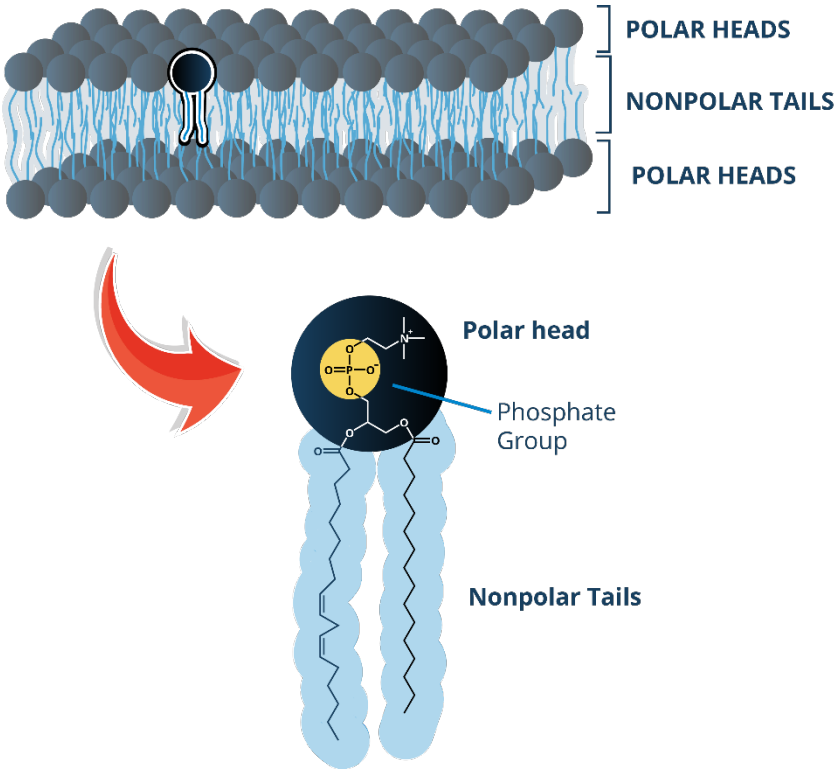
Phospholipids

Phospholipid Structure

Phospholipids are a diverse group of molecules with the same generalised structure of a phosphate group, two alcohols, and one or two fatty acids. These are structured into a polar head and an uncharged tail. The head consists of the phosphate group and one alcohol (typically glycerol). This end is polar (charged) and is hydrophilic. The tail consists of fatty acids - it is neutral and hydrophobic but fat-soluble. The phosphate group can be modified by an organic molecule.

This amphipathic nature (hydrophilic and hydrophobic regions) is critical to the role of phospholipids in biological membranes. The hydrophilic polar head faces out into the surface to interact with water, whereas the hydrophobic tails turn inward and point toward each another.



Classification and Biological Roles

Membrane phospholipids vary widely and can be grouped based on the nature of the molecule attached to the head phosphate group. The general grouping of phospholipids is as follows, with some product examples given:

Phosphatidylcholine - Choline joined to the phosphate group.

The most common cell membrane phospholipid; it is important for maintaining structural integrity and shape. Phosphatidylcholines are also found in bile and assist in fat digestion as well as having roles in liver function, lipid, and cholesterol transport.

Product Code	CAS No	Name
FL171315	97281-47-5	L-aPhosphatidylcholine - ex Soy
FP172374	8002-43-5	L-a-Phosphatidylcholine - PC30
XDA28145	97281-45-3	L-±-phosphatidylcholine, hydrogenated (Egg, Chicken)

Phosphatidylserine- Serine joined to the phosphate group.

Involved in cell signalling and normally on the inside of cell membranes of living cells, but exposed on dying cells, the presence of phosphatidylserine on the outside of cells leads to phagocytosis by macrophages.

Product Code	CAS No	Name
FP161254	383907-32-2	L-alpha-Phosphatidylserine sodium salt - porcine brain
FP47183	39382-08-6	L-a-Phosphatidyl-L-serine
FP16194	51446-62-9	Phosphatidyl-L-serine

Phosphatidylethanolamine - ethanolamine joined to the phosphate group.

The second-most common cell membrane phospholipid, and also a key part of the mitochondrial membrane. Phosphatidylethanolamine's small head allows proteins to align for fusion and budding of the membrane.

Product Code	CAS No	Name
FP71719	383907-18-4	L-a-Phosphatidylethanolamine

Phosphatidylinositol- inositol joined to the phosphate group

A minor cell membrane component with roles in the formation of cell signalling molecules and membrane trafficking.

Product Code	CAS No	Name
FP167873 FP171222	383907-33-3	L-α-Phosphatidylinositol (Liver, Bovine) (sodium salt) L-α-Phosphatidylinositol (Liver, Bovine) (sodium salt) - Chloroform
FL175739 MP32572	97281-52-2	L-a-Phosphatidylinositol - from Soy bean, 50% L-α-Phosphatidylinositol, from soy bean, 20%
FP178828	383907-36-6	Phosphatidylinositol soy sodium - 50mg/ml in chloroform

Sphingolipids and Lipid Rafts

Sphingolipids are membrane-embedded molecules composed of a long chain amino alcohol (sphingosine) and a fatty acid chain. They have important signalling and regulatory roles in cell growth, cell death, senescence, adhesion, migration, inflammation, angiogenesis, intracellular trafficking, membrane reorganization, and neuron differentiation.

