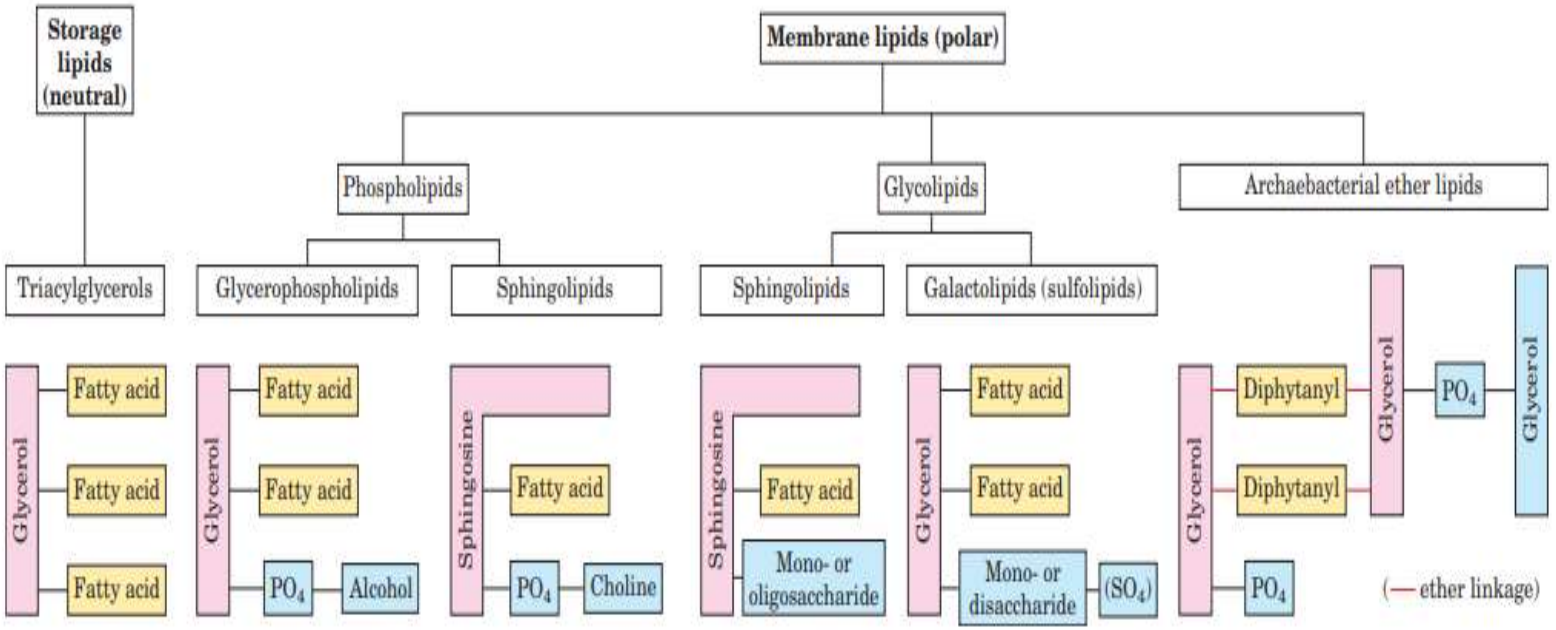
Lipids

- Lipids are organic compounds that are found in living organisms.
- They have variety of structures and functions, and soluble in organic solvents due to their hydrocarbon component.



Structural Lipids in Membranes

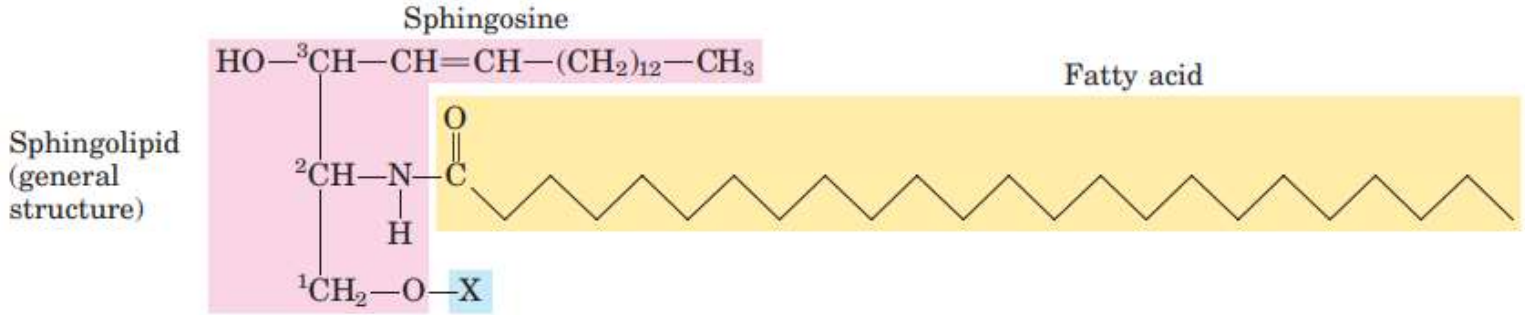
- Central architectural feature of biological membranes is a double layer of lipids, which acts as a barrier to the passage of polar molecules and ions.
- Membrane lipids are amphipathic: one end of the molecule is hydrophobic, the other hydrophilic.

