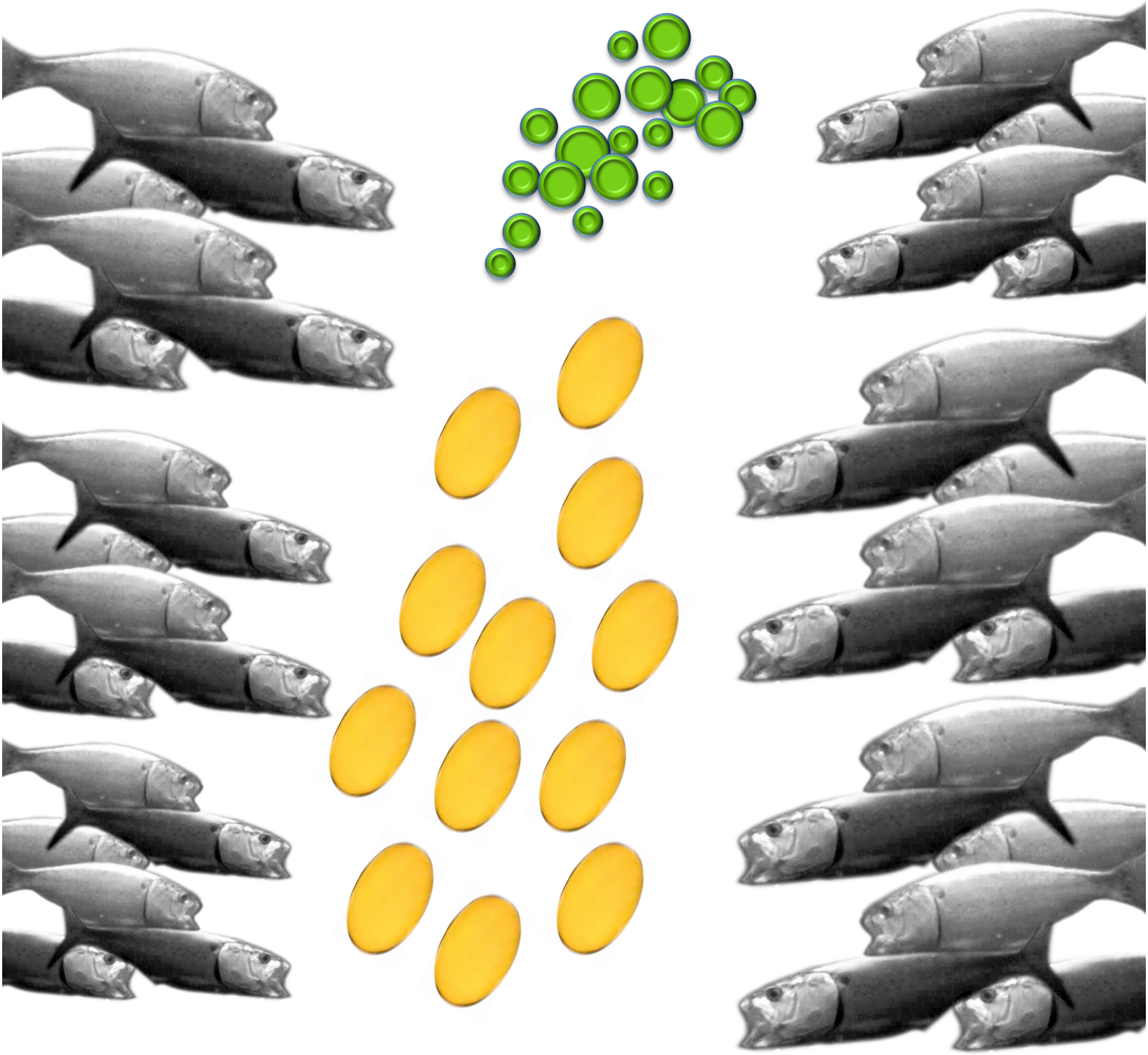
Fish Oil, *Really*?



Sea Grant
Maryland

www.mdsg.umd.edu/lesson-plans

Stroll through the vitamin and health supplements aisle at the grocery or pharmacy and take a look at the fish oil capsules or other omega 3 fatty acid sources and ask yourself a question, "Where do these natural compounds come from?" The answer, as well as the impact on the environment, may be surprising.

