



Benefits of Fish oil in the diet

Replacing essential fatty acids with fish oil



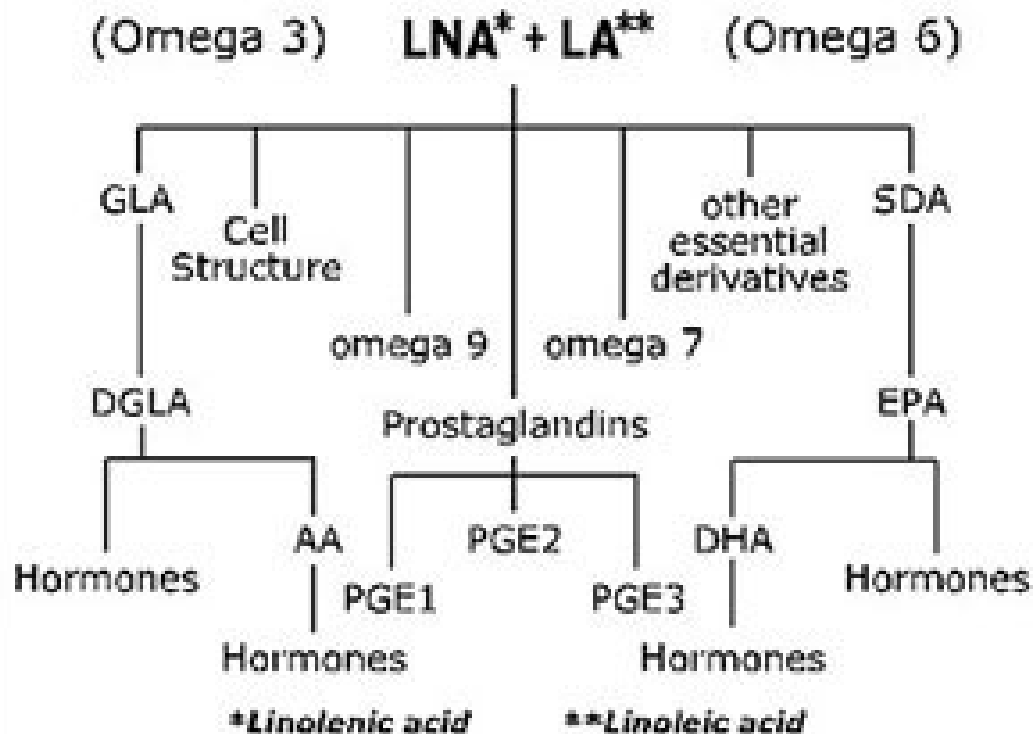
What are essential fatty acids?

- Essential for survival
- Not naturally produced in the body
- Must be obtained from the diet
- EFAs are long-chain polyunsaturated fatty acids derived from linolenic, linoleic, and oleic acids.
- EFAs support the cardiovascular, reproductive, immune, and nervous systems. The human body needs EFAs to manufacture and repair cell membranes and for production

Essential Fatty Acids

Essential Fatty Acids

*Critical parent components
for many body functions and structures*

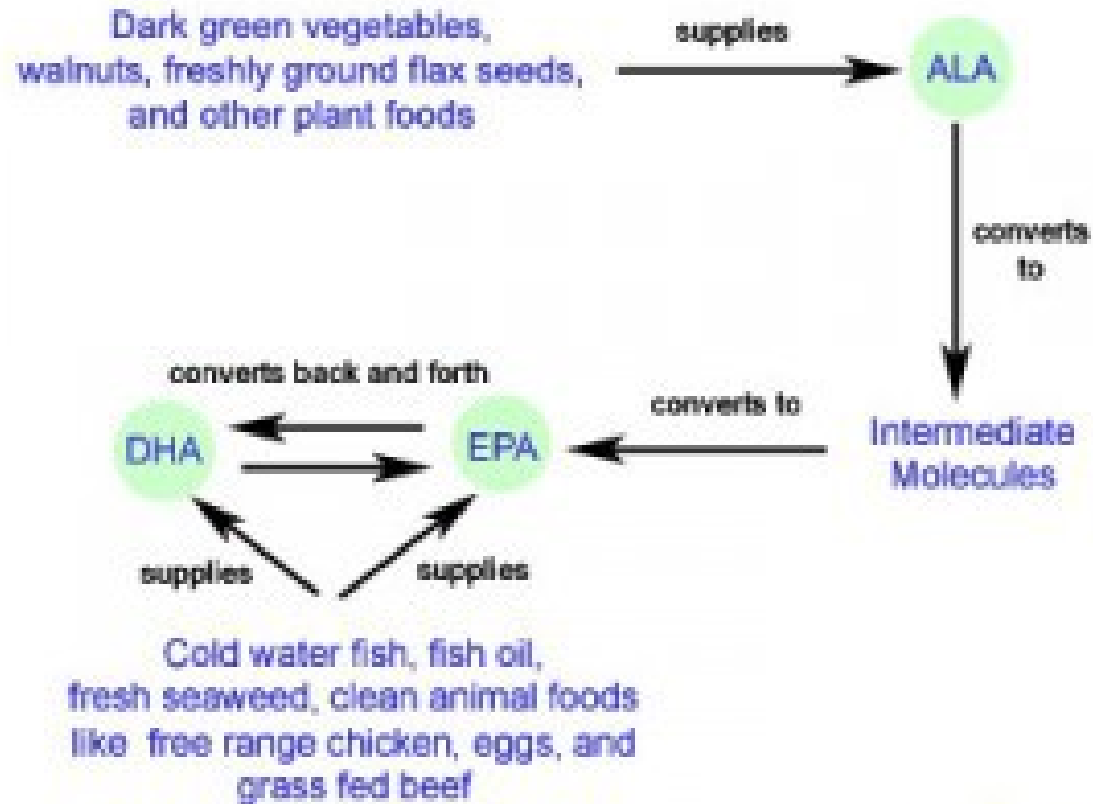


Source: <http://drpinna.com/all-omega-3s-are-not-equal-13333>

Essential Fatty Acids

- Needed for proper development in children: neural development and maturation of sensory systems
- EFA deficiency is common in the United States, particularly Omega-3 deficiency.
- No RDA (recommended dietary allowance) for EFAs
- Requirement for men may be higher than women
- Conditions of disease or stress modify EFA

Essential Fatty Acids



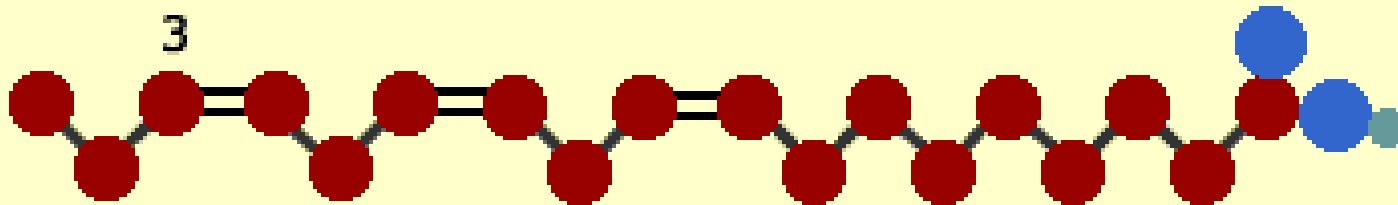
drbenkim.com

Source: <http://www.crossfitsouthbay.com/2012/03/why-fish-oil-3/>

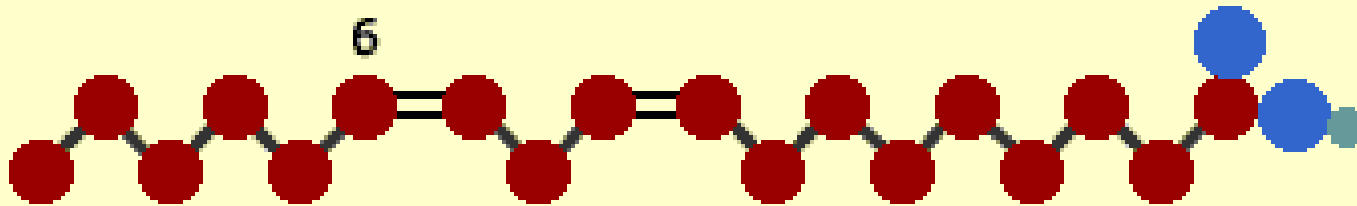
Essential Fatty Acids

- The minimum healthy intake for both linolenic (Omega-3) and linoleic (Omega-6) acid via diet, per adult per day, is 1.5 grams of each.
- High heat destroys linolenic acid. Cooking in linolenic-rich oils or eating cooked linolenic-rich fish is unlikely to provide a sufficient amount.
- EFA deficiency and Omega 6/3 imbalance is linked with serious health conditions, such as heart attacks, cancer, insulin resistance, asthma, lupus, schizophrenia, depression,

Essential Fatty Acids



Alpha-Linolenic acid (omega 3)



Linoleic acid (omega 6)

Source: <http://www.siberiantigernaturals.com/omega3.htm>

Essential Fatty Acids

- Both EPA and DHA fall into an even larger category of poly-unsaturated fatty acids (PUFAs).
- Compared to saturated fats, PUFAs are more readily used for energy when initially ingested.
- Increasing the degree of unsaturation at a given carbon chain length increases the relative mobility of stored fat, making PUFAs more bioavailable.

