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Relevance of dietary glycerophospholipids and sphingolipids to human health

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ABSTRACT

Glycerophospholipids and sphingolipids participate in a variety of indispensable metabolic, neurological, and intracellular signaling processes. In this didactic paper we review the biological roles of phospholipids and try to unravel the precise nature of their putative healthful activities. We conclude that the biological actions of phospholipids activities potentially be nutraceutically exploited in the adjunct therapy of widely diffused pathologies such as neurodegeneration or the metabolic syndrome. As phospholipids can be recovered from inexpensive sources such as food processing by-products, ad-hoc investigation is warranted.

Contents

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1. Introduction

Glycerophospholipids and sphingolipids are polar lipids (PLs) ubiquitous to all tissues because they are essential components of cell membranes. The most important ones among the former are phosphatidylethanolamine (PE), phosphatidylinositol (PI), phosphatidylserine (PS), and phosphatidylcholine (PC); among the latter, sphingomyelin is the most biologically important one (Fig. 1). In this didactic paper we review the biological roles of PLs and try to discriminate the exact and precise nature of their putative healthful activities.

The biological importance of PLs derives from their amphiphilic qualities, in that the hydrophilic head and the hydrophobic tail create a bi-layer that makes it possible to build cells' and organelles' membranes. Of note, in addition to their structural roles, cell membranes exert important physiological roles, due to the proteins interjected among PLs and to the roles of PLs themselves as precursors of lipid mediators. Therefore, PLs participate in a variety of indispensable metabolic, neurological, and intracellular signaling processes [1], such as development, necrosis and apoptosis, transport, DNA replication, neuronal signaling, or secretion, to name a few [2]. In addition, cell membranes need other compounds such as protein- or lipid-associated carbohydrates (glycoproteins and glycolipids) and cholesterol (CHOL) to function correctly.

2. Glycerophospholipids and sphingolipids. Biosynthesis, chemical structure, and functions

Glycerophospholipids share a common structure consisting of two fatty acid (FA) molecules esterified in the *sn*-1 y *sn*-2 positions of the glycerol moiety. This portion of the molecule contributes to its hydrophobicity. However, the *sn*-3 position features a phosphate group that contributes hydrophilicity. Four such groups have been identified: ethanolamine, inositol, serine, and choline [3] (Fig. 1). Glycerophospholipid biosynthesis starts with the enzyme glycerol-3-phosphate acyltransferase (located in the external leaflet of the mitochondrial membrane and of the endoplasmic reticulum) linking

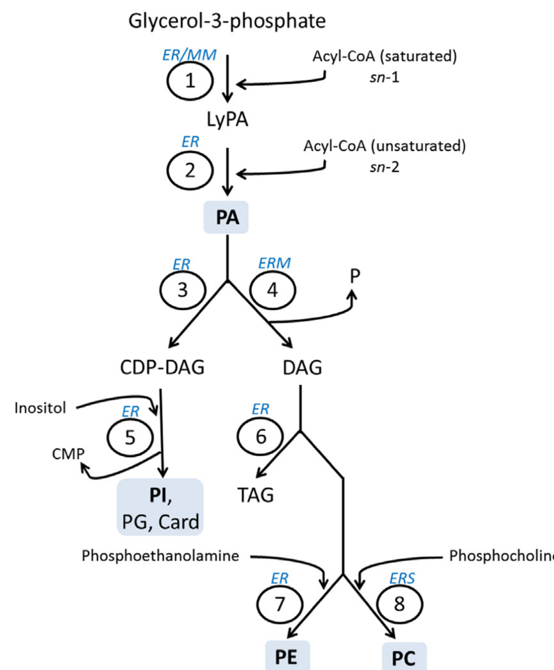

Fig. 2. Biochemical pathways of phosphatidic acid (PA), phosphatidylethanolamine (PE), phosphatidylinositol (PI), and phosphatidylcholine (PC) synthesis.

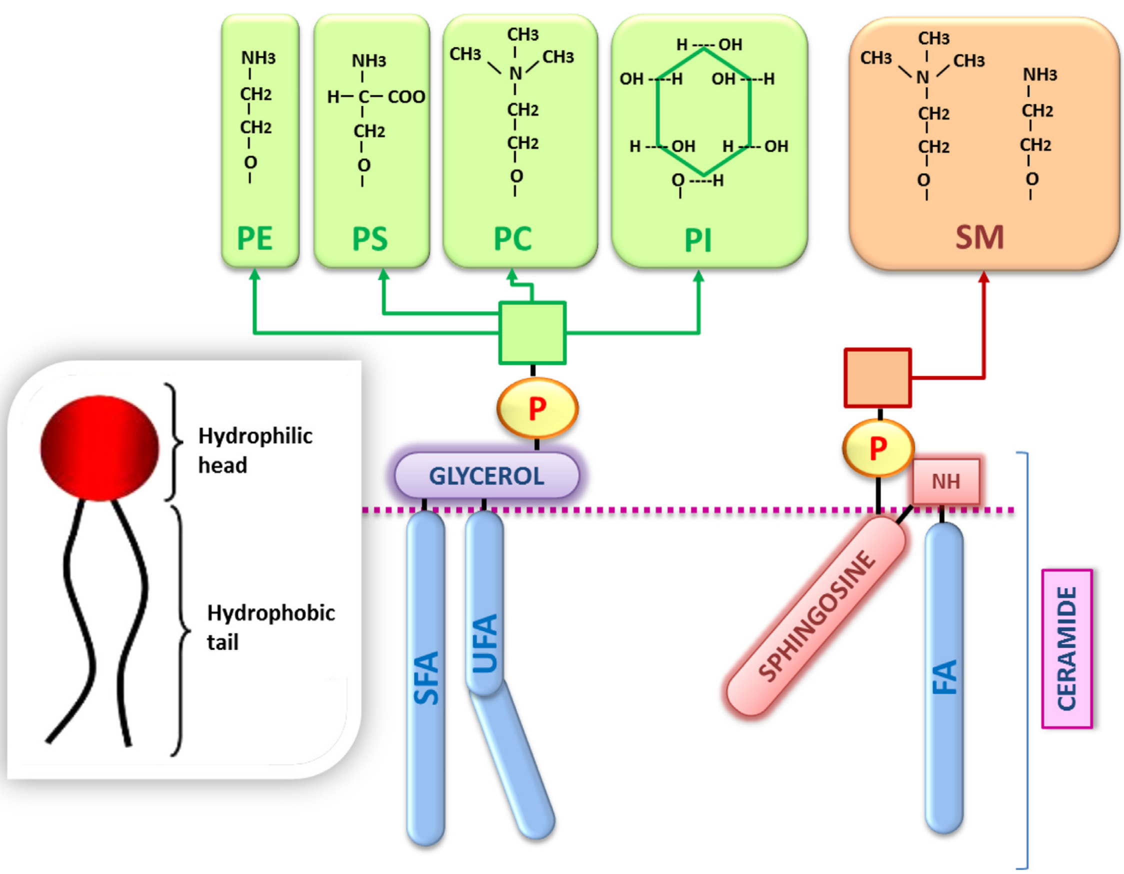

Fig. 1. Chemical structures of phospho- and sphingolipids.