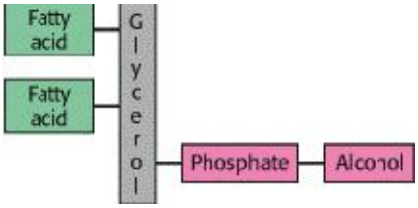
Glycerophospholipids

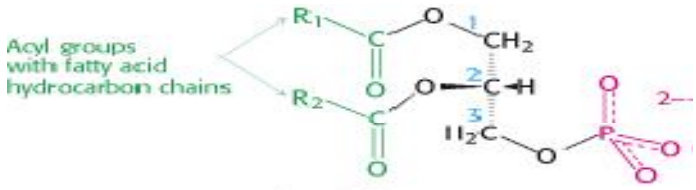
A 1,2-diacylglycerol that has a phosphate group esterified at carbon atom 3 of the glycerol backbone is a **glycerophospholipid,** also known as a *phosphoglyceride* or a *glycerol phosphatide.* These lipids form one of the largest classes of natural lipids and one of the most important. They are essential components of cell membranes and are found in small concentrations in otherparts of the cell. It should be noted that all glycerophospholipids are members of the broader class of lipids known as **phospholipids.** The numbering and nomenclature of glycerophospholipids present a dilemma in that the number 2 carbon of the glycerol backbone of a phospholipid is asymmetric. It is possible to name these molecules either as D- or L-isomers. Thus, glycerol phosphate itself can be referred to either as D-glycerol-1-phosphate or as L-glycerol-3-phosphate. Instead of naming the glycerol phosphatides in this way, biochemists have adopted the *stereospecific numbering* or *sn*-system. In this system, the *pro-S* position of a prochiral atom is denoted as the *1-position,* the prochiral atom as the *2-position,* and so on. When this scheme is used, the prefix *sn-* precedes the molecule name (glycerol phosphate in this case) and distinguishes this nomenclature from other approaches. In this way, the glycerol phosphate in natural phosphoglycerides is named *sn*-glycerol-3-phosphate.



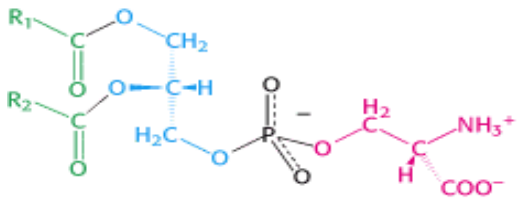
Schematic Structure of a Phospholipid.

The Most Common Phospholipids

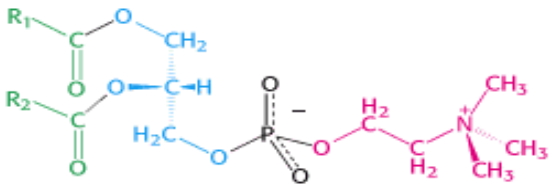
Phosphatidic acid, the parent compound for the glycerol-based phospholipids consists of *sn*-glycerol-3-phosphate, with fatty acids esterified at the 1- and 2-positions. Phosphatidic acid is found in small amounts in most natural systems and is an important intermediate in the biosynthesis of the more common glycerophospholipids In these compounds, a variety of polar groups are esterified to the phosphoric acid moiety of the molecule. The phosphate, together with such esterified entities, is referred to as a "head" group. Phosphatides with choline or ethanolamine are referred to as **phosphatidylcholine** (known commonly as **lecithin**) or **phosphatidylethanolamine,** respectively. These phosphatides are two of the most common constituents of biological membranes. Other common *head groups* found in phosphatides include glycerol, serine, and inositol. Another kind of glycerol phosphatide found in many tissues is **diphosphatidylglycerol.** First observed in heart tissue, it is also called **cardiolipin.** In cardiolipin, a phosphatidylglycerol is esterified through the C-1 hydroxyl group of the glycerol moiety of the head group to the phosphoryl group of another phosphatidicacid molecule.