Mechanism of Action

- EPA and DHA compete with arachidonic acid (AA) for the enzyme cyclo-oxygenase.
- EPA is converted by platelet cyclo-oxygenase to thromboxane A3 (TXA3), which is only a very weak vaso-constrictor, unlike thromboxane A2 (TXA2), which is formed by the action of cyclo-oxygenase on AA and is a strong vasoconstrictor.
- However, prostacyclin I3 (PGI3), formed from EPA in the endothelium, is as potent a vasodilator and inhibitor of platelet aggregation

Mechanism of Action

- 2 EPA yields the 5-series of leukotrienes, which are only weakly chemotactic. A relative reduction in chemotaxis might be expected to be antiatherogenic.
- Fish oil decreases both very low density lipoproteins (VLDLs) and triglycerides due to inhibition of hepatic triglyceride synthesis.
- Because VLDL is a precursor to LDL, a reduction in LDL cholesterol is seen in some patients with hypertriglyceridemia; however, fish oil does not appear to lower plasma

Types of Essential Fatty Acids

- Omega -3
- Omega-6
- Omega-9

Omega-3

- Omega-3
 - ▣ Produced modestly in the body
 - ▣ Need dietary intake to meet body's needs
 - ▣ Helps organ function, cell activities, cell wall formation, oxygen circulation, red blood cells
 - ▣ Deficiency in the diet can cause blood clots, memory problems, vision problems, irregular heartbeat, decreased immune function, increased triglycerides and "bad" cholesterol (LDL) levels, impaired membrane function, hypertension

Omega-3

- Sources: flaxseed oil, walnuts, sesame seeds, hempseed oil, hempseeds, pumpkin seeds, Brazil nuts, avocados, some dark leafy green vegetables (kale, spinach, purslane, mustard greens, collards, etc.), canola oil (cold-pressed and unrefined), soybean oil, wheat germ oil, salmon, mackerel, sardines, anchovies, albacore tuna, and others.

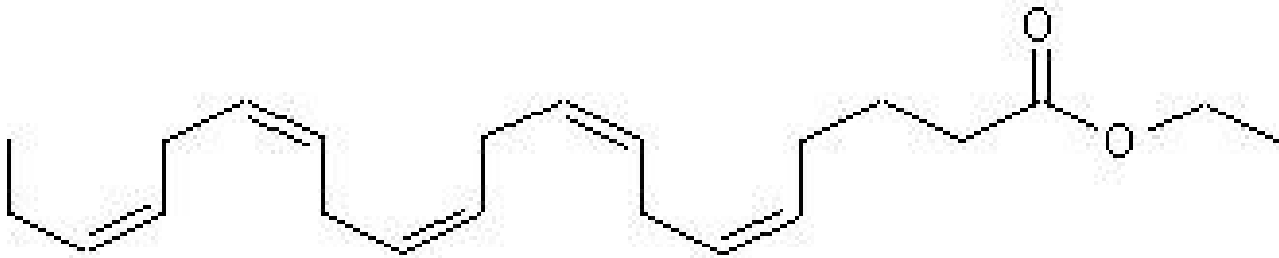
Omega-3

- Alpha Linolenic Acid (ALA) is the principal Omega-3 fatty acid, which a healthy human will convert into eicosapentaenoic acid (EPA), and later into docosahexaenoic acid (DHA).
- EPA and the GLA synthesized from linoleic (Omega-6) acid are later converted into hormone-like compounds known as eicosanoids, which aid in many bodily functions including vital organ function and intracellular activity.

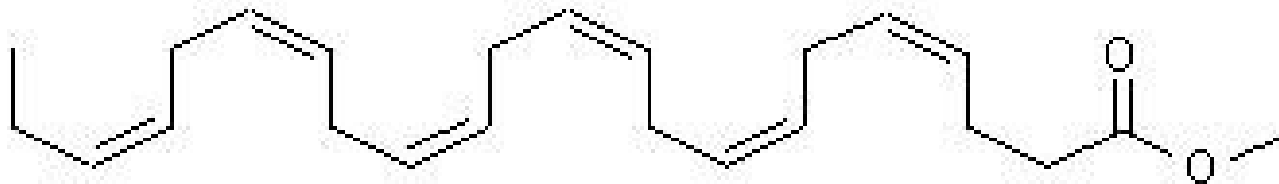
Omega-3

- Two crucial Omega 3s: EPA and DHA
- Primarily found in certain fish
- Plants like flax contain ALA, an omega-3 fatty acid that is partially converted into DHA and EPA in the body.
- Algae oil often provides only DHA.
- DHA and EPA are found together only in fatty fish and algae.

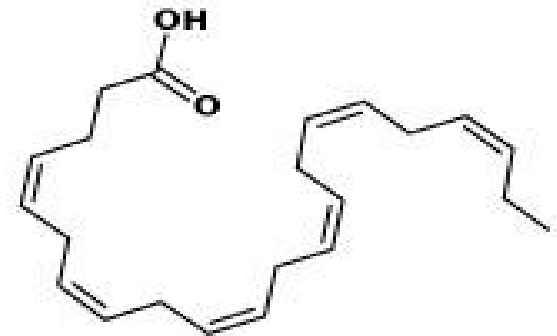
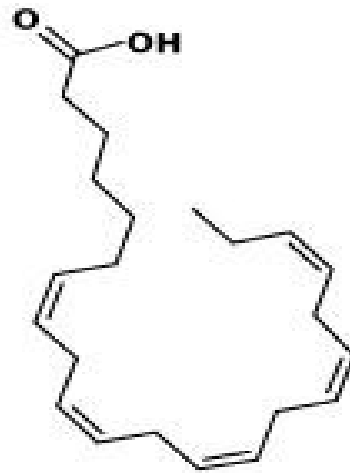
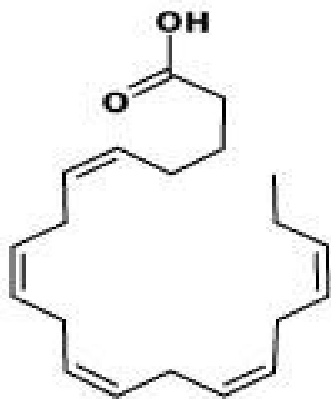
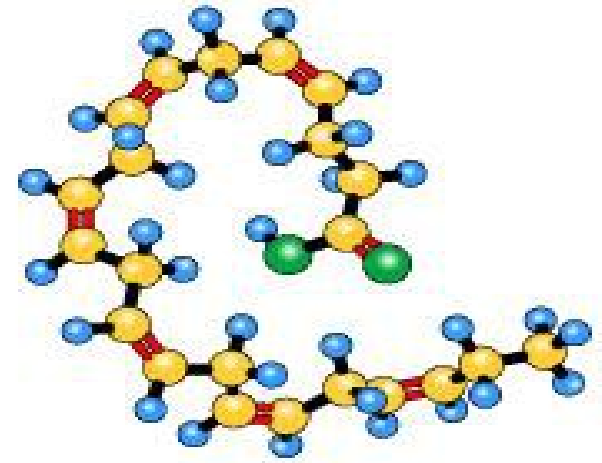
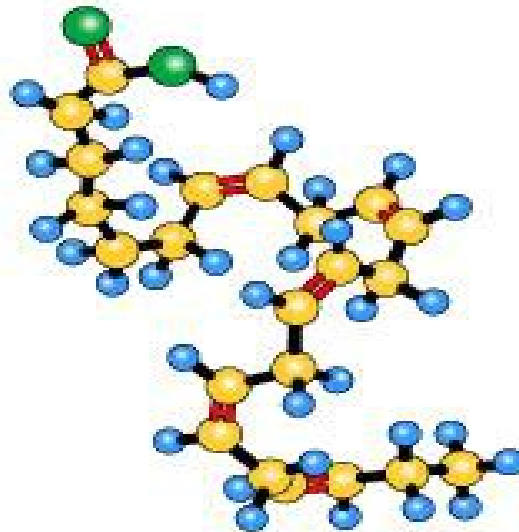
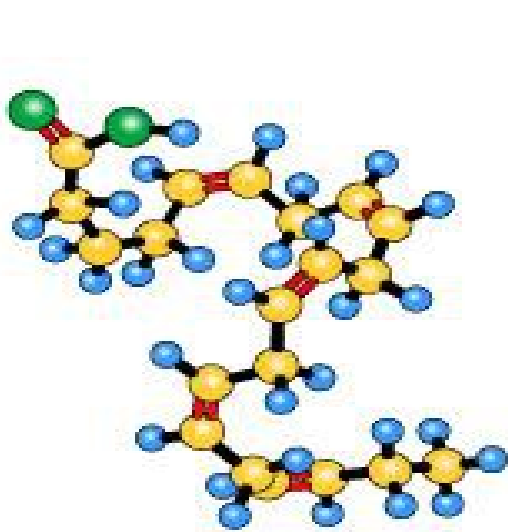
Omega-3



EPA: ethyl ester of eicosapentaenoic acid



DHA: ethyl ester of docosahexaenoic acid



Eicosapentaenoic acid
EPA (20:5n-3)

Docosapentaenoic acid
DPA (22:5n-3)

Docosahexaenoic acid
DHA (22:6n-3)

Why Fish Oil?

