

## DHA Background

The objective of this background is to differentiate the OmEGGa DHA® from other sources of DHA for use in prenatal vitamins.

### Introduction

DHA (docosahexaenoic acid, C22:6) is an omega-3 polyunsaturated fatty acid (PUFA) that encompasses 25% of the grey matter in the brain and 50% of the fatty acids in the retina. DHA is an essential nutrient required for brain development, especially during the third trimester of fetal growth (26 weeks of gestation) and throughout the first 2 years of life. [Valenzuela, Sanhueza /229-230]

In the brain, DHA is bound to a phospholipid – a fat molecule with a backbone of 3 carbons, to which 2 fatty acids and one phosphate-amino molecule attach. The major phospholipids in the brain are phosphatidylcholine (PC) phosphatidylethanolamine (PE), phosphatidylserine (PS), and phosphatidylinositol (PI). [Valenzuela, Sanhueza/230] The two DHA phospholipids in highest concentration in OmEGGa®DHA® are DHA-PC and DHA-PE, which are bioidentical to the DHA-PC and DHA-PE found naturally in the brain. As shown in Figure 1, the phosphate-amino molecule is attached at the sn-3 position, while the major site of attachment for DHA is at the sn-2 carbon atom. [Watson/272; [Valenzuela, Valenzuela/14]

DHA is not produced by the body, and it is not readily available in most foods that Americans typically eat. Therefore, a DHA supplement is recommended for women who are pregnant, planning a pregnancy, or breastfeeding. [Valenzuela, Nieto/325]

DHA supplements are developed from several sources such as fish, krill, algae, ethyl esters, and the newest source: egg. The source of the DHA is important because DHA must be bound to a “carrier” from the time it is ingested, until it is deposited in the brain. The rate and extent of absorption, distribution, and penetration through the blood-brain barrier depends on the type of “carrier” the DHA is bound to. There are 2 types of carriers – triglycerides (TG) and phospholipids (PL). Triglycerides have a backbone of 3 carbons with 3 fatty acids attached.

DHA derived from fish and algae sources is bound to a triglyceride, while DHA derived from krill and egg sources is bound to a phospholipid such as PC and PE. Ethyl esters containing DHA are synthesized from fish triglycerides to produce a concentrated fish oil.

### DHA Bioavailability

The bioavailability of DHA into the systemic circulation, and then distribution into the brain really depends on the route the DHA carrier must travel. After ingestion, both triglyceride and phospholipid carriers of DHA move to the small intestine. However, phospholipids can be directly absorbed through the intestinal lining into the bloodstream or converted into lysophospholipids, whereas triglycerides must go through a series of physical and biochemical reactions before they can be absorbed. [Chen/214-215] A little less than 10% of the triglyceride remain unchanged, and are therefore not absorbed. [Chaney/2] Neither carrier is affected by first-pass metabolism.