Figure 1. Selection of fish oil supplements on grocery store shelf

Omega-3 fatty acids, popularly known as "fish oil" are fats commonly found in marine plant and algae sources. Since these specific fats are produced by algae in the marine environment they are, in fact, plant fats. Marine sources (fatty fish like salmon, mackerel and sardines and other seafood such as krill) provide eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), and plant sources like flax, walnuts, canola oil provide α-linolenic acid (ALA).

Here is a brief description of each type of Omega 3[1]:

DHA, a long chain omega-3 fatty acid, is the most abundant omega-3 in the brain and retina. It is also an important structural component of heart tissue and naturally found in breast milk.

EPA, a long chain omega-3 fatty acid, is important for human health. However, unlike DHA, EPA is not stored in significant levels in the brain and retina and is not considered a significant structural part of the body.

ALA, an essential fatty acid (EFA), is a shorter-chain omega-3 fatty acid that serves as a source of energy. It is also a precursor for EPA and DHA and is needed for skin health. Studies have shown that approximately 8% of dietary ALA is converted to EPA and 0-4% to DHA in healthy young men and around 21% of dietary ALA is converted to EPA and 9% to DHA in healthy young women.[2] Plant sources like flaxseed and canola oil contain ALA. But they don't contain DHA or EPA.

[1] http://www.lifesdha.com/what-is-dha/the-omega-3-facts.aspx
[2] http://lpi.oregonstate.edu/infocenter/othernuts/omega3fa/

Omega 3 chemistry

Omega 3's are polyunsaturated fatty acids with the double bond in the third carbon position from the methyl terminal (hence the use of "3" in their description).

How does this production happen? Omega 3s are produced as a part of photosynthesis in the Calvin cycle. So, instead of just manufacturing glucose and oxygen marine plants and algae produce this valuable commodity.

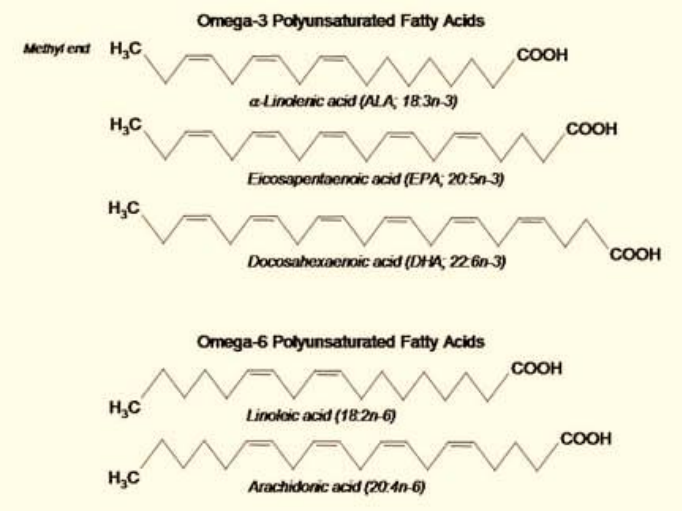


Figure 2. Omega 3 & 6 Fatty Acid Structures

Summary of Recommendations for Omega-3 Fatty Acid Intake

Population	**Recommendation**
Patients without documented Coronary Heart Disease (CHD)	Eat a variety of (preferably oily) fish at least twice a week. Include oils and foods rich in α-linolenic acid (flaxseed, canola, and soybean oils; flaxseed and walnuts)
Patients with documented CHD	Consume ≈1 g of EPA+DHA per day, preferably from oily fish. EPA+DHA supplements could be considered in consultation with the physician.
Patients needing triglyceride lowering	Two to four grams of EPA+DHA per day provided as capsules under a physician's care

(http://www.heart.org/HEARTORG/GettingHealthy/NutritionCenter/HealthyEating/Fish-101_UCM_305986_Article.jsp)

In January 2017, FDA and EPA issued draft updated advice for fish consumption to encourage pregnant women, breastfeeding mothers, and young children to eat more fish (8 to 12 ounces each week) because the Omega 3 fatty acids in fish is important during growth and development before birth, in early infancy for breastfed infants, and in childhood. (https://www.fda.gov/Food/ResourcesForYou/Consumers/ucm393070.htm)

Other Fatty Acids

In addition to omega 3 fatty acids there are omega 6 and omega 9. Omega 6 fatty acids are represented by linoleic acid (LA). The typical American diet contains about 15-17 times more omega-6 fatty acids than omega-3 fatty acids[3].