- Popular interest in the health benefits of fish oil was spurred in the 1940s, when a British physiologist theorized that fish oil might be responsible for low rates of heart disease among the Inuit people, despite their high fat intake.
- Fish oil is a rich source of the omega-3 fatty acid eicosapentanoic acid, or EPA, which your body uses to manufacture important anti-inflammatory molecules called eicosanoids.
- Fish oil is also one of only a few dietary

Why fish oil?



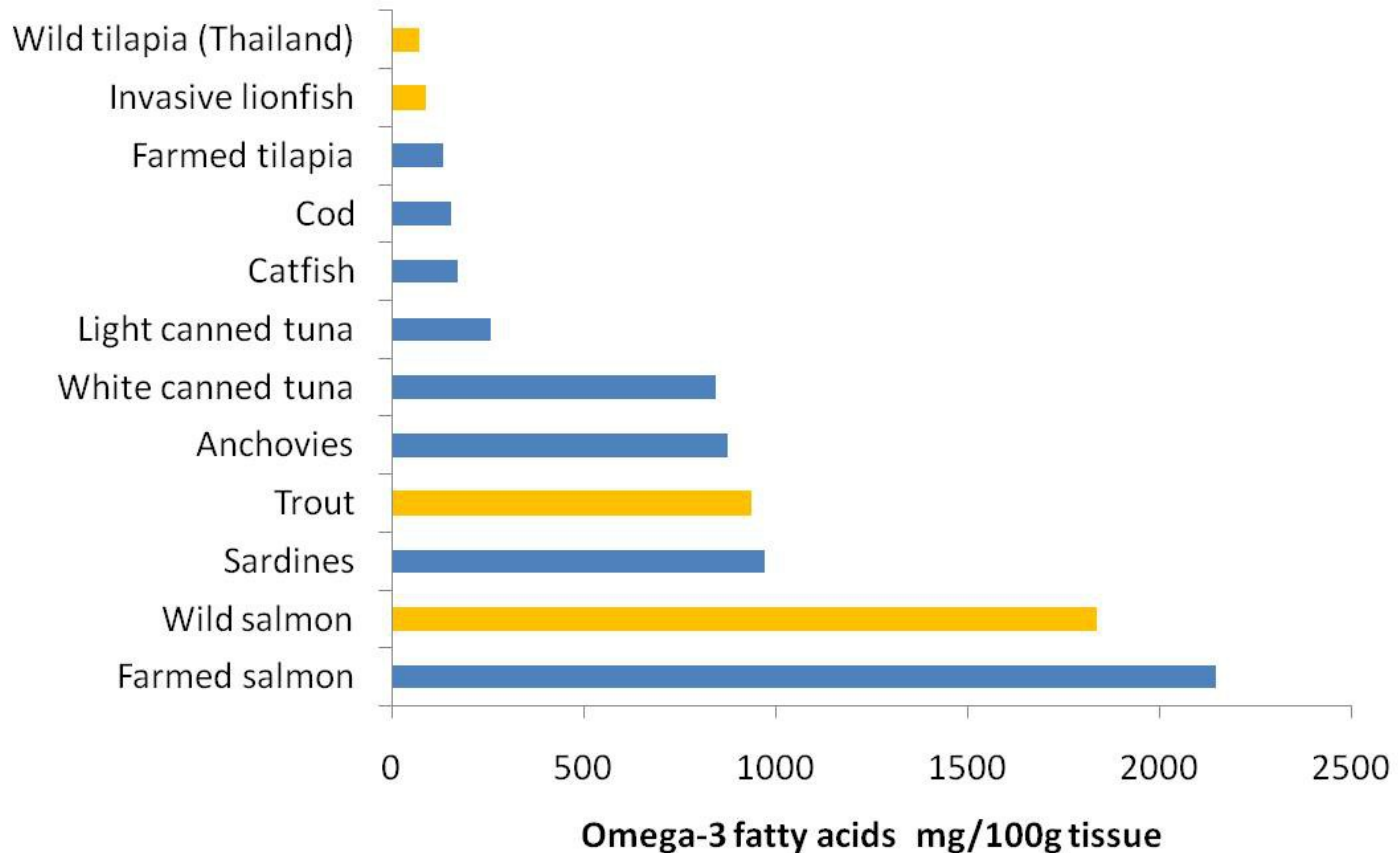
- ✓ Can help reduce risk of heart disease
- ✓ Omega-3s provide other health benefits
- ✓ Other nutrients in fish provide health benefits



- ✓ Can help reduce risk of heart disease
- ✓ Omega-3s provide other health benefits

Source: <http://salmonfarmscience.com/2012/09/18/omega-3-supplements-wont-make-you-healthy-no-kidding/>

Omega 3s found in fish



Source: <http://invasivore.org/2011/05/omega-3-fatty-acids-how-do-edible-invaders-compare/>

	EPA	DHA	ALA
Anchovy, European	0.6	0.9	-
Bass, Striped	0.2	0.6	trace
Bluefish	0.2	0.5	-
Cod, Atlantic and Pacific	trace	0.1	trace
Haddock	trace	0.1	trace
Halibut, Greenland	0.5	0.4	trace
Mackerel, Atlantic	0.9	1.4	0.2
Mackerel, Pacific and Jack	0.6	0.9	trace
Pike, Walleye	trace	0.2	trace
Salmon, Atlantic, Farmed	0.6	1.3	trace
Salmon, Atlantic, Wild	0.3	1.1	0.3
Salmon, Chinook	1.0	0.9	trace
Salmon, Coho, Farmed	0.4	0.8	trace
Salmon, Coho, Wild	0.4	0.7	0.2
Salmon, Pink	0.4	0.6	trace
Salmon, Pink, Canned ^c	0.9	0.8	trace
Salmon, Sockeye	0.6	0.7	trace
Sardine, Atlantic, Canned in Oil ^d	0.5	0.5	0.5
Trout, Rainbow, Wild	0.2	0.4	0.1
Tuna, Fresh, <u>Bluefin</u>	0.3	0.9	-
Tuna, Light, Canned in Oil ^e	trace	0.1	trace
Tuna, Light, Canned in Water	trace	0.2	trace
Tuna, White, Canned in Oil	trace	0.2	0.2
Tuna, White, Canned in Water	0.2	0.6	trace
Crab, Blue	0.2	0.2	-
Lobster, Northern	-	-	-
Mussel, Blue	0.2	0.3	trace
Oyster, Pacific	0.4	0.3	trace
Scallop, Mixed Sp.	trace	0.1	-
Shrimp, Mixed Sp.	0.3	0.2	trace

Source: <http://www.marksdailyapple.com/omega-3-fish-oil-food-quantities/#axzz2MDZVAoIU>

Omega-3

- Fish high in DHA and EPA omega-3 fatty acids include anchovies, bluefish, herring, mackerel, salmon (wild has more omega-3s than farmed), sardines, sturgeon, lake trout, and tuna.
- Many experts recommend eating these fish two to three times a week.
- Some fish have higher levels of mercury, PCBs, or other toxins. These include wild swordfish, tilefish, and shark.
- Farm raised fish of any type may also have

Benefits of Omega-3

- Blood fat (triglycerides)- Fish oil supplements can cut elevated triglyceride levels. Having high levels of this blood fat is a risk factor for heart disease. DHA alone has also been shown to lower triglycerides.
- Cardiovascular health - appear to lower the overall risk of death from heart disease. Fish oil may reduce arrhythmias, and people who take fish oil supplements after a heart attack cut their risk of having another heart attack. Eating fish once or twice a week seems to significantly lower the risk of stroke.

Benefits of Omega-3

- Rheumatoid arthritis - Fish oil supplements [EPA+DHA] significantly reduced stiffness and joint pain. Omega-3 supplements also seem to boost the effectiveness of anti-inflammatory drugs.
- Depression – Cultures that eat foods with high levels of omega-3s have lower levels of depression. Fish oil also seems to boost the effects of antidepressants. Fish oil may help reduce the depressive symptoms of bipolar disorder.

Benefits of Omega-3

- Prenatal health - EPA and DHA supplementation during pregnancy boost the health of pregnant women and the development of their children. DHA appears to be important for visual and neurological development in infants.
- Asthma - A diet high in omega 3s reduces inflammation, a key component in asthma.
- ADHD – Fish oil may reduce the symptoms of ADHD in some children and improve their cognitive function.

Benefits of Omega-3

- Alzheimer's disease and dementia - Some research suggests that omega-3s may help protect against Alzheimer's disease and dementia.
 - ▣ Recent studies have also evaluated whether the omega-3 supplement DHA can slow the decline seen in those with Alzheimer's dementia or in age-associated memory impairment.
 - ▣ One recent study showed that DHA can be a beneficial supplement and may have a positive effect on gradual memory loss associated with aging.