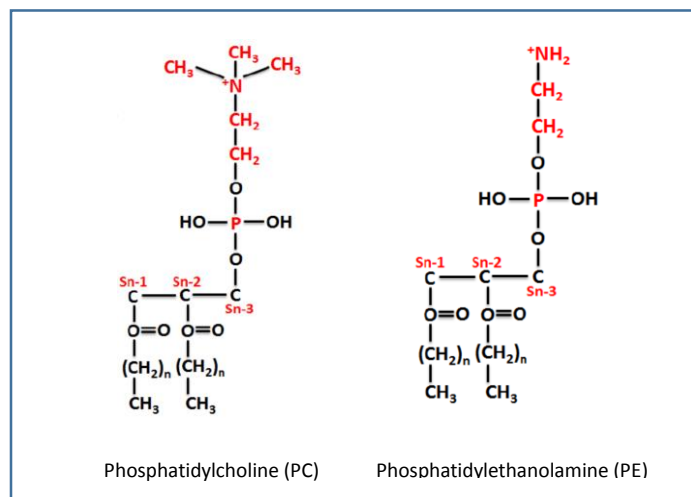


Figure 1. Chemical structures of phospholipids PC and PE

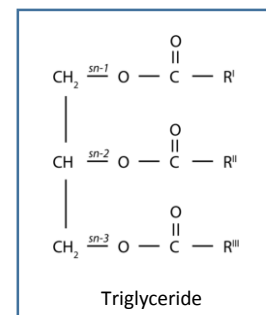


Figure 2. Chemical structure of a triglyceride

- A study measuring long-chain polyunsaturated fatty acids (LCPs) in preterm breast milk and formula showed that LCPs bound to phospholipids are better absorbed than triacylglycerol LCPs from either formula or breast milk. [Carnielli/100]
- In a human pharmacokinetic study comparing DHA carried by PC or triglycerides, DHA bound to PC was found to be more bioavailable in the blood (and therefore the brain) compared to DHA bound to triglycerides. [Lemaitre-Delaunay/1873]
- In an animal study conducted by Liu, et al, DHA bound in the sn-2 position of PC were 1.9-fold more efficacious for supply of cerebral cortex gray matter than DHA bound to the sn-2 position of triglycerides. [Liu/7]
- In addition, DHA bound to PC can easily be converted in the intestine to lysophosphatidylcholine (lyso-PC) in the intestine. DHA Lyso-PC is the preferred configuration for DHA passage through the blood-brain barrier (BBB), which is transported by the protein Mfsd2a. [Nguyen-Shui/3] Once in the brain, lyso-PC is converted back to PC.
- In a study comparing the bioavailability of DHA from triglycerides or ethyl esters, DHA-TG was superior (124%) compared with natural fish oil, whereas the bioavailability of DHA ethyl esters was inferior (73%). Free fatty acid bioavailability (91%) did not differ significantly from natural triglycerides. [Dyerberg1]

### **Stability (Oxidation)**

Marine oils (derived from fish, krill, shellfish, calamari, or algae) are susceptible to oxidation from heat, light, exposure to oxygen, and can become rancid during storage over a few months. [Albert/1-2] Independent testing revealed that some brands of fish oil did not meet their shelf life claim of 24 months (if not opened). [Ascente shelf life/2] In New Zealand, reports of excess oxidation discovered in over-the-counter omega-3 supplements on the store shelves was found to be between 11% and 62%. [Albert/2] Oxidized DHA supplements may not only be ineffective, but can also potentially be harmful. [Albert/1-2; Pak/9]

### Composition of DHA in Breast Milk

- The mean concentration of DHA in breast milk (by weight) is  $0.32 \pm 0.22\%$  (range: 0.06–1.4%). [Brenna/1457]
- DHA in breast milk ranges from 0.05% to 1.4% of total fatty acids. [Carnielli/97]

### **Benefits of pure OmEGGa DHA®**

- DHA phospholipids are bioidentical to the DHA-PC and DHA-PE in the brain
- Simpler absorption than DHA-TG
- Easily passed through the blood-brain barrier
- OmEGGa DHA® is made from eggs produced by cage-free hens, not marine-based sources (fish, shellfish, or microalgae)
  - No mercury or other ocean-based contaminants or toxins
  - A safer formulation for those allergic to shellfish
  - No fishy odor, aftertaste, or burp
- OmEGGa DHA® contains less than 1% eicosapentaenoic Acid (EPA), a common ingredient in DHA products from fish, krill, and microalgae sources. [EMedicine1-2, Doughman/1]
  - No EPA adverse effects that are associated with fish oil, such as nausea, fishy taste, belching, and loose stools.
  - Reduced risk of EPA anticoagulant effect, thereby increasing the risk of bleeding complications during pregnancy
  - No EPA drug interactions that may increase the risk of bleeding when taken with aspirin, NSAIDs, or other “blood-thinning” drugs

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