PHOSPHOLIPIDS. PHYSICOCHEMICAL PROPERTIES OF PHOSPHOLIPIDS

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Abstract. The article discusses the composition and physical and chemical properties of phospholipids and the study of the chemical composition of phospholipids. It also discusses the development of methods for identifying and establishing the chemical composition of phospholipids.

Key words: Phospholipids, lipids, esters, lecithin, living cells, cell membranes, amphiphilic substances, hydrophilic, liposomes, cholesterol.

Introduction. There are several classes of membrane lipids. They differ from triacylglycerols in that, along with hydrocarbon chains, they contain one or more highly polar "heads". For this reason, membrane lipids are often also called polar lipids. Polar lipids, represented by phospholipids, are present in the greatest quantity in membranes.

Phospholipids are derivatives of either the trihydric alcohol glycerol or the more complex amino alcohol sphingosine. Phospholipids that are derivatives of glycerol are called phosphoacylglycerols. These compounds consist of glycerol (as the basis of the entire structure), two fatty acid residues, and a phosphorylated alcohol. In phosphoacylglycerols, the hydroxyl groups at the C1 and C2 atoms in glycerol esterified with carboxyl groups of two fatty acids. The third hydroxyl group of glycerol esterified with phosphoric acid. The resulting compound is the simplest phosphoacylglycerol and is called diacylglycerol-3-phosphate or phosphatidic acid. This compound is a key intermediate in the biosynthesis of other more complex phospholipids. All major membrane phospholipids are formed by esterification of the phosphate group of phosphatidic acid with the hydroxyl groups of alcohols such as serine, ethanolamine, choline, glycerol, and inositol. Thus, the phospholipids include phosphatidic acid, phosphatidylserine, phosphatidylethanolamine, phosphatidylcholine, phosphatidylglycerols, and phosphatidylinositol, respectively. The only membrane phospholipid that is not a derivative of glycerol is sphingomyelin.

Discussion. Phosphatidic acid and phosphatidylglycerols. The starting compound for all phosphoacylglycerols (phospho -lipids) is, as already mentioned, phosphatidic acid (Fig. 1). In free form, this compound is found in extremely small quantities. On the other hand, phosphatidic acid is the most important intermediate compound in the processes of bio - synthesis triacylglycerols and many phospholipids.

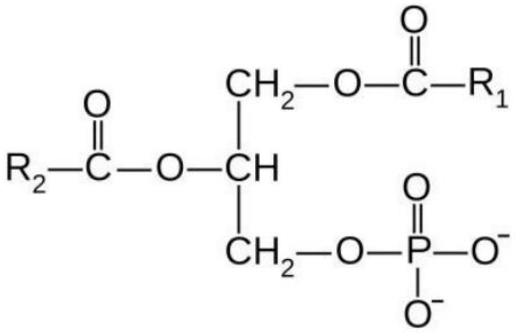


Fig. 1. Structural formula of phosphatidic acid.

Extremely interesting phospholipids are the so-called cardiolipins, which are “double” phosphatidylglycerols. lycerols (Fig. 2). The main feature of cardiolipins is that these compounds are localized mainly in the inner membrane of mitochondria.

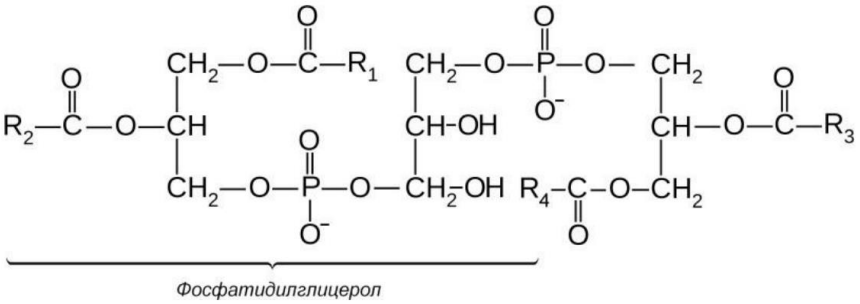


Fig. 2. Cardiolipin (“double” phosphoglyceride) is found in large quantities in mitochondrial membranes.

Cardiolipin is a phospholipid that is part of mitochondrial membranes. It is formed from two molecules of phosphatidic acid that are connected to each other by a “bridge” represented by a glycerol residue.

Phosphatidylcholine (lecithin). Lecithins, like neutral fats, contain glycerol and fatty acid residues, but they also contain phosphoric acid and a nitrogenous base, choline. Lecithins are widely present in the cells of various tissues, and they perform both metabolic and structural functions. Most of these phospholipids, as a rule, contain a saturated acyl radical in position C1 and an unsaturated radical in position C2 of glycerol .

