

# Phosphatidylcholine

## Dietary Supplement



### For Healthcare Professionals Only Support for Healthy Membrane & Liver Function

Dietary choline, an essential cellular nutrient, is ingested in the diet primarily in the form of phosphatidylcholine. Phosphatidylcholine is the principal circulating phospholipid in plasma, where it is an integral component of the lipoproteins, especially HDL. It plays an important role in both the structure and function of mammalian organ membranes,<sup>1, 2</sup> and is the prime phospholipid in the mammalian heart, accounting for ~40% of the total membrane phospholipids.<sup>3</sup> It is estimated that greater than 98% of the blood and tissue choline is sequestered in phosphatidylcholine.

Phosphatidylcholine, a glycerophospholipid, is the key building block of membrane bilayers, and makes up a very high proportion of the outer leaflet of the plasma membrane. Following ingestion, most of the phosphatidylcholine is broken down and subsequently incorporated into cellular membranes. Phosphatidylcholine serves as an excellent source of methyl groups for various chemical reactions, as it can supply up to three methyl groups per molecule, thus plays an important role in metabolic regulation. Additionally, it is present in a variety of molecular species in human tissues, primarily due to the variability of the fatty acid tails.

Choline plays a fundamental role in the synthesis of membrane phospholipid components of the cell membrane. Although choline may be synthesized *in vivo*, from either methionine or serine, it is considered an essential nutrient.<sup>4</sup> The composition of essential fatty acids in phosphatidylcholine determines its value in promoting health. Lowered blood choline is frequently displayed as liver steatosis (fatty liver) and related dysfunctions, and a deficiency in choline has been correlated with deleterious effects on the expression of a variety of genes, including those involved in cell proliferation, cell differentiation and apoptosis. Choline deficiency has also been associated with liver dysfunction and neoplastic diseases, as well as with neurodegenerative disorders, including Alzheimer's and Parkinson's disease.<sup>5</sup> A source of choline contributes to the

biosynthesis of the neurotransmitter acetylcholine, a neurotransmitter which has many functions in the body, including its involvement in muscle control and memory. Phosphatidylcholine has been implicated as the preferred source of choline for this action.<sup>6</sup>

Hepatic phosphatidylcholine is considered an important component in liver function as well as in metabolic regulation.<sup>7</sup> A decrease in hepatic phosphatidylcholine has been associated with an accumulation of triglycerides in the liver, along with a reduced level of plasma lipids and plasma lipoprotein.<sup>8</sup> In animal studies choline intake was correlated to a hepatoprotective effect. Consequently phosphatidylcholine supplementation in persons with liver impediments is particularly important.

Biotics Research Corporation's **Phosphatidylcholine** is supplied as a highly bioavailable form, which is well tolerated, odor free, readily absorbed and most importantly tested to ensure quality and purity.

**Product #: 1410 Contains: 100 Capsules**

#### References:

1. White DA. Form and Function of Phospholipids. Eds. Ansell GB, Hawthorne JN, Dawson RMC. Elsevier, Amsterdam. 1973 pp. 441-482.
2. Coleman, R. Biochim. Biophys. Acta 1973 300: 1-30.
3. Ansell GG, Spanner S. Phospholipids. Eds. Hawthorne JN, Ansell GB. Elsevier. Amsterdam 1982 pp. 1-49.
4. Blusztajn JK. Developmental neuroscience: enhanced choline, a vital amine. *Science* 1998 281:794-795.
5. Michel v, Yuan Z, Ramsbir S, Bakovic M. Choline Transport for Phospholipid synthesis. *Exp Biol Med* 2006 231:490-504.
6. Werbach MR, Moss J. Textbook of Nutritional Medicine. 1999 Third Line Press, Inc.
7. Chang HM, Mai FD, Chen BJ, Wu UI, Huang YL, Lan CT, Ling YC. Sleep deprivation predisposes liver to oxidative stress and phospholipid damage: a quantitative molecular imaging study. *J Anat.* 2008 Mar;212(3):295-305. Epub 2008 Jan 25.
8. Jacobs RL, Devlin C, Tabas I, Vance DE. Targeted deletion of hepatic TP:phosphocholine cytidyltransferase alpha in mice decreases plasma high density and very low density lipoproteins. *J Biol Chem.* 2004 Nov 5;279(45):47402-10.