There are three subclasses of sphingolipids: sphingomyelin, glycosphingolipids, and gangliosides. Biosynth supply a range of Sphingolipids, some of which can be found in our dedicated sphingolipids guide.

Phospholipids are often used in research alongside sphingolipids, which form 'lipid rafts', domains of the phospholipid plasma membrane. Proteins targeted to rafts include those with a GPI (glycosyl phosphatidylinositol) anchor.

Applications of Phospholipids

As well as being used in experiments looking into cell membranes, phospholipids have numerous other experimental and industrial applications. In particular modified phospholipids with a range of substituents are used in the pharmaceutical industry, in cosmetics and in the food industry.

Liposomes

Phospholipids are often used to form liposomes - double-walled, hollow spheres of lipid bilayer, used to encapsulate a target. These are increasingly being used as delivery systems as outlined below. By exploiting the amphipathic nature discussed at the start of this brochure, self-aggregating liposome form based on the critical micelle concentration (CMC). At concentrations below the CMC, the phospholipids are in monomeric form; at the CMC, aggregation of the molecules produce liposomes (micelles).

In drug delivery

Liposomes can be loaded with DNA, vaccines or other pharmaceuticals. Liposome properties are affected not only by its composition, but also by size, charge, rigidity of the bilayer, surface modification and method of preparation.

In cosmetics

In a similar manner to drug delivery, liposomes are often used in cosmetic formulations to deliver moisture as well as active ingredients or fragrance. This is often more effective in delivering the target, for example, moisturizer containing aloe vera leaf gel extract encapsulated liposomes were more effective than application of the gel alone. Vitamins, fat-soluble amino acids and active ingredients can also be encapsulated into these liposomes successfully to formulate various skin care products (Soni et al, 2016).

Food Emulsifiers

A common food emulsifier and additive is lecithin. Made of a mixture glycerophospholipids outlined above (phosphatidylcholine, phosphatidylserine phosphatidylethanolamine, phosphatidylinositol) along with phosphatidic

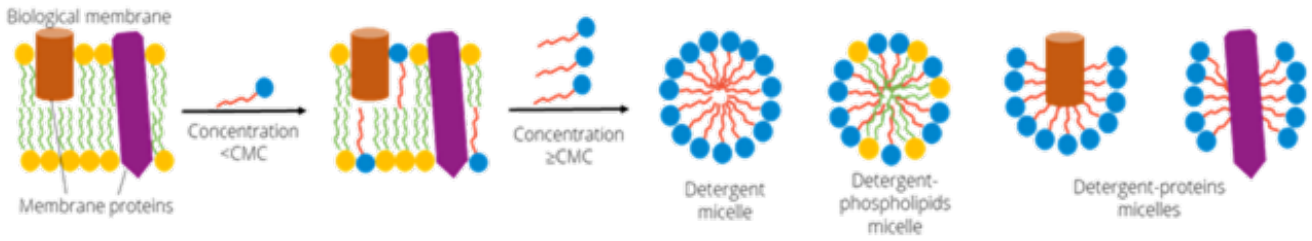
acid, it was first (and is most typically) extracted from egg yolk. It can be hydrolysed to become enriched phosphatidylcholine lecithin.

Pharma and Medical Research

Phospholipids are used in many areas of pharmaceutical and medical research. Some areas of focus are:

- In cell signalling, vesicle formation, endocytosis, and exocytosis
- In studies of the cardiovascular (particularly blood clotting), nervous and digestive systems and their disorders.

Action of Detergents



Like phospholipids themselves, detergents are amphiphilic, organic compounds containing well separated hydrophilic domains (heads) and hydrophobic domains (tails). The way detergents act on membranes is shown in the scheme below.

At detergent concentration lower than critical micelle concentration (CMC), molecules of detergent insert in the lipid bilayer of the membrane. When the CMC is reached, the lipid bilayer is saturated by the detergent, which causes lysis of the membrane. At this point, mixed detergent-phospholipid micelles, detergent micelles, and protein-detergent micelles are formed (where the hydrophobic domains of the protein are located towards the centre of the micelle and its hydrophilic domains towards the outer surface).

It is important to use the correct concentration of detergent to make sure that each individual protein is isolated in a single micelle, therefore usually an excess is employed. The optimal detergent concentration depends on: the detergent's physical properties, on the protein concentration and membrane characteristics. More information can be found in our dedicated detergents brochure.

Key Membrane Phospholipids

Biosynth provides a vast range of phospholipids with modified head groups which can be seen in our extensive phospholipids category. A selection of these that are used in cell membrane research are shown in the table below (based on Table 1 from Beltrán-Gracia et al, 2019).