At pH 7.0, the phosphoric acid residue in lecithins, as well as in all other phospholipids, carries a negative charge. In addition, at pH close to neutral, the nitrogenous bases in phospholipids can carry one or more electrical charges. Thus, phospholipids contain two different types of groupings: polar hydrophilic "heads" and non-polar hydrophobic tails. Such compounds are called amphipathic substances.

Phosphatidylinositol. In addition to glycerol , two fatty acid residues and a phosphoric acid residue, phosphatidylinositol also contains the hexatomic cyclic alcohol inositol . Inositol in this compound is represented by one of its stereoisomers – myoinositol .

This compound has pronounced physiological effects.

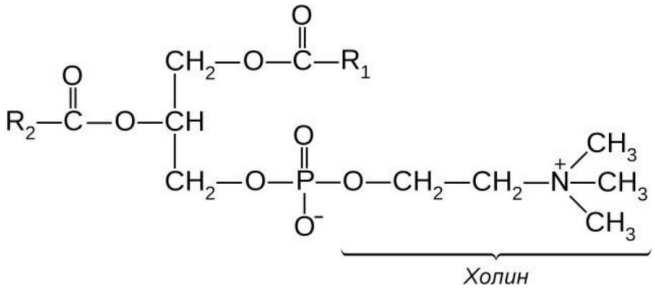
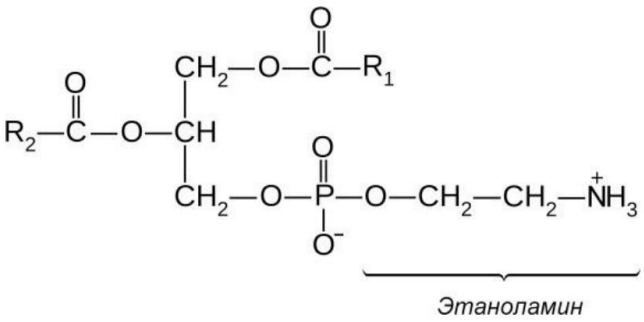


Fig. 3. Structural formula of phosphatidylcholine.

Phosphatidylethanolamine (cephalin). Cephalins differ from lecithins only in that their nitrogenous base choline is represented by another nitrogenous base - ethanolamine.



Rice. 4. Structural formula of phosphatidylethanolamine.

phosphatidylinositol itself, its phosphorylated form, represented by phosphatidylinositol-4,5 -diphosphate, is present in cells , which is also an important component of cell membranes. Thus, phosphatidylinositol-4,5-diphosphate takes part in the physiological regulation of secretion processes, carried out with the help of secretogenic compounds that interact with the corresponding receptors on the basal side of exocrine cells. For example, as a result of the binding of acetylcholine or cholecystokinin to their receptors on the basal side of exocrine cells, activation of intracellular phosphatidylinositol -specific phospholipase C occurs, which breaks down phosphatidylinositol -4,5-diphosphate with the formation of inositol-1,4,5-triphosphate and diacylglycerol . The latter initiate the release of Ca2+ from the endoplasmic reticulum into the cytosol (inositol-1,4,5-triphosphate) or activate protein kinase C (diacylglycerol), which ensures the release of protein products from exocrine cells. Thus , both of these compounds act as intracellular second messengers of signal transduction.

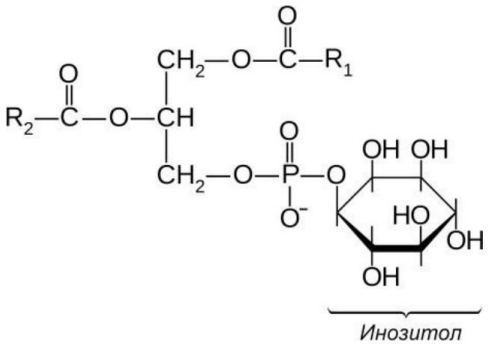


Fig. 5. Structural formula of phosphatidylinositol

Conclusions. 1. Precipitation of phospholipids with acetone. Phospholipids, being amphipathic compounds, are poorly soluble in many organic solvents, for example, in acetone. 2.Emulsification of phospholipids. Emulsification of phospholipids is due to their ability to form micelles and other structures in an aqueous solution. 3. Precipitation of lecithin (phosphatidylcholine) with cadmium chloride. When cadmium chloride is added to an alcohol solution of phosphatidylcholine, the latter falls out as a white flocculent precipitate, as a complex compound of phospholipid with cadmium chloride is formed, in which there are 4 molecules of salt for every 3 molecules of phosphatidylcholine. This compound is poorly soluble in water.

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