HealthEXTRA

The Power of *Essential* Phospholipids

By Lane Lenard, Ph.D.

It may be a philosophical cliché, but it applies as much to living, breathing bodies as it does to spiritual quests: in our endless pursuit of the "secret of life," the final answer is no obscure herb or bioengineered spider venom, but one of the most common substances of them all, the proverbial tree that blocks our view of the forest.

The "secret," in fact, is no secret at all. The not-so-secret stuff of life turns out to be a ***phospholipid*** called ***phosphatidylcholine (PC).*** Given its role in cellular functioning, it's no exaggeration to say that without the presence of phosphatidylcholine, life as we know it could not exist. In fact, research shows that ingesting high concentrations of quality PC provides enormous health benefits in terms liver, cardiovascular, kidney, lung, gastrointestinal (GI), neurologic, and skin function.

Phospholipids are lipid-protein complexes that bind together to form a membrane or "skin" that surrounds every living cell in the body, serving at their most basic level, to keep the cell's contents from spilling out onto the sidewalk. Phospholipids are among the most *plentiful* of substances in any living organism, and with good reason. We need lots of them, especially PC, to live; and in order to keep on living, we need to keep on replenishing them. The body creates much of what it needs, but dietary supplementation can be very helpful, especially when certain organs are overstressed and increasingly, as the body ages.

As illustrated in **Figure 1,** cell membranes consist primarily of PC molecules (about 40% overall) plus other phospholipids interspersed with cholesterol, glycolipids, and protein molecules. Cholesterol helps to strengthen the membrane, and protein molecules, which speckle the cell surface, perform multiple vital tasks. Principally, they serve as receptors for biologically active substances, like hormones and neurotransmitters, which are programmed to attach to specific proteins and trigger important cellular functions. Other proteins may function as cross-membrane transport systems that usher important enzymes, ions, nutrients, and other proteins into and out of the cell. In essence, protein receptors are the cell's way of staying in touch with the extracellular world, allowing them to coordinate their actions with other cells in response to hormonal signals coming in from all over the body.

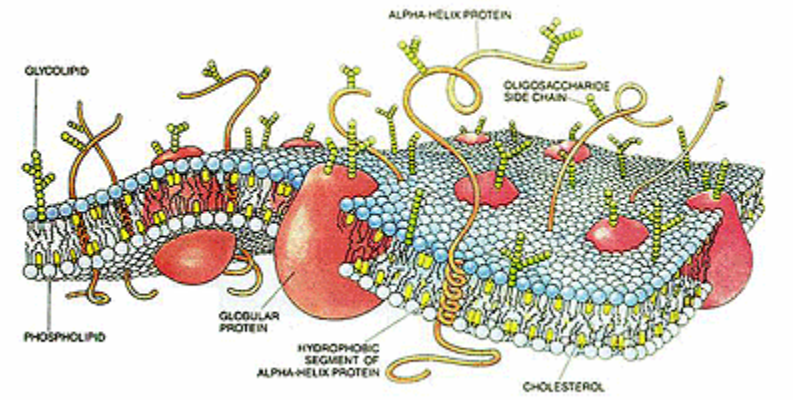

Figure 1. *Cross-section of a cell membrane. (Wikipedia.com)*

The Fluid Mosaic

While we may think of the cell membrane as a kind of "skin," it is, in fact, quite delicate and fluid, and not really skin-like at all. The cell membrane has been commonly described as a "fluid mosaic" composed of proteins that shift tile-like around the membrane surface, or float like "loosely anchored ships on a lipid sea."[1] The fluid nature of cell membranes, which is vital to their function, depends largely on the presence of PC and other phospholipids.