Types of membrane lipids:

1. **Glycerophospholipids**, in which the hydrophobic regions are composed of two fatty acids joined to glycerol;
2. **Glycolipids,** which also contain two fatty acids esterified to glycerol, have a simple sugar or complex oligosaccharide at their polar ends
3. **Phospholipids** In glycerophospholipids and some sphingolipids, a polar head group is joined to the hydrophobic moiety by a phosphodiester linkage
4. **Tetraether lipids**, in which two very long alkyl chains are ether-linked to glycerol at both ends;
5. **Sphingolipids,** in which a single fatty acid is joined to a fatty amine, sphingosine;
6. **Sterols,** compounds characterized by a rigid system of four fused hydrocarbon rings.

Sphingolipids

- Sphingolipids, the fourth large class of membrane lipids, also have a polar head group and two nonpolar tails, they lack glycerol.
- Sphingolipids are composed of one molecule of the long-chain amino alcohol sphingosine or one of its derivatives, one molecule of a long-chain fatty acid, and a polar head group that is joined by a glycosidic linkage in some cases and by a phosphodiester in others



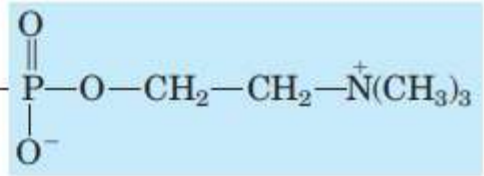
- Carbons C-1, C-2, and C-3 of the sphingosine molecule are structurally analogous to the three carbons of glycerol in glycerophospholipids.
- When a fatty acid is attached in amide linkage to the -NH2 on C-2, the resulting compound is a **ceramide**, which is structurally similar to a diacylglycerol.
- Ceramide is the structural parent of all sphingolipids.
- There are three subclasses of sphingolipids, all derivatives of ceramide but differing in their head groups: sphingomyelins, neutral (uncharged) **glycolipids**, and gangliosides.

Sphingomyelins

- Sphingomyelins resemble phosphatidylcholines in their general properties and three-dimensional structure, and in having no net charge on their head groups.
- Sphingomyelins are present in the plasma membranes of animal cells and are especially prominent in myelin, a membranous sheath that surrounds and insulates the axons of some neurons—thus the name "sphingomyelins."

Sphingomyelin

Phosphocholine

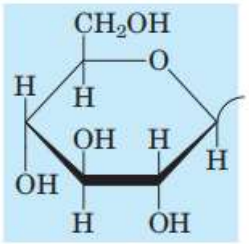


Glycosphingolipids

Largely found in the outer face of plasma membranes, have head groups with one or more sugars connected directly to the -OH at C-1 of the ceramide moiety; they do not contain phosphate.

Neutral glycolipids
Glucosylcerebroside

Glucose



Cerebrosides

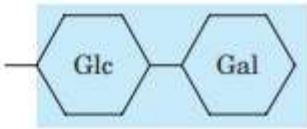
have a single sugar linked to ceramide; those with galactose are characteristically found in the plasma membranes of cells in neural tissue, and those with glucose in the plasma membranes of cells in nonneural tissues.

Globosides

are neutral (uncharged) glycosphingolipids with two or more sugars, usually Dglucose, D-galactose, or N-acetyl-D-galactosamine. Cerebrosides and globosides are sometimes called neutral glycolipids, as they have no charge at pH 7.