For additional information please contact us:

(800) 231 - 5777 • Biotics Research Corporation  
6801 Biotics Research Drive • Rosenberg TX 77471  
Email: [biotics@bioticsresearch.com](mailto:biotics@bioticsresearch.com)

**BIOTICS**  
RESEARCH  
CORPORATION  
"The Best of Science and Nature"  
[www.bioticsresearch.com](http://www.bioticsresearch.com)

# Phosphatidylserine

## Dietary Supplement

For Healthcare Professionals Only

## Support for Healthy Brain Function

Phosphatidylserine, a naturally occurring phospholipid nutrient, is a component of cell membranes. As such it serves as an essential constituent to the functioning of all cells in the body. In addition to its primary role as a structural component of cell membranes, it also plays a significant role in the biological processes of apoptosis and cell signaling.<sup>1</sup> In most cells phosphatidylserine is restricted to the inner leaflet of the plasma membrane; however it appears on the surface of apoptotic lymphocytes at the initiation of phagocytosis by activated macrophages,<sup>2</sup> and is believed to be a recognition signal for the phagocytic removal of apoptotic cells.<sup>3,4</sup> The cell surface exposure of phosphatidylserine also occurs in coordination with other cellular functions, for example in platelet initiation of the blood clotting cascade,<sup>4,5,6,7</sup> as well as in sperm maturation.<sup>8,9</sup>

Phosphatidylserine comprises only a small percentage of the total phospholipids, accounting for less than 10% of the phospholipid total. However, as a component of myelin it makes up a major part of the phospholipid concentration of the brain, and as such may offer a supportive aspect in regard to brain function. It is also present in high concentrations in the retina,<sup>10</sup> and is thought to play an important role in both vision and the nervous system.<sup>11</sup>

Functionally, phosphatidylserine serves as an essential cofactor for the binding and activation of protein kinase C,<sup>12,13</sup> a key enzyme in signal transduction, as well as a required component for the activity of other essential enzymes, including  $\text{Na}^+/\text{K}^+$  ATPase and neutral sphingomyelinase.<sup>15</sup> In blood coagulation, it is

transported to the membrane surface, where it serves to enhance the activation of prothrombin to thrombin.<sup>16</sup> Its importance in apoptosis is demonstrated by the fact that in its absence, the ingestion and clearing of apoptotic cells does not occur.<sup>17</sup> Additionally, Bleijerveld OB, *et al.* have hypothesized its essentiality in mitochondrial functioning as a component in the phosphatidylserine decarboxylation pathway.<sup>18</sup>

Due to the ability of phosphatidylserine to be converted into key lipid secondary messengers, it participates in important cellular regulatory mechanisms.<sup>19,20</sup> In platelets the translocation of phosphatidylserine from the inner to the outer leaflet of the plasma membrane marks the initiation of the blood-clotting cascade, thus implicating its importance in this function.<sup>21</sup> The exposure of phosphatidylserine on the cell surface, a characteristic of dying cells, allows for the safe clearance of apoptotic waste without induction of the inflammatory cascade. A defect in this clearance mechanism has been associated with autoimmune pathologies.<sup>22</sup> Cumulatively, phosphatidylserine plays a key role in many biochemical and physiological processes in mammalian cells, including immunity.

Biotics Research Corporation's Phosphatidylserine is supplied in 100 mg softgel caplets. As with all products from Biotics Research Corporation, the product is tested to ensure quality and purity.