The phospholipids that comprise the membrane “sea” have a unique structure that makes them ideal for their role. Each phosphatidylcholine particle consists of a *hydrophilic* (water-friendly) head made from *phosphorylcholine* (choline + phosphate) and *glycerol* and a two-pronged *hydrophobic fatty acid* tail **(Fig. 2).** Thanks to their structure and electric charge, phospholipids that find themselves in an aqueous medium tend to align so that their water-friendly heads face the aqueous medium, while their hydrophobic fatty acid tails turn inward, facing each other, and forming a bilayer molecular sheet that provides a barrier to the watery world just outside **(Fig. 1).**

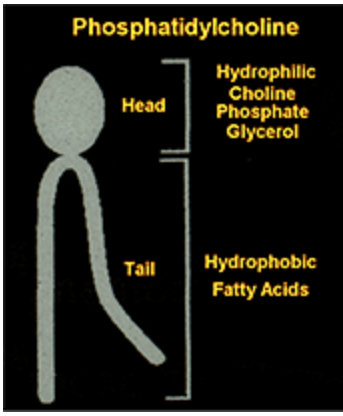

Figure 2. *The Structure of Phosphatidylcholine*

Ordinary dietary lecithin may start with phosphatidylcholine, but it typically includes saturated lipids, and in most cases, the percentage of actual PC may be as low as 20%. By contrast, essential phospholipids contain 90% or more PC with primarily polyunsaturated fatty acids.

Fats, of course, famously do not dissolve in water – imagine an oil slick on a river, or better, a globule of cooking oil floating in a pot of water. But, instead of a solid mass of lipids, the globular cell is more like a fatty little bubble – a microscopic mass of cytoplasm surrounded by a thin, filmy, bilayer membrane, which protects its aqueous contents from direct, *uncontrolled* contact with the aqueous extracellular world. Only molecules with the correct “password” that lets them bind to the receptor proteins that dot the cell membrane are allowed to pass through the membrane and into the cell.

Important as they are, though, cell membranes are also exceedingly thin and delicate structures that are particularly vulnerable to damage from common dangers of the cellular world, like drugs, toxins, and oxygen free radicals. Any phospholipid damage that makes the membrane more porous endangers the life of the cell. If cells are going to survive, damaged phospholipids must be quickly replaced; and if tissues are going to survive, damaged or dying cells must also be replaced in a timely manner.

The most vulnerable tissues are those marked by a rapid turnover of cells. Key among these are the skin, GI tract, lungs, kidneys, heart and blood vessels, and especially the liver.

Only dietary sources of high-quality PC can hope to fill the gap. One of the most common sources of phospholipids is *lecithin*, which appears naturally in foods like egg yolks, soy beans, sunflower seeds, and rapeseeds. Food processors commonly add lecithin as a natural *“emulsifier”* to certain foods, and you can also take lecithin as a nutritional supplement. But, while lecithin has become synonymous with phosphatidylcholine, in fact, dietary lecithin may start with PC, but it also includes other lipids. In most cases, the percentage of actual PC may be as low as 20%. Depending on its source, PC can also vary in its fatty acid make-up. PC derived from soy has far lower levels of saturated fatty acids and relatively high levels of the more healthful mono- and polyunsaturated fatty acids, including important amounts of *linoleic* and *α-linoleic* acids. PC is generally well-tolerated and nontoxic. The FDA classifies it as GRAS (**g**enerally **r**egarded **a**s **s**afe), the highest level of safety.

Essential Phospholipids

The most impressive clinical benefits of PC supplementation have been achieved using a product known as ***"essential phospholipids" (EPs).*** EPs are highly purified extracts containing from 76% to 94% PC, or four to five times as much as ordinary dietary lecithin. Essential phospholipids also supply a high content of polyunsaturated fatty acids, especially linoleic acid, and *choline.* Choline is an essential nutrient the body uses to make several compounds required by healthy cell membranes, as well as the neurotransmitter *acetylcholine* (ACh), a crucial brain chemical involved in functions from memory to muscle movement. In fact, PC is the body's primary source of choline.[2]
While dietary forms of lecithin are readily available, EPs, as you might imagine, are more difficult to come by. For example, you'd need to distill about 15 kg of soy beans to produce a single daily dose of EPs – 1.8 g.[2]

Once ingested and digested, EPs are distributed throughout the body where their effects vary with the location. A partial list of these effects includes:

- ***Supporting cell membrane structure and function.*** As described above, EPs supply the basic structural elements of every cell membrane in the body.