Phospholipid	CAS	Product Code	Abbreviation	Charge
Hydrogenated soy phosphatidylcholine	97281-48-6	XDA28148	HSPC	Neutral
Dilauroyl phosphatidylcholine	18656-40-1	FD111153	DLPC	
	18194-25-7	FD49404		
Dimyristoyl phosphatidylcholine	18194-24-6	FD49407	DMPC	
Dipalmitoyl phosphatidylcholine	63-89-8	FD46765	DPPC	
Distearoyl phosphatidylcholine	816-94-4	FP47180	DSPC	
Dioleoyl phosphatidylcholine	4235-95-4	FD15886	DOPC	
Diarachidoyl Phosphatidylcholine	61596-53-0	FD172067	DAPC	
Dilauroyl phosphatidylethanolamine	59752-57-7	FD111134	DLPE	
Dimyristoyl phosphatidylethanolamine	998-07-2	FD111136	DMPE	
Dipalmitoyl phosphatidylethanolamine	923-61-5	FD39284	DPPE	
Distearoyl phosphatidylethanolamine	1069-79-0	FD178397	DSPE	
Dioleoyl phosphatidylethanolamine	4004-05-1	FD148481	DOPE	
Dilauroyl phosphatidylglycerol	322647-27-8	XMA64727	DLPG	Negative
Dimyristoyl phosphatidylglycerol	200880-40-6	FD165443	DMPG	
Dipalmitoyl phosphatidylglycerol	200880-41-7	AIA88041	DPPG	
Distearoyl phosphatidylglycerol	4537-78-4	EAA53778	DSPG	
Dioleoyl phosphatidylglycerol	67254-28-8	FD146892	DOPG	
Dilauroyl phosphatidylserine	208757-51-1	FD181621	DLPS	
Dimyristoyl phosphatidylserine	105405-50-3	FEA40550	DMPS	
Phosphatidyl-L-serine	51446-62-9	FP16194	PS	
Dipalmitoyl phosphatidylserine	145849-32-7	VFA84932	DPPS	
Distearoyl phosphatidylserine	321595-13-5	FP141772	DSPS	
Dioleoyl phosphatidylserine	70614-14-1	VCA61414	DOPS	
	90693-88-2	FT177126		
Dilauroyl phosphatidic acid	108321-06-8	IEA32106	DLPA	
Dimyristoyl phosphatidic acid	80724-31-8	FDA72431	DMPA	
Dipalmitoyl phosphatidic acid	169051-60-9	UGA05160	DPPA	
Distearoyl phosphatidic acid	108321-18-2	IEA32118	DSPA	
Dioleoyl phosphatidic acid	108392-02-5	FD167442	DOPA	
Dioleoyl trimethylammonium-propane	132172-61-3	FD22461	DOTAP	Positive
	144189-73-1	FD157467		
Dioleoyl dimethylammonium propane	127512-29-2	CFA51229	DODAP	

About Biosynth

Securing Life Sciences Supply Chains - where Chemistry meets Biology, Products meet Services and Innovation meets Quality, Biosynth is at the Edge of Innovation.

With an unrivalled research product portfolio and end-to-end manufacturing services, we are science led and customer focused to solve problems and deliver key reagents at scale and quality. Our expertise and capability runs across Complex Chemicals, Peptides and Key Biologics all from one trusted partner.

Biosynth is an innovative life sciences reagents, custom synthesis and manufacturing services company. We are by scientists, for scientists, securing supply chains with consistent quality, across the globe. We manufacture and source a vast range of chemical and biochemical products, and take pride in delivering products that others cannot. We are experts in complex chemistry, peptides and key biological raw materials. We provide a full range of products and services to support life science research and development, with more than half a million products in our research catalog and hundreds of complex manufacturing service projects.

Our complex chemistry specialties include enzyme substrates, carbohydrate and nucleoside chemistry, with manufacturing services from the first idea to the finished product, from route scouting to GMP or ton scale production. For peptides, we also have a full end-to-end offering, from lead discovery and optimization, library production, through to GMP NCE or Neoantigen projects.

Across biologics we have a synergistic offering, with an extensive range of custom bioprocessing enzyme projects for production of key products. We are also able to offer custom antibody projects, and epitope mapping. Through the Biosynth group we also offer development of antibodies, antigens and supply of plasma for in vitro diagnostics.

The trusted supplier, manufacturer and partner for the pharmaceutical, life science and diagnostic sectors, along with customers across food, agrochemistry and cosmetics, we have facilities across three continents and a rapid global distribution network. Our main chemical research and manufacturing laboratories are in Switzerland, the United Kingdom, Slovakia and China, with peptide production in the USA and the Netherlands. Enzyme projects are based in Austria and biological IVD reagents in Ireland. Our R&D resources and production facilities are modern and versatile, allowing us to produce chemicals on the milligram to ton scale, and at ISO 9001 and GMP, with peptides at mg to multikilogram scale.

References

Soni et al. (2016). Chapter 5 - Role of liposomal drug-delivery system in cosmetics. Nanobiomaterials in Galenic Formulations and Cosmetics. William Andrew Publishing: 93-120.

Beltrán-Gracia et al (2019). Nanomedicine review: clinical developments in liposomal applications. Cancer Nanotechnology, 10, 11.