**Product #: 1430 Contains: 90 Capsules**

### References:

1. Vance JE. Phosphatidylserine and Phosphatidylethanolamine in Mammalian Cells: Two Metabolically-related Aminophospholipids. *Prog Nucleic Acid Res Mol Biol.* 2003;75:69-111.
2. Fadok VA, Voelker DR, Campbell PA, Cohen JJ, Bratton DL, Henson PM. Exposure of phosphatidylserine on the surface of apoptotic lymphocytes triggers specific recognition and removal by macrophages. *J Immunol.* 1992 Apr 1;148(7):2207-16.
3. Fadok VA, de Cathelineau A, Daleke DL, Henson PM, Bratton DL. Loss of phospholipid asymmetry and surface exposure of phosphatidylserine is required for phagocytosis of apoptotic cells by macrophages and fibroblasts. *J Biol Chem.* 2001 276:1071-1077.
4. Balasubramanian K, Mirnikjoo B, Schroit AJ. Regulated externalization of phosphatidylserine at the cell surface: implications for apoptosis. *J Biol Chem.* 2007 282:18357-18364.
5. Bevers E, Comfurius P, van Rijn J, Hemker H, Zwaal R. Generation of prothrombin-converting activity and the exposure of phosphatidylserine at the outer surface of platelets. *Eur J Biochem.* 1982 122:429-436.
6. Schroit AJ, Zwaal RFA. Transbilayer movement of phospholipids in red cell and platelet membranes. *Biochim. Biophys. Acta.* 1991 1071:313-329.
7. Zwaal RF, Comfurius P, Bevers EM, Scott syndrome, a bleeding disorder caused by defective scrambling of membrane phospholipids. *Biochim Biophys Acta.* 2004 1636:119-128.
8. Gadella BM, Harrison RA. The capacitating agent bicarbonate induces protein kinase A-dependent changes in phospholipid transbilayer behavior in the sperm plasma membrane. *Development.* 2000 127:2407-2420.
9. Flesch FM, Brouwers JF, Nijelstein PF, Vekleij AJ, van Golde LM, Colenbrander B, Gadella BM. Bicarbonate stimulates phospholipids scrambling induces cholesterol redistribution and enables cholesterol depletion in the sperm plasma membrane. *J Cell Sci.* 2001 114:3543-3555.
10. Ford DA, Monda JK, Brush RS, Anderson RE, Richards MJ, Fliesler SJ. Lipidomic Analysis of the Retina in a Rat Model of Smith-Lemli-Opitz Syndrome: Alterations in Docosahexaenoic Acid Content of Phospholipid Molecular Species. *J Neurochem.* 2008 105(3):1032-1047.
11. Kim HY. Novel metabolism of docosahexaenoic acid in neural cells. *J Biol Chem.* 2007 282:18661-18665.

12. Nishizuka Y. Intracellular signaling by hydrolysis of phospholipids and activation of protein kinase C. *Science.* 1992 258:607-614.
13. Bittova L, Stahelin RV, Cho W. Roles of ionic residues of the C1 domain in protein kinase C- $\alpha$  activation and the origin of phosphatidylserine specificity. *J Biol Chem.* 2001 276:4218-4226.
14. Nagai Y, Aoki J, Sato T, Amano K, Matsuda Y, Arai H, Inoue K. An alternative splicing form of phosphatidylserine-specific phospholipase A1 that exhibits lysophosphatidylserine-specific lysophospholipase activity in humans. *J Biol Chem.* 1999 274:11053-11059.
15. Tomiuk S, Zumbansen M, Stoffel W. Characterization and subcellular localization of murine and human magnesium-dependent neutral sphingomyelinase. *J Biol Chem.* 2000 275:5710-5717. <http://www.lipidlibrary.co.uk/Lipids/ps/index.htm>
16. Hoffmann P R, A M, de Cathelineau, C A, Ogden Y, Leverrier, D L, Bratton, D L, Daleke, A J, Ridley, V A, Fadok, and P M, Henson. 2001. Phosphatidylserine (PS) induces PS receptor-mediated macropinocytosis and promotes clearance of apoptotic cells. *J Cell Biol.* 155:649-659.
17. Bleijerveld OB, Brouwers JF, Vaandrager AB, Helms JB, Houweling M. The CDP-ethanolamine pathway and phosphatidylserine decarboxylation generate different phosphatidylethanolamine molecular species. *J Biol Chem.* 2007 Sep 28;282(39):28362-72. Epub 2007 Aug 2.
18. Berridge MJ, Irvine RF. Inositol trisphosphate, a novel second messenger in cellular signal transduction. *Nature.* 1984 312:315-321.
19. Nishizuka Y. Studies and perspectives of protein kinase C. *Science.* 1986 233:305-312.
20. Vance JE. Molecular and cell biology of phosphatidylserine and phosphatidylethanolamine metabolism. *Prog Nucleic Acid Res Mol Biol.* 2003;75:69-111.
21. Botto M. Phosphatidylserine receptor and apoptosis: consequences of a non-ingested meal. *Arthritis Res Ther.* 2004, 6:147-150.



**BIOTICS  
RESEARCH  
CORPORATION**

"The Best of Science and Nature"  
[www.bioticsresearch.com](http://www.bioticsresearch.com)