Health benefit	Proposed mechanism of action	Source
Antidepressant effect	DHA may promote neuronal membrane stability. EPA reduces membrane AA and prostaglandin E2 synthesis, both linked to depression	Su (2009)
Cancer prevention	Suppression of <i>n</i> -6 eicosanoids, altered transcription factor and gene expression activity, altered estrogen metabolism and membrane fluidity; direct inhibition of cyclo-oxygenase-2, which is involved in cancer development	Larsson <i>et al.</i> (2004), World Cancer Research Fund/American Institute for Cancer Research (2007)
Cardiovascular wellbeing	EPA and DHA are anti-arrhythmic agents and help to improve vascular endothelial function, lower blood pressure and serum triglyceride levels. LC3PUFA are also anti-thrombotic and improve plaque stability	Wijendran and Hayes (2004), Ruxton <i>et al.</i> (2005)
Dementia and ARMD prevention	DHA is concentrated in brain and retinal tissue. LC3PUFA have anti-atherogenic, anti-inflammatory, anti-oxidant, anti-amyloid and neuroprotective properties	Johnson and Schaefer (2006)
Immunomodulation	EPA and DHA give rise to resolvins which are anti-inflammatory and inflammation resolving	Calder (2008)
Maintenance of cognition	DHA stimulates neurogenesis, neurotransmission and may protect against oxidative stress in early life	Innis (2007)

Table II.
LC3PUFA and health:
proposed mechanisms of
action

Notes: AA, arachidonic acid; ARMD, age-related macular degeneration; EPA, eicosapentaenoic acid; DHA, docosahexaenoic acid

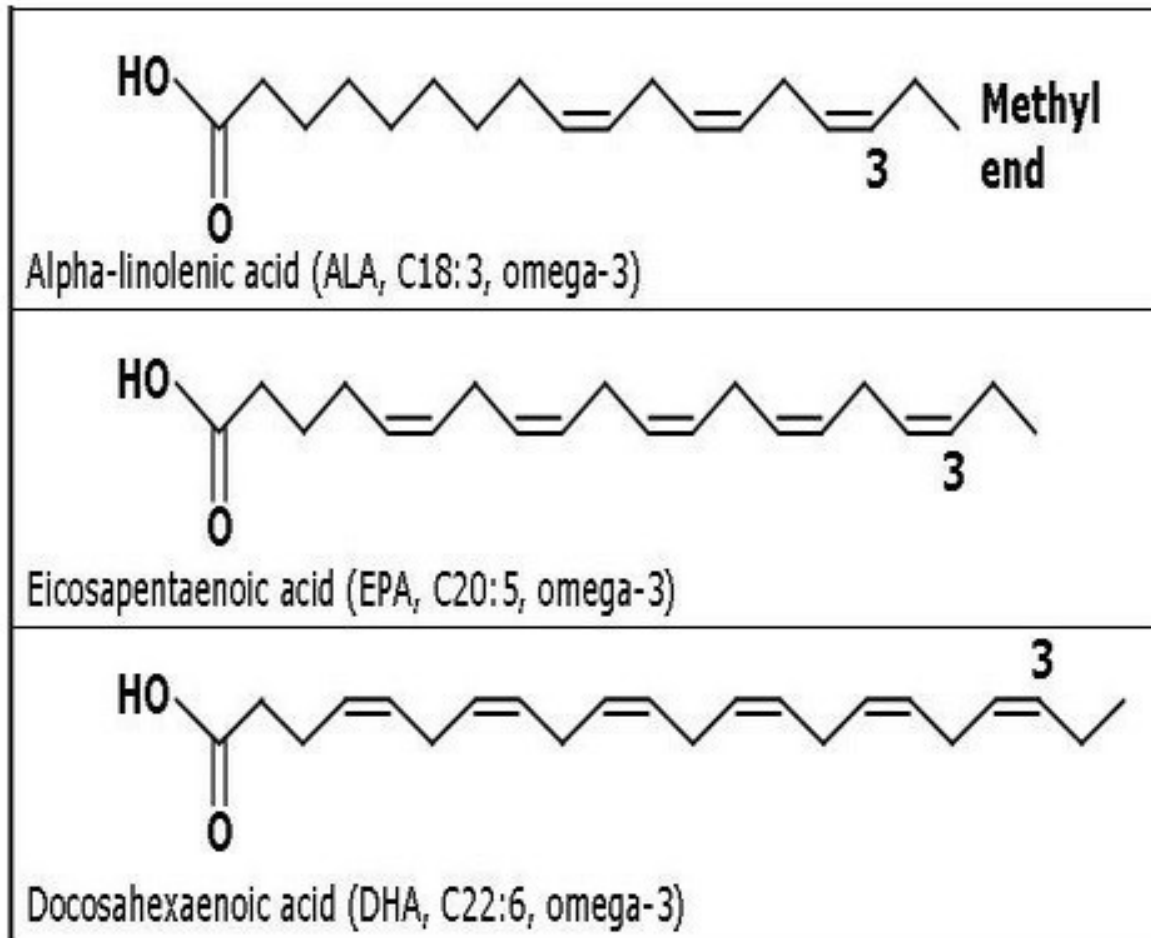
Biochemistry

- Omega 3s are polyunsaturated fatty acids with a double bond (C=C) starting after the third carbon atom from the end of the carbon chain.
- The fatty acids have two ends—the acid (COOH) end and the methyl (CH₃) end.
- The location of the first double bond is counted from the methyl end, which is also known as the omega (ω) end or the n end.

Biochemistry

- Omega-3 fatty acids that are important in human physiology are α -linolenic acid (18:3, $n-3$; ALA), eicosapentaenoic acid (20:5, $n-3$; EPA), and docosahexaenoic acid (22:6, $n-3$; DHA).
- These three polyunsaturates have either 3, 5, or 6 double bonds in a carbon chain of 18, 20, or 22 carbon atoms, respectively.
- As with most naturally-produced fatty acids, all double bonds are in the *cis*-configuration, in other words, the two hydrogen atoms are on

Biochemistry



Source: <http://chemistry.tutorvista.com/biochemistry/omega-3-fatty-acids.html>

Omega-6

- Omega-6
 - ▣ Linoleic Acid is the primary Omega-6 fatty acid.
 - ▣ A healthy human with good nutrition will convert linoleic acid into gamma linolenic acid (GLA), which will later be synthesized, with EPA from the Omega-3 group, into eicosanoids.
 - ▣ Some Omega-6s improve diabetic neuropathy, rheumatoid arthritis, PMS, skin disorders (e.g. psoriasis and eczema), and aid in cancer treatment.

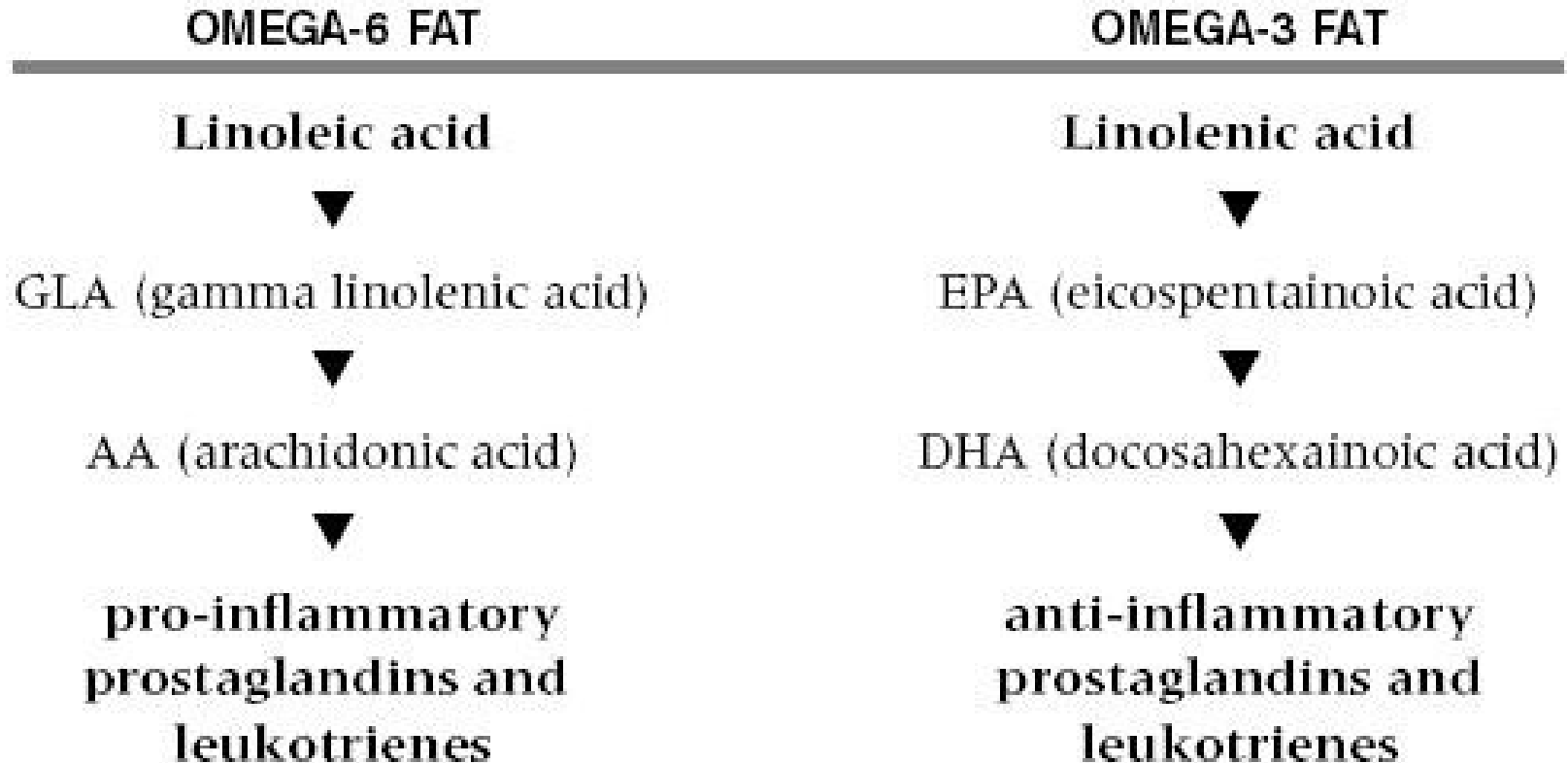
Omega-6

- Although most Americans obtain an excess of linoleic acid, often it is not converted to GLA because of metabolic problems caused by diets rich in sugar, alcohol, or trans fats from processed foods, as well as smoking, pollution, stress, aging, viral infections, and other illnesses such as diabetes.
- It is best to eliminate these factors when possible, but some prefer to supplement with GLA-rich foods such as borage oil, black currant seed oil, or evening primrose oil.