A healthy diet however contains a balance of omega 3 and omega 6 fatty acids. Omega 3 tends to reduce inflammation and omega 6 can promote inflammation. Most omega 6 in the diet comes from vegetable oils.

Omega 9 fatty acids are represented by oleic acid (OA) and are monounsaturated containing only one double bond. Omega 9 fatty acids are non-essential since they can be manufactured by the human body. Research indicates that supplemental Omega 9 in our diet can provide metabolic health benefits. One excellent source is olive oil.

Table 1 below lists some omega fatty acid food sources.

Figure 3. (Top) Selection of salad dressing on grocery store shelf
Figure 4. (Bottom): Selection of vegetable oils on grocery store shelf

Table 1. Dietary Sources of Omega Fatty Acids

Fatty Acid	Food Sources
Omega-3 types	
EPA (eicosapentaenoic acid)	Fish, fish oils, marine sources
DHA (docosahexaenoic acid)	Fish, fish oils, specialty egg/dairy products
ALA (alpha-linolenic acid)	Flaxseed oil, canola oil and walnuts
Omega-6 types	
LA (linoleic acid)	Avocados, Vegetables oils (corn, safflower, soybean, sunflower)
AA (arachidonic acid)	Meat, eggs
Omega-9 types	
Oleic acid, Erucic acid	Nuts (almonds, macadamia, hazelnuts, pecans), olives, olive oil, canola oil

[3] https://www.ncbi.nlm.nih.gov/pubmed/12442909

Table 2. EPA and DHA Contents of Oil from Marine Animals and Plants

EPA and DHA Contents of Oil from Marine Animals and Plants (g/100g oil)							
Biological Sources	EPA	DHA	EPA+DHA	Biological	EPA	DHA	EPA+DHA
Pacific Squid	12.2	39.4	51.6	Ribbonfish	5.8	14.4	20.2
Cuttlefish	14.0	32.7	46.7	Mackerel	8.0	9.4	17.4
Cod	16.5	29.5	46.0	Pacific saury	4.9	11.0	15.9
Big eye tuna	3.9	37.0	40.9	Sea eel	4.1	16.5	20.6
Spanish mackerel	8.4	31.1	39.5	Oyster	25.8	14.8	40.6
Skipjack	10.4	26.5	36.9	Scallop	17.2	19.6	36.8
Yellow fin tuna	5.1	26.5	31.6	Blood clam	23.1	13.5	36.6
Shark	5.1	22.5	27.6	Razor clam	15.0	20.6	35.6
Salmon	8.5	18.2	26.7	Hard clam	19.2	15.8	35.0
Blue fin tuna	8.7	18.8	27.5	Clam	18.4	11.3	29.7
Sardine	16.8	10.2	27.0	Swimming crab	15.6	12.2	27.8
Japanese Mackerel	9.1	16.1	25.2	Prawn	14.6	11.2	25.8
Yellow croaker	5.3	16.3	21.6	Chlorella	35.2	8.7	43.9
Horse Mackerel	8.3	12.7	21.0	Spirulina	32.8	5.4	38.2

Source: Comprehensive Utilization of Marine Bioresources, (C. Liu, ed.), Chemistry Industry Press, Beijing, China. 2006.

Why Omega 3 fatty acids are an important issue

Omega 3 fatty acids are considered "essential" fatty acids: they are necessary for human health but can't be manufactured by the human body and need to be obtained through food. Like us, fish are in the same boat, they also lack the ability to produce omega 3 fatty acids.

Figure 5. School of menhaden, Baltimore Inner Harbor, July 2010. SONY HDR-XR500V in underwater housing.

Omega 3s claims as a defense against ailments are far and wide – from heart disease to depression. Since 2006 the

U.S. market for Omega 3 supplements has doubled.[4] Omega 3 supplements have been added to a variety of food items from infant formula to breakfast cereals to eggs. The best source of Omega 3 is oily fish like salmon, mackerel and sardines.

Fish Oil, really?

The fish *that we come to think of as a dietary source of Omega 3 Fatty acids actually can't synthesize the Omega 3's; they obtain them from the food they eat in the marine environment.*

The fish we come to think of the best sources of Omega 3 feed on a smaller fish lower on the food chain. These smaller fish, like the Atlantic menhaden, play a major role in the marine ecosystem. Menhaden are inedible by people because of their foul smell and many tiny bones. Menhaden and other fish like sardines and herring eat algae and zooplankton by swimming through the water with their mouth open and filtering out plankton with their gills. As a result their omega 3 contents get passed along the food chain to the larger fish that prey on menhaden. This process is known as bioaccumulation and is the reason that the consumption of fish is part of a healthy diet. In general, the higher a fish is on the food chain the higher its concentration of omega-3 fatty acids. Although the benefits of Omega 3 seem to be agreed upon there can be concerns. One problem is that fish high on the food chain may also contain risk levels of toxic substances such as mercury.