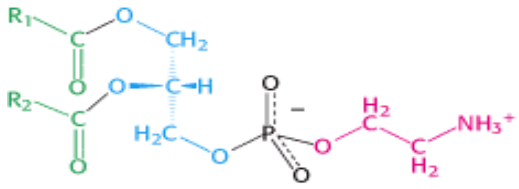
Phosphatidate
(Diacylglycerol 3-phosphate)



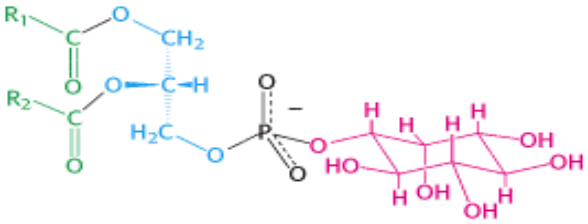
Phosphatidyl serine



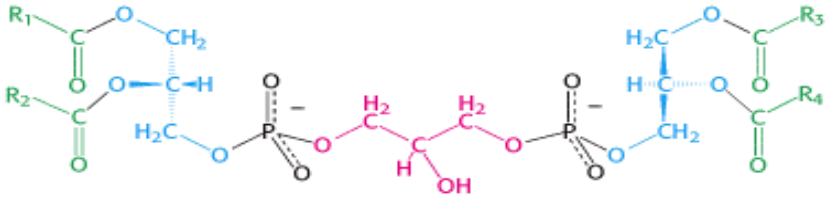
Phosphatidyl choline



Phosphatidyl ethanolamine



Phosphatidyl inositol

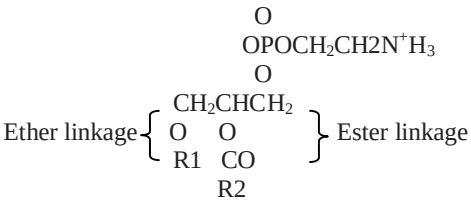


Diphosphatidyl glycerol (cardiolipin)

Phosphatides exist in many different varieties, depending on the fatty acids esterified to the glycerol group. As we shall see, the nature of the fatty acids can greatly affect the chemical and physical properties of the phosphatides and the membranes that contain them. In most cases, glycerol phosphatides have a saturated fatty acid at position 1 and an unsaturated fatty acid at position 2 of the glycerol. Thus, **1-stearoyl-2-oleoyl-phosphatidylcholine** is a common constituent in natural membranes, but **1-linoleoyl-2 palmitoylphosphatidylcholine** is not.

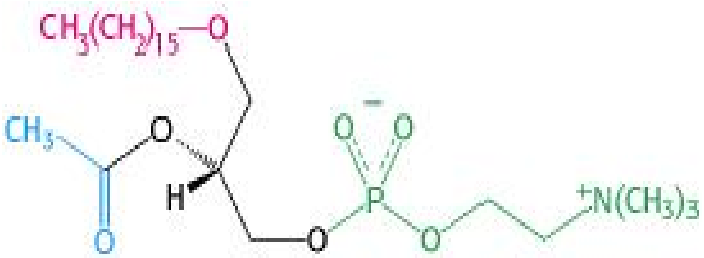
Ether Glycerophospholipids

Ether glycerophospholipids possess an ether linkage instead of an acyl group at the C-1 position of glycerol.



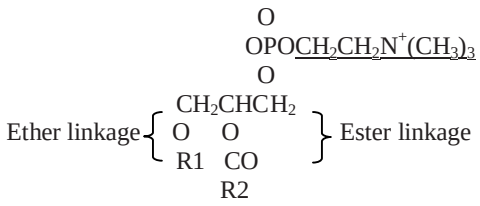
1-alkyl-2-acyl phosphatidylethanolamine, an ether glycerophospholipid.

One of the most versatile biochemical signal molecules found in mammals is **platelet activating factor,** or **PAF,** a unique ether glycerophospholipid called 1-alkyl 2-acetyl-phosphatidylcholine. The alkyl group at C-1 of PAF is typically a 16-carbon chain, but the acyl group at C-2 is a 2-carbon acetate unit. By virtue of this acetate group, PAF is much more water-soluble than other lipids, allowing PAF to function as a soluble messenger in signal transduction.



Platelet activating factor (PAF)

Plasmalogens are ether glycerophospholipids in which the alkyl moiety is *cis*-α,β-unsaturated. Common plasmalogen head groups include choline, ethanolamine, and serine. These lipids are referred to as phosphatidal choline, phosphatidal ethanolamine, and phosphatidal serine.



For phosphatidal choline,

R1 = -CH=CH(CH2)13CH3

R2 = -(CH2)16CH3

For phosphatidal ethanolamine, ethanolamine is in place of choline above.