Omega-6

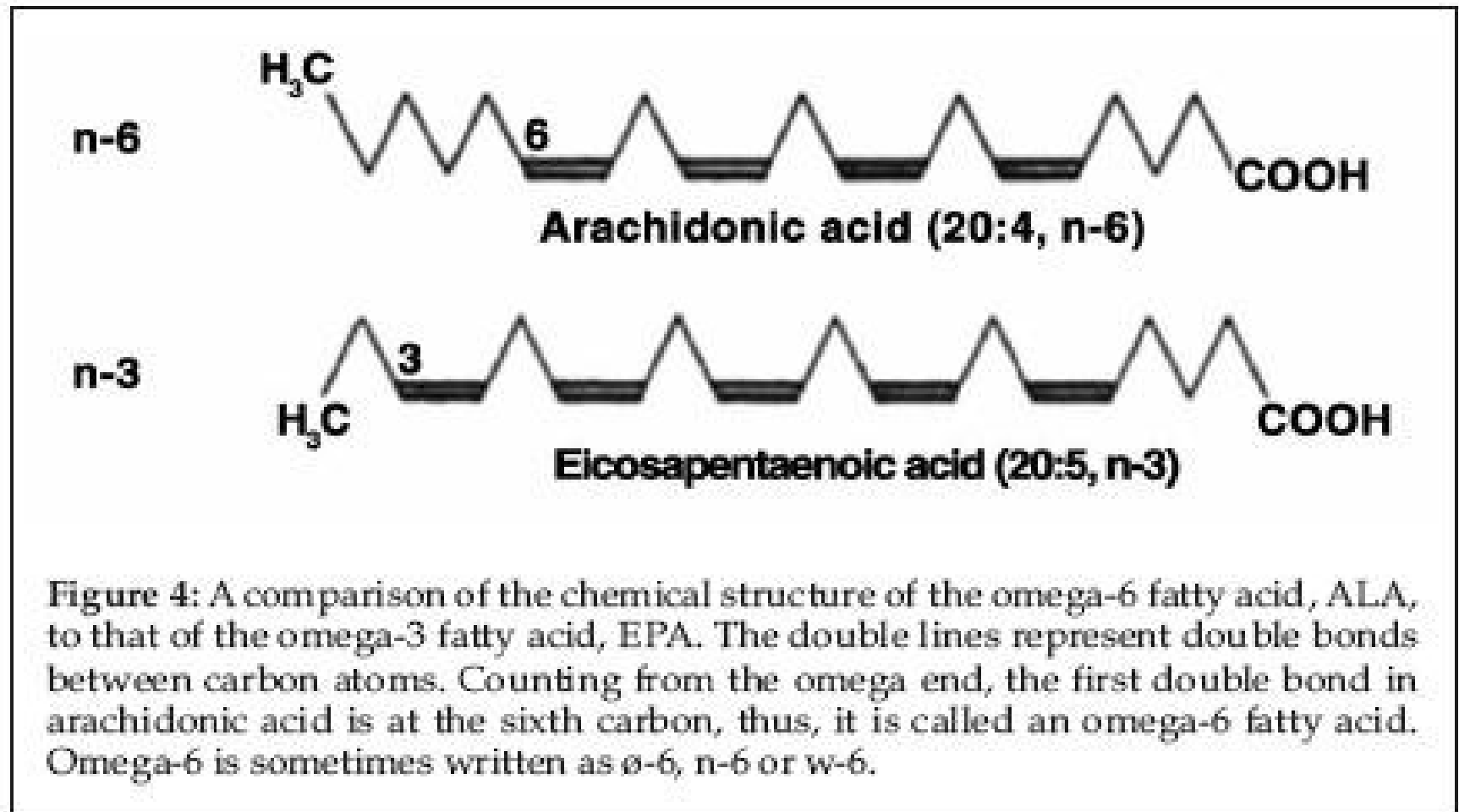
- Sources: Flaxseed oil, flaxseeds, flaxseed meal, hempseed oil, hempseeds, grapeseed oil, pumpkin seeds, pine nuts, pistachio nuts, sunflower seeds (raw), olive oil, olives, borage oil, evening primrose oil, black currant seed oil, chestnut oil, chicken, among many others.
- Avoid refined and hydrogenated versions of these foods.
- Corn, safflower, sunflower, soybean, and cottonseed oils are also sources of linoleic acid, but are refined and may be nutrient-

Metabolic pathway



Source: <http://www.diseaseproof.com/archives/healthy-food-essential-fatty-acids.html>

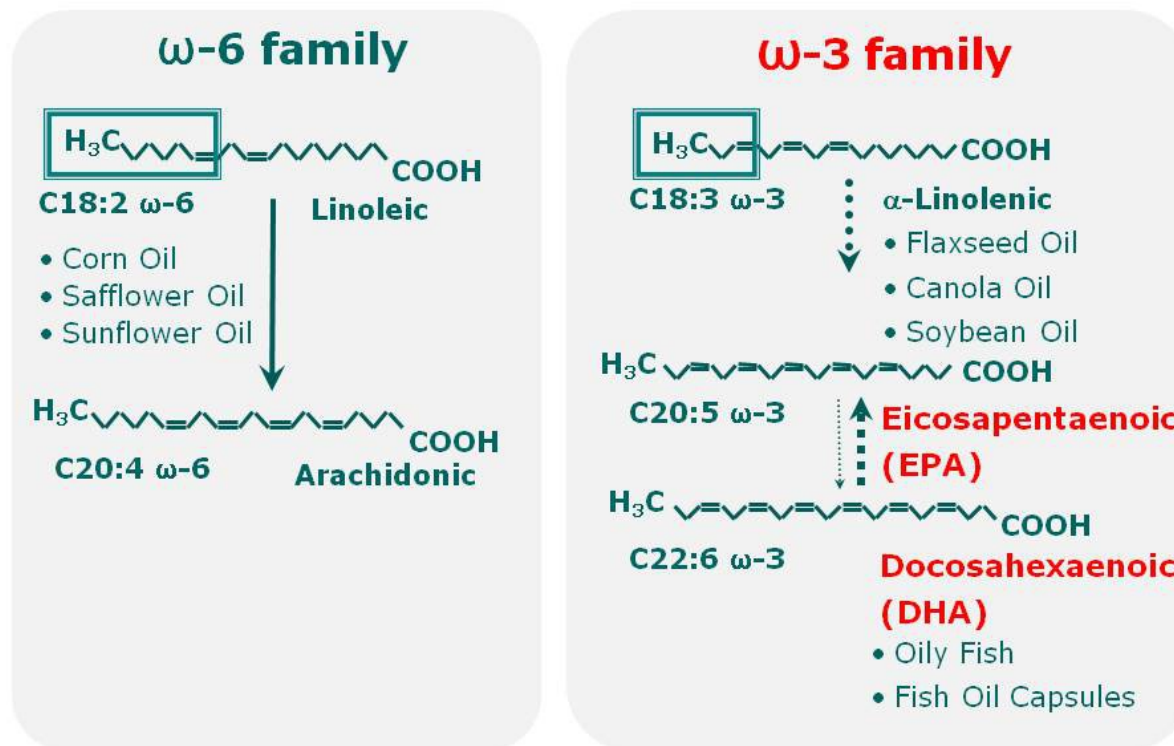
Omega-3 vs Omega-6



Source: <http://www.wholefoodsmagazine.com/columns/vitamin-connection/omega-3-fish-oils-greatest-nutritional-health-discovery-vitamins-part-two>