- ***Supplying choline for ACh.*** Also as noted above, PC is an excellent source of choline for the neurotransmitter ACh. More than 98% of choline in blood and other tissues is held in the form of phosphatidylcholine. Thus, PC serves as a kind of "slow-release" source of the essential nutrient,[3] causing levels to rise for up to 12 hours after ingestion.

- ***Energy production.*** The body oxidizes (*literally,* burns) fatty acids and glycerol to produce energy.

- ***Energy storage.*** Fatty acids and glycerol that are not oxidized may be stored as fat, a process called *lipogenesis.* Stored body fats provide a ready source of potential energy.

- ***Prostaglandin production.*** The body uses linoleic acid, one of the fatty acids in EPs, to make *prostaglandins,* a valuable family of biochemicals.

- ***Emulsification of fat and bile.*** In the GI tract, EPs aid digestion by emulsifying dietary fats and bile produced by the liver.

- ***Aid in blood clotting.*** EPs help modulate the aggregation of erythrocytes (red blood cells) and clotting agents called platelets.

- ***Increasing cholesterol solubility.*** By increasing the solubility of cholesterol, EPs decrease cholesterol's propensity to promote atherosclerosis. PC also aids in lowering cholesterol levels, removing cholesterol from tissue deposits, and inhibiting platelet aggregation.[4]

- ***Antioxidant protection.*** Studies in animals demonstrate that PC has potent antioxidant activity, which can protect against one of the most important factors promoting body aging – oxygen free radical damage.[5] By this and other mechanisms, PC protects the body against a wide variety of adverse drug effects and other chemical toxins. The high content of linoleic acid in phosphatidylcholine may be responsible for much of its antioxidant benefit.

Both niacin and essential phospholipids were effective in reducing the number and intensity of angina attacks, but only EPs significantly increased patients' physical working capacity.

The Vulnerable Liver

The organ that's subject to more membrane damage than any other – and therefore, one that can benefit enormously from EPs – is the liver. If all liver cell membranes were laid out flat on the ground, they would cover about 33,000 square meters,[6] or about five football fields. What does the liver need with all that cell surface area?

The liver is like the body's customs agent. Anything that enters the body via the GI tract first passes through the liver before entering the general circulation. This is called "first-pass metabolism." Circulating blood also gets a hepatic cleansing as it passes through the liver in its journey around the body.

The liver's primary roles include processing nutrients into a form body cells can utilize optimally and also eliminating potential toxins before they can cause serious damage in other parts of the body. But while the liver protects the body from the full force of most ingested toxins, in so doing, it can bear the full brunt of a toxin's destructiveness, basically "taking one" for the body.

Alien agents like alcohol, organic solvents, medicines and other drugs, fatty foods, viruses, various pollutants, and others all take their toll on the membrane fluidity and permeability of liver cells, or hepatocytes, which can impair the liver's vital metabolic processes. Ironically, the liver sometimes makes things worse for itself by breaking down some alien compounds, which may or may not be toxic, into metabolites that may be even more toxic.

Normally, built-in antioxidants, such as glutathione, cysteine, and taurine, neutralize these toxins, protecting hepatocytes to a large degree. However, in good time, with repeated exposure to toxins of all kinds, antioxidant protection is eventually exhausted and liver cells give themselves up for the "cause." Fortunately, the liver has powerful regenerative properties, which can readily replace those hepatocytes that fail.

However, during a toxic overload, as occurs with heavy alcohol consumption or other egregious insult, severe structural damage may exceed the liver's ability to regenerate and also deplete its stores of protective antioxidants. And since the liver keeps only enough spare parts, like PC and other phospholipids, around to keep up with a normal rate of hepatocyte death, a toxic overload can easily overwhelm it.

