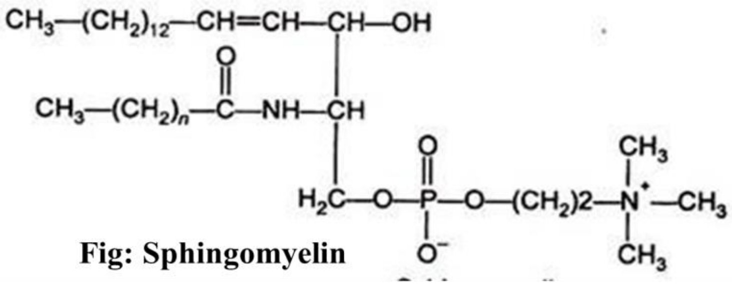
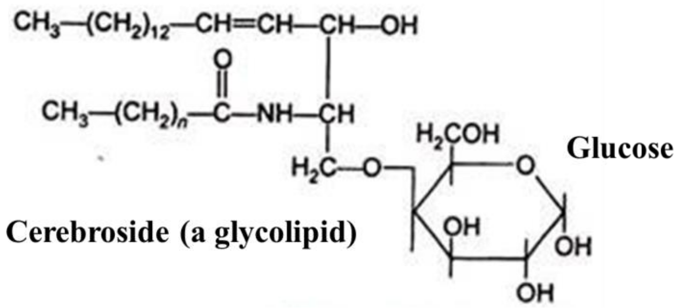


Fig: Sphingomyelin

Glycolipids:

Glycolipids (and glycoproteins) occur in the plasma membrane. The former play vital roles in immunity, blood group specificity and cell-cell recognition. The lipid portion of a glycolipid is similar to sphingosine with the amino group of the sphingosine skeleton acylated by a fatty acid (as in sphingomyelin) and the hydroxyl group associated with the carbohydrate.



Cerebroside (a glycolipid)

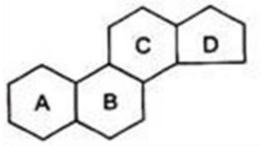
The simplest glycolipids are the cerebrosides, which as the name suggests, are abundant in the brain tissue where they occur in the myelin sheaths and may account for as much as 20% of the sheath's dry weight.

The sugar of a cerebroside is either glucose or galactose. In the gangliosides of the nerve tissue, the carbohydrate portion of the molecule consists of a chain of sugar molecules usually including glucose, and neuraminic acid.

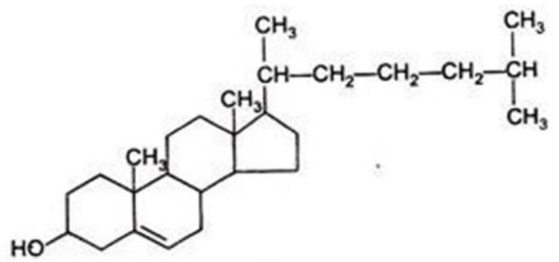
STEROIDS:

These are fat-soluble derivatives of cyclopentanoperhydro- phenanthrene and play important roles in metabolic activities of the organism.

They include cholesterol, vitamin D, cholic acid and a number of sex hormones:



Basic unit of all steroids



Cholesterol

The most common animal steroid is cholesterol, found in all cell membranes in the myelin sheath of nerves and in many lipids. It is also the metabolic precursor of most steroid hormones. In its structure, there is phenanthrene nucleus (ring A, B and C) and the attached cyclopentane ring (D) characteristic of all steroids.

Cholesterol gives rise to three basic types of steroid hormones:

1. Androgens (C_{19} compounds)
2. Estrogens (C_{18} compounds)
3. Progesterones and corticosterones (C_{21} compounds).

The blood contains cholesterol (215 mg/litre) as free cholesterol and cholestrides (esters of cholesterol with fatty acids). Cholesterol is also present in bile (0.6 to 1.7 g/litre). The concentration of the bile which occurs in the gall bladder may lead to a further rise in the cholesterol concentration and crystallization. Cholesterol crystals, in turn, form nuclei for the crystallization of bile pigments and calcium salts (bile stones).

A diet high in saturated fats and cholesterol can lead to reduced blood flow caused by the deposit of fatty materials on the linings of blood vessels. Cholesterol is ferried in the blood by two types of plasma proteins -LDL and HDL. LDL (called **"bad"** or low density lipoprotein) transports cholesterol to the tissue from the liver, and HDL (called **"good"** or high-density lipoprotein) transports cholesterol out of the tissue to the liver.

When LDL level in blood is abnormally high or the HDL level is abnormally low, cholesterol accumulates in the cells. When cholesterol-laden cells line the arteries, plaque develops; it bulges out into the lumen of an artery, obstructing blood flow.

Individuals with a high level (240 mg/100 ml) should always be further tested to determine what their LDL blood cholesterol is. If the LDL level is 160mg/100ml or higher, and/or if the total cholesterol-to-HDL cholesterol is higher than 4.5, the person is considered at risk