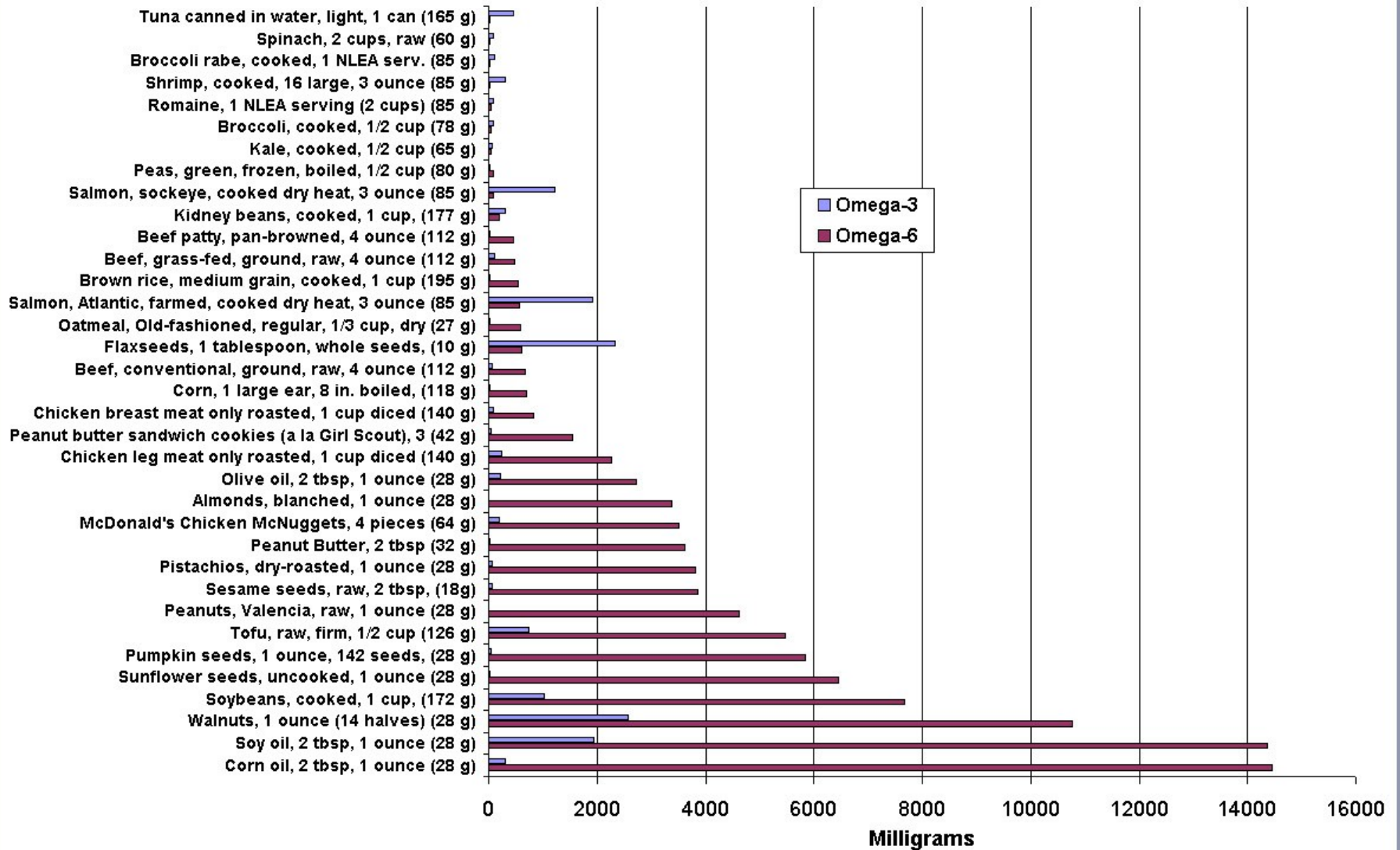
Omega-3 vs Omega-6

Essential Fatty Acid Families



Source: <http://www.omegaquant.com/omega-3-fatty-acids-2/omega-3-biochemistry/>

Omega-6 and Omega-3 in Common Foods



Source: http://www.happyhealthylonglife.com/happy_healthy_long_life/food-rules/page/2/

Ratio

- A healthy diet contains a balance of omega-3 and omega-6 fatty acids. Omega-3 fatty acids help reduce inflammation, and some omega-6 fatty acids tend to promote inflammation.
- Excessive amounts of omega-6 polyunsaturated fatty acids (PUFA) and a very high omega-6/omega-3 ratio, as is found in today's Western diets, promote the pathogenesis of many diseases, including cardiovascular disease, cancer, and inflammatory and autoimmune diseases,

...but excessive amounts of omega-6 PUFA /

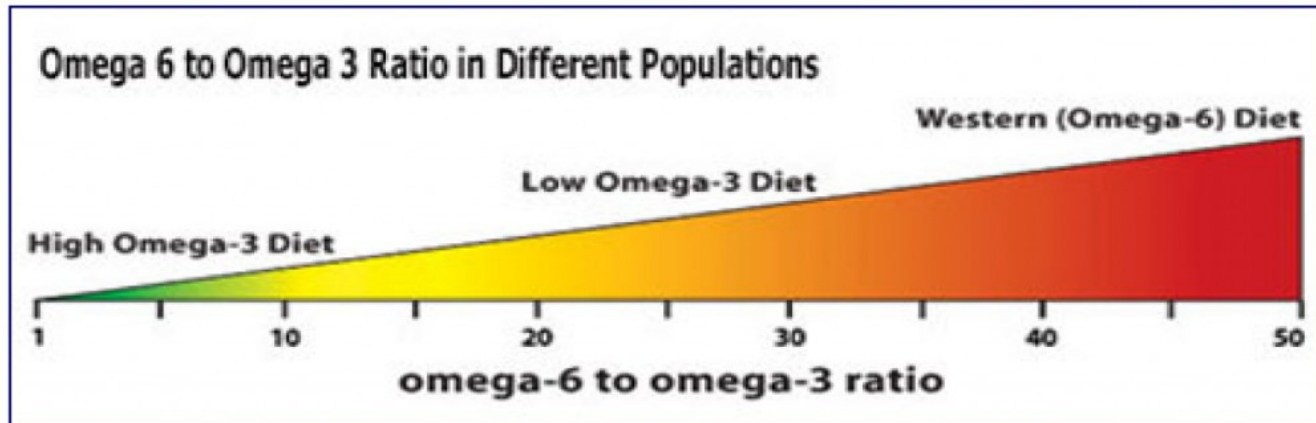
Ratio

- Therapeutic dose of omega-3 fatty acids will depend on the degree of severity of disease resulting from the genetic predisposition.
- A lower ratio of omega-6/omega-3 fatty acids is more desirable in reducing the risk of many of the chronic diseases of high prevalence in Western societies.

Ratio

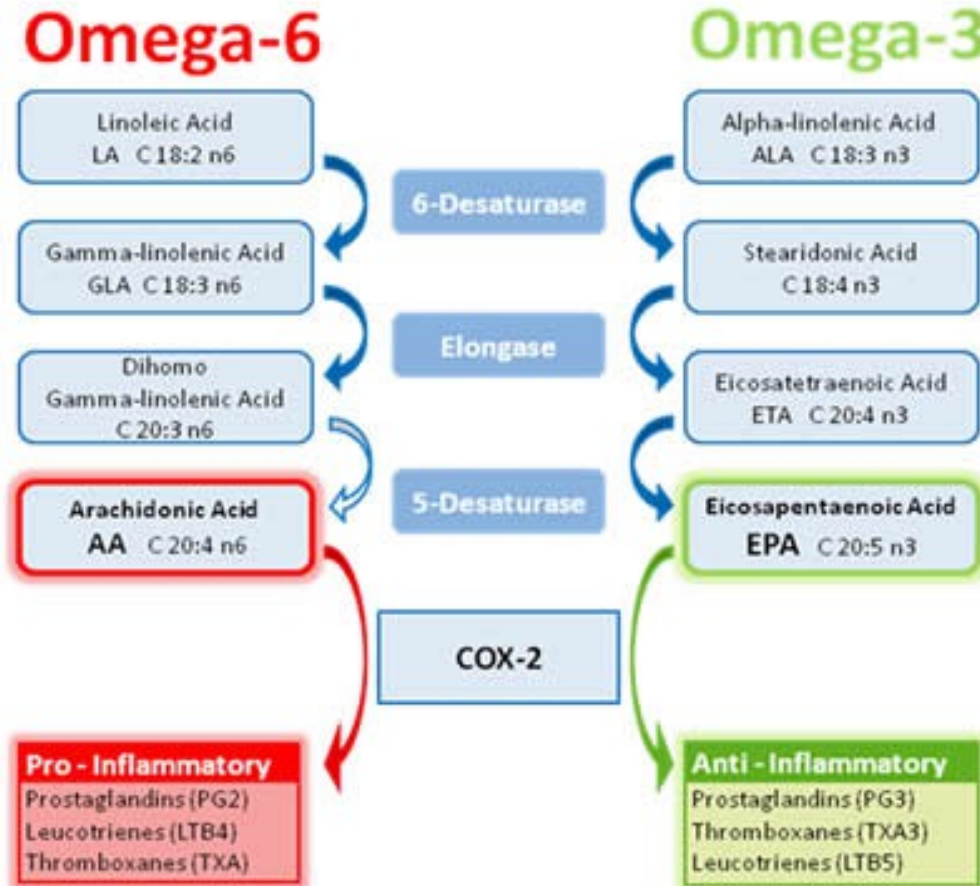


Oil	Omega-6 Content	Omega-3 Content
Safflower	75%	0%
Sunflower	65%	0%
Corn	54%	0%
Cottonseed	50%	0%
Sesame	42%	0%
Peanut	32%	0%
Soybean	51%	7%
Canola	20%	9%
Walnut	52%	10%
Flaxseed	14%	57%
Fish*	0%	100%



Source: <http://www.cholesterolbattle.com/imbalance-omega-3-omega-6-inflammation/>

