
Cell Membrane Health

Your Door to Health

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Biological cell membranes are fluid membranes as depicted by the fluid mosaic model of phospholipids and proteins. They possess amphipathic (polar and nonpolar) characteristics, which enables them to spontaneously form bilayers, with the hydrophilic portions facing the aqueous side, and the hydrophobic (water repelling) core on the inner side. As a chief component of these membranes, essential fatty acids play a major role in both membrane structure and function. As summarized by Mead, their actions fall into three major classes. The first class is depicted by their involvement in the "homeoviscous control of the membrane bilayer." In this capacity they serve to regulate intrinsic membrane enzymes and proteins, both of which are critical for the structural integrity of the membrane. Secondly, they are required as precursors to the eicosanoids, which includes various end products such as prostaglandins, leukotrienes, and thromboxanes, all of which profoundly influence cellular reactions. Finally, they serve to regulate the transport processes across the cell membrane. An additional critical function of essential fatty acids not mentioned by Mead is their action in the modulation of gene expression.

As one of the classes of essential fatty acids, omega-3 (ω -3) fatty acids serve a number of basic biological roles, including: their involvement in the structure and function of biological membranes; and their importance as both cellular signals and hormone precursors. They are also vital to the cellular metabolism, acting as an aide in the regulation of nutrient uptake and excretion. Diets deficient in essential fatty acids have the potential to result in enormous consequences, both on body metabolism and function. Additionally, it is currently estimated that the typical North American diet contains a much greater percentage of omega-6 fatty acids, outnumbering the intake of omega-3 fatty acids by a factor of twenty. Symptoms of fatty acid deficiency are numerous and comprise skin problems, including eczema, psoriasis, and dry skin, inflammatory arthritis, learning problems, attention deficit, irritability, melancholy, fatigue, frequent infections and an increased synthesis of triglycerides. Numerous studies have correlated ω -3 fatty acid intake with beneficial attributes for a wide range of these

physiological situations, and recent research has associated their intake with the modulation of gene expression.

The most active and beneficial derivatives of marine-derived ω -3 fatty acids are eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). Both the brain and nervous system are higher in DHA, as compared to the rest of the body. Low brain serotonin levels have been linked to low levels of DHA, resulting in an increased tendency towards despair, suicide, and violence. Additionally, based on observations in animals, it has been hypothesized that high levels of DHA in the brain may enhance neuronal survival. Low levels of ω -3 fatty acids have been associated with behavioral issues and learning problems in children with attention shortfalls, including behavior and learning problems. Seafood, cold-water fish in particular, is known to be an excellent source of ω -3 fatty acids. Thus it is not surprising that seafood consumption during pregnancy was correlated to the child's verbal intelligence quotient (IQ), noting that low maternal seafood intake (<340g per week) increased the risk of children ranking in the lowest quartile of IQ scoring, compared to those mothers who consumed a higher quantity of seafood (> 340 g per week). In addition, low maternal seafood intake was correlated to suboptimal social development, with lower indices in social behavior, fine motor, communication, and social development scores.

A reduction in inflammatory markers, including C-reactive protein, IL-6, COX and lipooxygenase (LOX), has been correlated with a high intake of polyunsaturated fatty acids (PUFAs). Numerous studies have documented the beneficial effects of diets high in ω -3 PUFAs. Consequently, an increased intake of ω -3 PUFAs has been associated with a reduction in cardiovascular events and other related complications, and in many populations the risk of cardiovascular illness has been inversely correlated with the dietary intake of ω -3 PUFAs. Conversely, a diet high in ω -6 EFAs, such as the Standard American Diet, results in the production of inflammatory prostaglandins, thromboxanes, leukotrienes, and other metabolites of arachidonic acid (AA; 20:5n-3), which, in turn, contributes to the formation of thrombi and atheromas, allergic and inflammatory consequences, and cellular proliferation. EPA-derived eicosanoids have established effectiveness in blocking the production of series-2 prostaglandins, for example PGE2 and PGF2- α , which when elevated ensues in an anti-inflammatory response. Additionally, an increase in ω -3 fatty acids has demonstrated a diminishing effect on the level of proinflammatory markers, including IL-6, high density lipoprotein, TNF- α and C-reactive protein, along with a corresponding elevation in anti-inflammatory markers, in-

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cluding soluble IL-6 receptor and IL-10. Accordingly, a fitting dietary change for cardiovascular health benefits is to emphasize an increase in the dietary amounts of ω -3 fatty acids, including the fish oil constituents EPA and DHA, while simultaneously decreasing the dietary content ω -6 fatty acids. Conservative estimates indicate that to balance this ratio, there would have to be a four-fold increase in fish consumption. Alternately, supplemental forms of ω -3 fatty acids could be incorporated into the diet to achieve adequate EFA intake.

In addition to its benefit in inflammation, ω -3 fatty acids have also demonstrated beneficial therapeutical effects for persons with symptoms of depression. It is well known that the essential fatty acids play a central part in both the development and function of the central nervous system. Epidemiological evidence has correlated the intake of fish/seafood with a lower occurrence of these symptoms. In addition to general melancholy symptoms, a high intake of fish/seafood has also been correlated to protection against symptoms of melancholy following pregnancy, unbalanced/mood instability and seasonal sadness. A random sampling study confirmed the benefits of frequent fish consumption, indicating that it was significantly associated with a decreased frequency of melancholy and suicidal contemplation. A cross-sectional study also established a correlation between fish consumption and mental health, as a result of a higher self-reported mental health status. In a separate study, depressive symptoms were correlated to a higher ω -6: ω -3 ratio, which as indicated above enhances the production of pro-inflammatory cytokines, confirmed by elevated levels of TNF- α and IL-6.

Published trials utilizing ω -3 fatty acids have correlated a broad range of benefits to its use. For example randomized controlled trials with diabetic individuals having elevated levels of triglycerides indicated that supplementation with ω -3 significantly lowered serum triglycerides in these individuals, thus demonstrating the effectiveness of ω -3 fatty acids in reducing plasma triglycerides and platelet reactivity in these patients. In two large studies, positive correlations were associated with an increase in ω -3 fatty acid intake and a decreased risk of cerebrovascular events, implicating a significantly lower risk of thrombotic or ischemic events with an increased intake of omega-3 fatty acids. Omega-3 polyunsaturated fatty acids were also shown to benefit cardiac arrhythmia (abnormal heart rhythm). Since abnormal heart rhythm is correlated to an increased risk of cerebrovascular events, ω -3 fatty acids should provide benefit in these populations.

The average North American population's daily intake

of EPA and DHA is currently estimated at 130 mg. The minimal EPA and DHA intake, as proposed by an international panel of lipid experts, is 650 mg/day, suggesting that daily consumption should be increased **five-fold**. Considering the many benefits of increased intake, it is reasonable to recommend increased consumption for all, thus subsequently offsetting the dominance of the inflammatory mediating omega-6 fatty acids. Be it that contamination issues, particularly that of heavy metals, are of concern with an increased consumption of dietary EPA/DHA from fish, a favorable method of increasing the daily allowance is via supplementation. Quality fish oil, specifically one that is assayed for and known to be harvested free of contaminants so as not to require distillation, thus remaining fully functional (biologically active), is a smart choice for all.

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