Lactosylceramide
(a globoside)

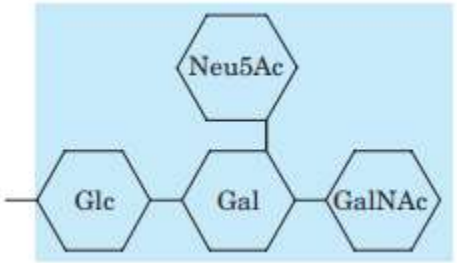
Di-, tri-, or
tetrasaccharide



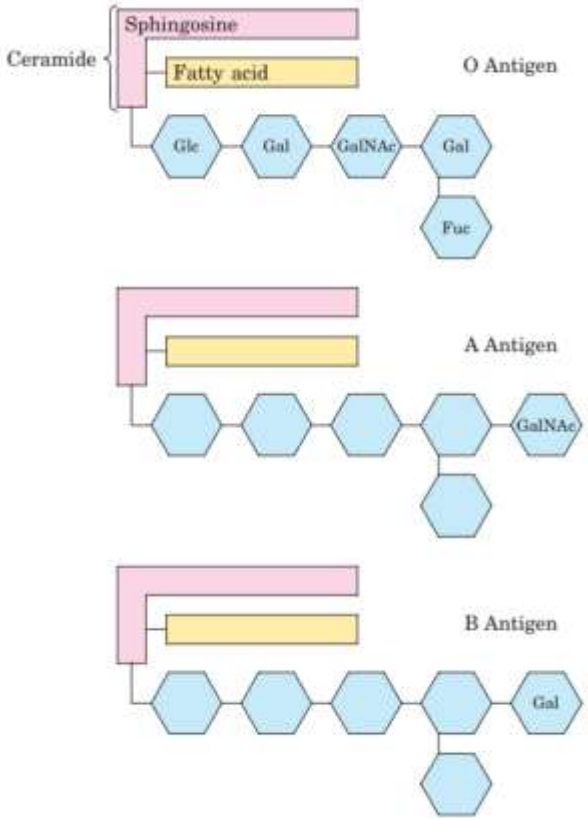
- Gangliosides, the most complex sphingolipids, have oligosaccharides as their polar head groups and one or more residues of N-acetylneuraminic acid (Neu5Ac), a sialic acid, at the termini.
- Sialic acid gives gangliosides the negative charge at pH 7 that distinguishes them from globosides. Gangliosides with one sialic acid residue are in the GM (M for mono-) series, those with two are in the GD (D for di-) series, and so on (GT, three sialic acid residues; GQ, four).

Ganglioside GM2

Complex oligosaccharide

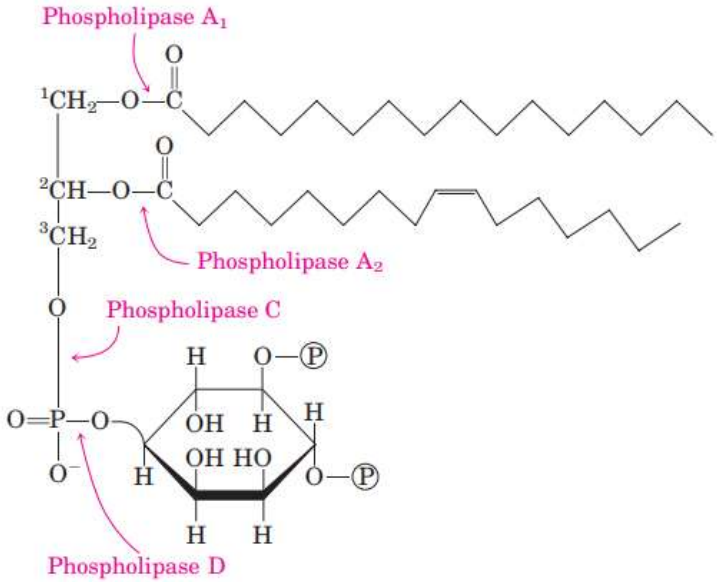


- The carbohydrate moieties of certain sphingolipids define the human blood groups and therefore determine the type of blood that individuals can safely receive in blood transfusions



- The human blood groups (O, A, B) are determined in part by the oligosaccharide head groups (blue) of these glycosphingolipids.
- The same three oligosaccharides are also found attached to certain blood proteins of individuals of blood types O, A, and B, respectively.

Phospholipases



- Phospholipases A1 and A2 hydrolyze the ester bonds of intact glycerophospholipids at C-1 and C-2 of glycerol, respectively. Phospholipases C and D each split one of the phosphodiester bonds in the head group.
- Some phospholipases act on only one type of glycerophospholipid, such as phosphatidylinositol 4,5-bisphosphate (shown here) or phosphatidylcholine; others are less specific. When one of the fatty acids has been removed by a type A phospholipase, the second fatty acid is cleaved from the molecule by a lysophospholipase