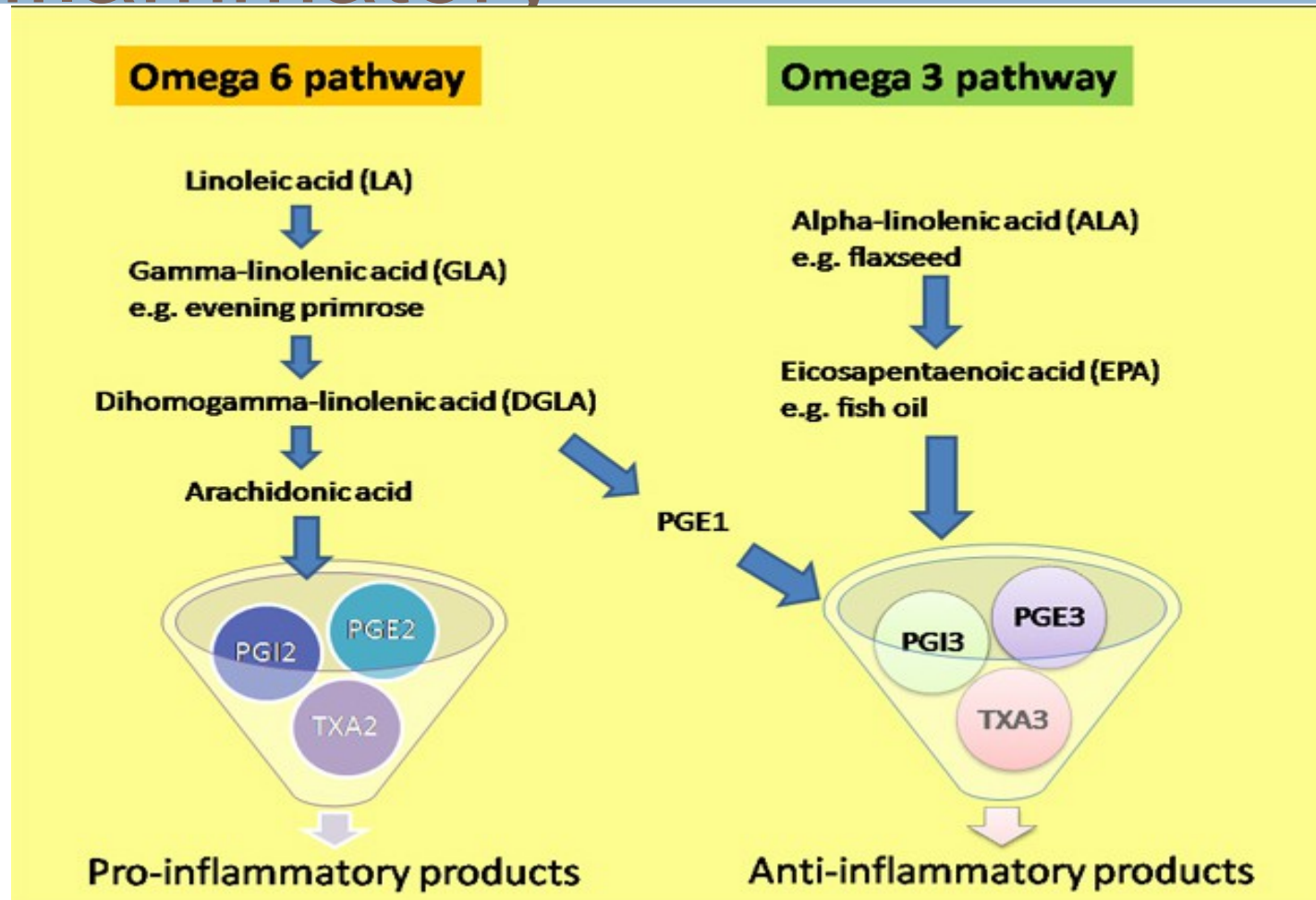
Pro-inflammatory vs Anti-inflammatory



Source:

<http://cardiologydoc.wordpress.com/2012/04/>

Pro-inflammatory vs Anti-inflammatory

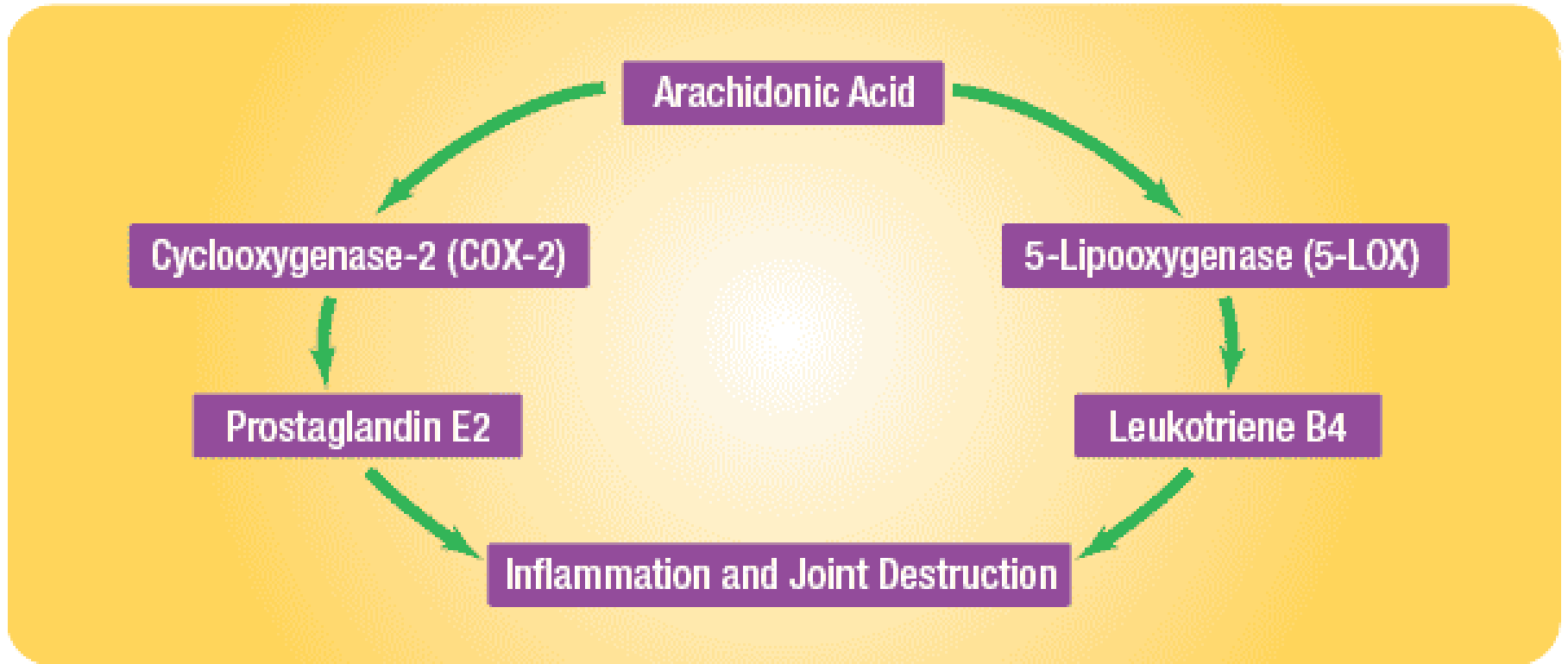


Source: <http://www.cholesterolbattle.com/imbalance-omega-3-omega-6-inflammation/>

Inflammation

- Some Omega 6 fatty acids can reduce inflammation. Not all omega 6s act the same.
- Linoleic acid (LA) - found in cooking oils and processed foods - is converted to GLA and then to arachidonic acid (AA) and/or Dihomogamma-linolenic acid (DGLA)
- AA can be consumed directly from meat
- LA and AA tend to promote inflammation
- Gamma-linoleic acid (GLA) may reduce inflammation

Inflammation



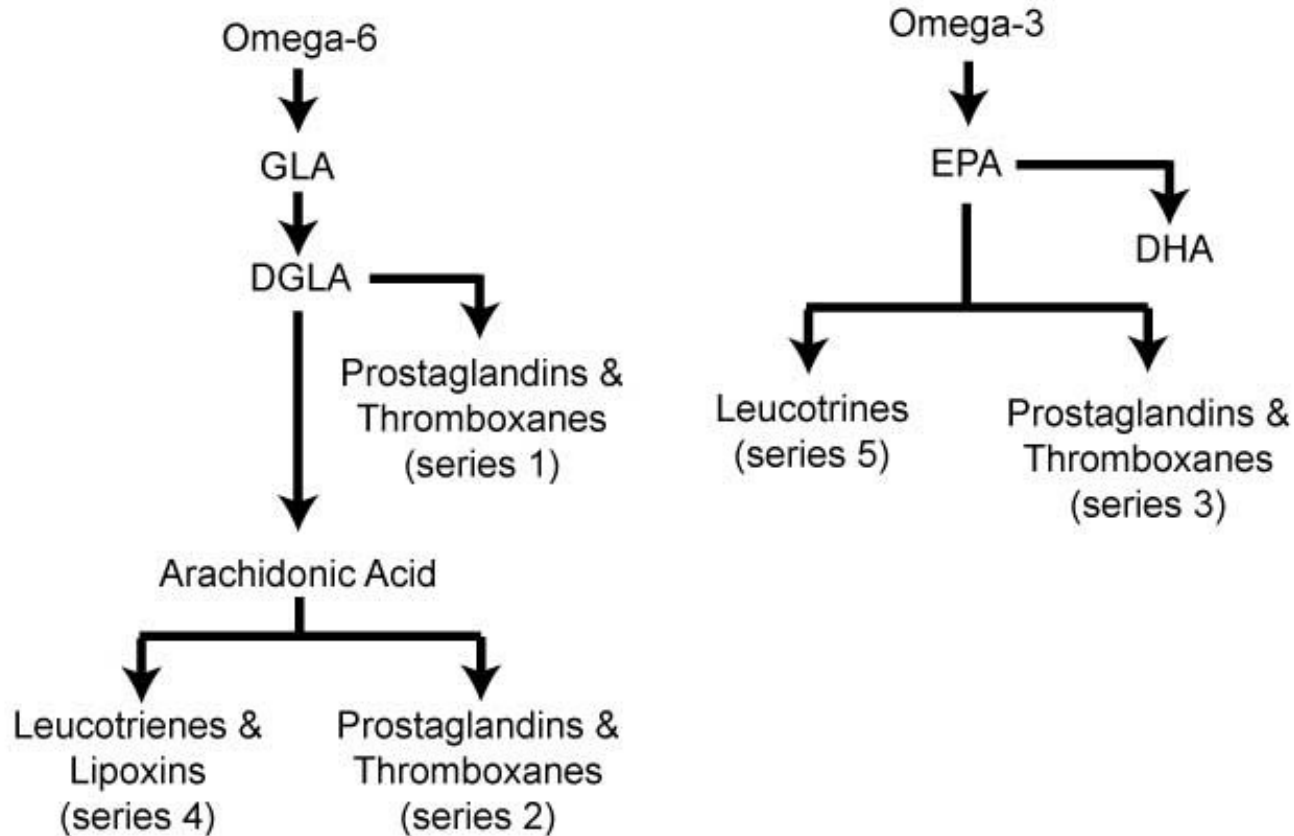
Source:

http://www.lef.org/magazine/mag2004/dec2004_supp_joints_01.htm

Inflammation

- GLAs taken from certain oils (plant seed oils like evening primrose, black currant, borage, and fungal oils – also spirulina – or blue green algae) or as a supplement are converted to DGLA instead of AA.
- DGLA competes with AA and prevents negative inflammatory effects
- Having adequate amounts of certain nutrients in the body like magnesium, zinc, vitamin C, B3, and B6 help promote conversion of GLA to DGLA instead of AA

Routes of Omega-6 and Omega-3



Source: <http://www.modernherbalmedicine.com/articles/fat-facts-2.html?page=4>

Omega 9

- ▣ Essential but technically not an EFA, because the human body can manufacture a limited amount, provided essential EFAs are present.
- ▣ Monounsaturated oleic acid lowers heart attack risk and arteriosclerosis, and aids in cancer prevention
- ▣ Olive oil (extra virgin or virgin), olives, avocados, almonds, peanuts, sesame oil, pecans, pistachio nuts, cashews, hazelnuts, macadamia nuts, etc.
- ▣ One to two tablespoons of extra virgin or virgin olive oil per day should provide sufficient oleic acid for adults.

Supplements

- Fish oil supplements are usually made from mackerel, herring, tuna, halibut, salmon, cod liver, whale blubber, or seal blubber. Fish oil supplements often contain small amounts of vitamin E to prevent spoilage. They might also be combined with calcium, iron, or vitamins A, B1, B2, B3, C, or D.
- Fish oil is **LIKELY SAFE** for most people, including pregnant and breast-feeding women, when taken in low doses (3 grams or less per day).

Supplements

□ **Special Precautions & Warnings:**

- **Liver disease:** Fish oil might increase the risk of bleeding.
- **Fish or seafood allergy:** Some people who are allergic to seafood such as fish might also be allergic to fish oil supplements. There is no reliable information showing how likely people with seafood allergy are to have an allergic reaction to fish oil; however, until more is known advise patients allergic to seafood to avoid or use fish oil supplements cautiously.
- **Bipolar disorder:** Taking fish oil might increase

Supplements

- ▣ **High blood pressure:** Fish oil can lower blood pressure and might cause blood pressure to drop too low in people who are being treated with blood pressure-lowering medications.
- ▣ **HIV/AIDS and other conditions in which the immune system response is lowered:** Higher doses of fish oil can lower the body's immune system response. This could be a problem for people whose immune system is already weak.
- ▣ **An implanted defibrillator** (a surgically placed device to prevent irregular heartbeat):

Supplements

- When possible, try to get omega-3 fatty acids from foods rather than supplements.
- Experts usually recommend 1 gram (1,000 milligrams) of DHA and EPA combined from fish oil daily for those with heart disease.
- People with certain health conditions may take doses of up to 4 grams a day -- but only under a doctor's supervision.
- Clinical trials show dosages of 4g/day to be effective.

Supplements

- The most common side effect from fish oil is indigestion and gas. Getting a supplement with an enteric coating might help.
- In high doses -- 3 grams and above -- omega-3 supplements (EPA/DHA) can increase the risk of bleeding. People with bleeding conditions -- or who take medicines that could increase bleeding should talk with their doctor.
- Bleeding-related complications are separate effects for EPA and DHA. DHA has not been associated with bleeding problems.

Dosage

- **300- 500 Milligrams Daily** - For adults with no history of heart disease, the U.S. National Institutes of Health and World Health Organization recommend 300 to 500 mg of DHA and EPA each day.
- **1 Gram Daily** - Practitioners may recommend 1,000 mg of DHA and EPA each day to certain groups of people. The American Heart Association advises people with coronary heart disease to consume one gram of DHA and EPA each day; this

Category	Daily Dosage	Source
Infants (0-12 months)	.50 g of EPA and DHA	Institute of Medicine
Ages 1-3	70 mg DHA (+ EPA)	The Food and Nutrition Board, Institute of Medicine (National Academy of Sciences, U.S.A.)
Ages 4-8	90 mg DHA (+ EPA)	The Food and Nutrition Board, Institute of Medicine (National Academy of Sciences, U.S.A.)
Ages 9-13 (girls/boys)	100/120 mg DHA (+ EPA)	The Food and Nutrition Board, Institute of Medicine (National Academy of Sciences, U.S.A.)
Ages 14-18 (girls/boys)	110/160 mg DHA (+ EPA)	The Food and Nutrition Board, Institute of Medicine (National Academy of Sciences, U.S.A.)
Children with Developmental Coordination Disorder	558 mg EPA/174 mg DHA	Oxford Durham Study
Expecting & Lactating Women	300 mg of DHA	ISSFAL
Adults without documented coronary heart disease (CHD)	650 mg of EPA and DHA	ISSFAL
Adults with documented CHD	1 g of EPA and DHA	American Heart Association
Patients who needs to lower triglycerides	2-4 g of EPA and DHA (under a physician's care)	American Heart Association

Source: <http://allaboutfishoils.wordpress.com/>

Dosage

- For high triglycerides: 1-4 grams/day of fish oils.
- For high blood pressure: Either 4 grams of fish oils or fish oils providing 2.04 grams of EPA and 1.4 grams of DHA per day.
- For atrial fibrillation (one of the chambers of the heart doesn't empty properly and this increases the risk of blood clot formation leading to stroke): Eating tuna or baked or broiled fish providing omega-3 fatty acids (fish oils) one or more times per week seems to

Dosage

- For Raynaud's syndrome: A daily dose of 3.96 grams EPA and 2.64 grams DHA.
- For weight loss: A daily serving of 2-7 ounces of fish containing approximately 3.65 grams omega-3 fatty acids (0.66 gram from EPA and 0.60 gram from DHA).
- For slowing weight loss in patients with cancer: 7.5 grams/day of fish oils providing EPA 4.7 grams and DHA 2.8 grams.
- For improving movement disorders in children with poor coordination (dyspraxia): Fish oils

Dosage

- For treating asthma in children: 17-26.8 mg/kg EPA and 7.3-11.5 mg/kg DHA.
- For preventing and reversing the progression of hardening of the arteries: 6 grams/day of fish oil for the first three months, followed by 3 grams/day thereafter.
- For rheumatoid arthritis: Fish oils providing 3.8 grams/day of EPA and 2 grams/day DHA.
- For attention deficit-hyperactivity disorder (ADHD): A specific supplement containing fish oils 400 mg and evening primrose oil 100 mg

Dosage

- For keeping veins open after coronary bypass surgery: 4 grams/day of fish oil containing EPA 2.04 grams and DHA 1.3 grams.
- For preventing the collapse of arteries opened by “balloon” therapy (PTCA): 6 grams/day of fish oil starting one month before PTCA and continuing one month after PTCA, followed by 3 grams of fish oil daily thereafter for six months.
- For reducing and preventing the long-term continuous rise in blood pressure and to

Dosage

- For preserving kidney function in patients with severe IgA nephropathy: 4-8 grams/day of fish oil has been used.
- For combined high triglycerides and high cholesterol: Fish oils providing EPA 1800-2160 mg and DHA 1200-1440 mg combined with garlic powder 900-1200 mg/day has been used to lower total cholesterol, LDL, triglycerides, and the ratios of total cholesterol to HDL, and LDL to HDL.
- For preventing miscarriage in women with

Sources

- http://en.wikipedia.org/wiki/Omega-3_fatty_acid
- <http://www.mcvitamins.com/essential%20fatty%20acids.htm>
- <http://www.webmd.com/healthy-aging/omega-3-fatty-acids-fact-sheet?page=3>
- <http://www.fitday.com/fitness-articles/nutrition/fats/what-are-essential-fatty-acids.html>
- <http://www.thorne.com/altmedrev/.fulltext/5/6/5>