For sure, the clearest and most common liver toxin is alcohol. As it passes through the liver on its way into the bloodstream, alcohol gets broken down into a variety of toxic by-products, including two of the most destructive, acetaldehyde and oxygen free radicals, which can, among other injurious acts, literally dissolve the phospholipid membranes right off the hepatocytes they contact![7]

Alcohol also directly attacks the liver cells' power plants, the mitochondria, leaving the cells literally powerless to perform their many critical – and even life-saving – functions. Key among these functions is the burning of triglycerides, the mitochondria's primary fatty fuel. Fat that does not get burned in the liver starts to build up there, making "fatty liver" one of the earliest signs of alcoholic liver damage. Early fatty liver may have no symptoms, but as the fat depots grow in size, they eventually impair liver function, leading to inflammation, fibrosis (scarring), liver failure, and death.[8-10]

Essential Phospholipids: The Membrane Therapeutic

Numerous studies have demonstrated that nutritional factors, like L-cysteine and vitamins B_1 and C [see **"Going to a Party? Be Prepared!"** in the November 2005 issue of *Life Enhancement], glutathione, vitamin A,* and of course, *phosphatidylcholine,* provide significant protection against liver damage from alcohol and other hepatotoxic substances.

In addition to its vital cell maintenance functions, concentrated PC in the form of essential phospholipids also has therapeutic benefits that can sometimes be life-saving. You can get some PC from foods containing lecithin, but the lone source of high-concentration (90% +), high-quality phosphatidylcholine is EPs, the only form of PC that is capable of effectively countering toxic overload in the liver. Thanks to their efficacy in treating diseases related to cell membrane damage, reduced phospholipid levels, and impaired membrane fluidity, EPs have been characterized as a "membrane therapeutic."[2]

Studies suggest that PC can not only slow the progression of alcohol-induced liver damage, but can actually halt it in its tracks, before it develops into generalized fibrosis (cirrhosis).

Many studies have demonstrated that PC supplementation, especially with EPs, provides consistently significant clinical benefits. These include normalization of liver enzymes and other biochemical markers of hepatic function, accelerated hepatocyte replacement, and improved liver function all leading to improved overall wellbeing, and ultimately, to enhanced survival.

In a classic study of baboons fed alcohol for years at a time, those whose diets were *not* supplemented with PC all progressed to liver cirrhosis, while the PC-fed primates evidenced only fatty liver and mild fibrosis.[5,9,11]

Tests of EPs in human alcoholics are in their early stages, but the results are encouraging. In one study from Slovakia,[12] 29 men and women diagnosed with alcoholic fatty liver took two capsules of an EP formulation (2 x 300 mg) 3 times a day over 3 months. EP therapy subjectively improved well-being in 76% of the patients. Objectively, it improved liver function within 2 to 3 months of treatment, as evidenced by significantly reduced levels of key liver enzymes **(Fig. 3).** Elevation of these enzymes is an indication of fatty liver (and other liver pathology), which, as shown here, is completely reversible in most instances with appropriate nutritional therapy, including PC.[13]

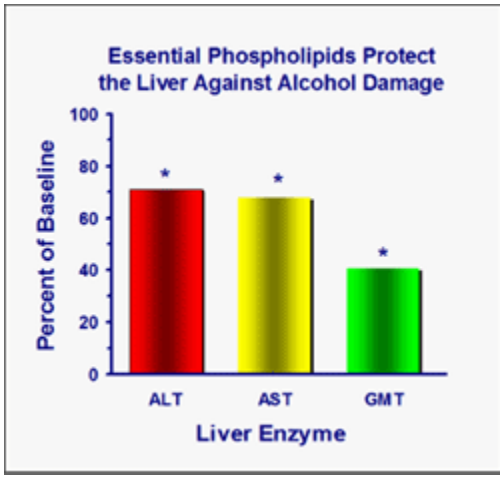

Figure 3. *Reduction in liver enzymes symptomatic of fatty liver in alcoholic patients taking essential phospholipids for 3 months. ALT = alanine aminotransferase; AST = aspartate aminotransferase; GMT = gamma-glutamyltransferase. * P =0.05*
Adapted from Turecky et al, 2003.