Omega 3s are an important issue not only for human health but also related to maintaining healthy marine ecosystems as you'll see in the following section.

[4] http://www.time.com/time/magazine/article/0,9171,1953700,00.html

Overfishing

Widespread overfishing began in the mid-20th century, when efforts were made to increase fishing capacity. In 1989 about 90 million tons of catch were taken from the ocean and yields have declined since.[5] Currently, almost 90% of the world's seafood stocks are overfished.[6] Of the 600 marine fish stocks monitored by the Food and Agriculture Organization a full 7% are depleted. In the U.S., the seafood trade deficit totaled more than 14 billion in 2016, the largest amount among agriculture products.[7] That means, "catches are well below historical values, irrespective of the amount of fishing effort extended".[8]

Menhaden populations have risen and fallen in the past 55 years[9] and scientists fear that they along with other small species of fish are being overfished for oil supplements**.** In fact, 13 of 15 Atlantic states have banned a fish oil company that catches 90% of the country's menhaden.[10] The concern is that there may not be a sustainable supply in the future if these types of fish are overharvested. Menhaden can be caught and processed cheaply. But how long will they be around if we keep catching them?

Figure 6. Map of Atlantic States Menhaden Fishing Ban. Inset photo, Menhaden in pursed seine[11]

[5] http://ocean.nationalgeographic.com/ocean/critical-issues-overfishing/
[6] https://www.chesapeakequarterly.net/V17N1/main1/
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Sustainability

Are there sustainable ways of getting DHA & EPA Omega 3s? Contrary to popular belief, it is not necessary to eat fish to get these Omega 3s. There are other ways to get Omega 3s, "including the way the fish get them. They eat them. They get them with the plankton that they consume", says Oceanographer Silvia Earle.[12]
Again, since marine algae manufacture omega 3 then why not go to the source for supplements instead of grinding up fish valuable to the marine ecosystem? That is what some companies like Martek/DSM (http://www.lifesdha.com) are doing by manufacturing DHA straight from the algae source itself and eliminating the need for capturing fish. These companies raise algae in fermentation tanks for DHA and some EPA production. Algae based supplements are rich in DHA and may be better than consuming other vegetarian supplements like flaxseed, canola and walnut oil that only provide ALA. Another company, Veramaris, is taking DHA and EPA production from algae to the next level. Their focus is to use the algal products as a replacement for fishmeal in aquaculture and agriculture feeds. According to Veramaris, in 2016, a total of 16 million metric tons of wild-caught fish were used to produce fish oil and fishmeal.

Research at the Institute of Marine and Environmental Technology (IMET) in Baltimore Maryland is also providing valuable evidence for sustainability as it applies to the field of aquaculture. One issue with aquaculture is that it requires as many fish to make fish meal (food) as are produced in an aquaculture system. This pressure on the marine environment places aquaculture on the fine line of sustainability. However, if the food used to feed the fish is vegetarian/algae sourced then the tables may be turned in favor of aquaculture production. IMET research scientists Allen Place and Aaron Watson have met this challenge by developing a food that is vegetarian/algae sourced with the addition of taurine thereby making a connection to producers in the marine food chain and eliminating the need for fishmeal production. The use of algae products from the marine food chain help produce fish with healthier profiles for human consumption by significantly decreasing trace pollutants that can be found in predatory fish like striped bass and cobia. For more information about this research read the article in the Baltimore Sun listed in the References.

So the next time you are on a trip to the grocery store, health food store, or other health supply outlet take the time to consider alternative options for fish oil supplements as well as other food sources that are high in Omega 3 and 9. Look for supplements that are produced from algae culture like those mentioned in the article and you can become a contributing member to fisheries sustainability. In the end, remember it's not fish oil in that capsule or delicious filet that you are going to have for dinner but omega 3 fatty acid manufactured from algae - Really.

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[12] http://www.npr.org/2012/04/20/151047262/exploring-the-deepest-darkest-spots-on-earth

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