Another double-blind study from Germany[14] found a similar result. In this trial, 40 alcoholic men diagnosed with fatty liver and possibly liver inflammation (an indication of even more severe disease), randomly received daily doses of either 1350 mg of PC (fortified with B vitamins) or placebo. Beginning as early as 2 weeks after the start of therapy, the results showed improvement in the PC-treated group. By Week 8, every important parameter of liver function was significantly improved (P <0.05). A double-blind Spanish study confirmed the benefits of "fortified PC" in men with alcoholic fatty liver.[15] A third double-blind study found that PC was effective in alleviating fatty liver due to causes other than alcoholism.[16]

Overall, studies in both animals and humans suggest that PC can be effective not only for slowing the progression of alcoholic liver damage, but for actually halting it in its tracks, before it

develops into generalized fibrosis (cirrhosis), which is usually fatal unless the patient receives a liver transplant. Moreover, PC can provide protection against other liver toxins, such as drugs, anesthetics, certain foods and herbs, pollutants, viruses (eg, hepatitis A, B & C) and even radiation.[6]

PC Therapeutics beyond the Liver

While the benefits of PC have been most clearly demonstrated in the liver, a few studies show that its therapeutic effects may benefit vital systems all over the body. For example:

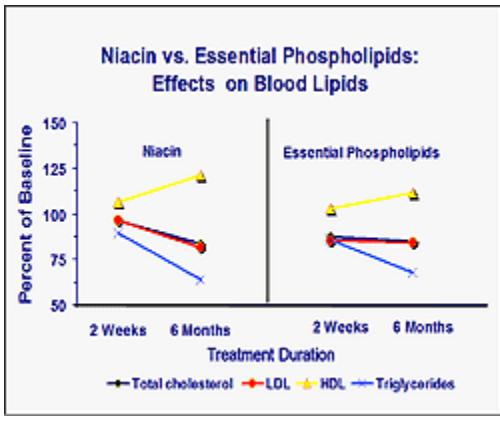

Figure 4. *Both niacin and EPs significantly improved serum lipoprotein profiles in patients with hyperlipidemia and angina pectoris, compared with pretreatment baseline levels.*
(Adapted from Klimov et al, 1996)

Cardiovascular function. High-density lipoprotein (HDL) particles ("good cholesterol") enriched with EPs are able to take up more cholesterol from low-density lipoprotein (LDL) ("bad cholesterol") and transport it back to the liver, a function known as *reverse cholesterol transport,* Other types of lipid-lowering agents (eg, "statins") either reduce cholesterol absorption in the body or cholesterol synthesis in the liver and its distribution around the body. The ability to enhance reverse cholesterol transport is unique to EPs.

A Russian study[17] compared the efficacy of EPs with that of niacin (nicotinic acid, vitamin B_3) in reducing serum levels of total cholesterol, LDL-cholesterol, and triglycerides and increasing levels of HDL-cholesterol in 100 men and women with elevated cholesterol levels and angina pectoris, an early sign of coronary artery disease. As shown in **Figure 4,** the treatments were comparable in significantly normalizing serum lipid levels (P <0.001) after just 2 weeks and especially after 6 months, although niacin was somewhat better at raising HDL levels after 6 months. Both treatments were also effective in reducing the number and intensity of angina attacks, but only EPs were significantly effective in increasing the patients' physical working capacity.

A German study in 30 patients with elevated serum lipid levels due to type 2 diabetes also found that an EP formulation significantly improved the lipoprotein profile. Total cholesterol decreased by 16%, triglycerides by 9%, and LDL-cholesterol by 17%, and HDL-cholesterol increased by 12%.[18]

Male sexual function. EPs may be beneficial in men with various common sexual disorders. In a preliminary, open-label study, a group of 23 men took two EP capsules (2 x 300 mg) 3 times a day for 60 days. The results showed significant decreases in the number of men with erectile dysfunction, loss of libido and impaired ejaculation. EP treatment also significantly improved sperm motility and increased sperm count, although this latter increase did not quite reach statistical significance. The researchers, from Bulgaria, hypothesized that EPs supply highly active polyunsaturated PC molecules that might promote a restructuring/regeneration of cell membranes and activate membrane-bound enzyme systems.[19]

Other therapeutic benefits. A large number of studies, many of them in animals, but many more in humans, suggest that treatment with EPs provides important clinical benefits for people with certain types of renal (kidney) disorders; GI inflammation; neurologic disorders, including dementias, multiple sclerosis, headache, dizziness, loss of memory and/or concentration, poor endurance, and insomnia; lung disorders related to membrane damage; and psoriasis.

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