



Understanding Fatty Acids & Eicosanoids

Everyone needs to eat fats.

Many people try to avoid dietary fat, but fats are critical to human health. The heart depends on fats for energy. Brain tissue, nerve tissue and cell membranes are rich in fats. The fats in our diet become the fatty components in our bodies, so it's crucial that the fats we consume are healthy fats. The building blocks of fats are called fatty acids.

Essential fatty acids must be supplied by the diet and are essential for health.

The body is capable of manufacturing many fatty acids but *essential fatty acids* (EFAs) must be obtained from foods. Two important EFAs, *linoleic acid* (omega-6) and *alpha-linolenic acid* (omega-3), are necessary both for health and for the creation of other fats. Linoleic acid can be converted into arachidonic acid, which is also plentiful in meat and other animal foods. Alpha-linolenic acid can be converted into the long chain fatty acids *docosahexaenoic acid* (DHA) and *eicosapentaenoic acid* (EPA), available from fish and cod liver / fish oils.

Are EPA and DHA essential?

Although EPA and DHA are primarily obtained from foods, the body can use its own enzymes to manufacture these fats (see reverse). This means that EPA and DHA, by strict definition, should not be termed "essential." However, because EPA and DHA are critical for health and many people lack sufficient enzymes to produce these fatty acids effectively (if at all), EPA and DHA are commonly referred to as essential. (Arachidonic acid is considered an essential fatty acid for similar reasons.)

What are omega-6 and omega-3 fatty acids?

The terms "omega-6" and "omega-3" refer to the chemical structure of certain fatty acids. These two types of fatty acids must be balanced in the diet to promote health. The "standard American diet" is overloaded with omega-6 fatty acids from fried foods, processed foods, meats and dairy. Eating too many omega-6 compared to omega-3 fatty acids is associated with inflammation, heart disease, certain cancers and several other disorders. For millenia, ancient human diets likely provided omega-6 and omega-3 EFAs in equal amounts (1:1). Many experts today recommend consuming not more than four times as many omega-6 fatty acids as omega-3 fatty acids (i.e. up to a 4:1 ratio of omega-6:omega-3).

Eicosanoids are hormone-like compounds made from fatty acids.

Eicosanoids (eye-CO-suh-noids) are short-lived chemical compounds. They are derived directly from EPA and arachidonic acid and indirectly from gamma-linolenic acid. Eicosanoids exert powerful, hormone-like influences on biological functions, notably inflammation, and rapidly degrade after producing their effects. Types of eicosanoids include *prostaglandins*, *leukotrienes* and *thromboxanes*.

Why are eicosanoids important?

Eicosanoid compounds control almost every aspect of inflammation. Depending upon the type of EFA from which it is derived, a given eicosanoid may either promote or inhibit inflammatory responses. Inflammation is a positive biological response to infection or injury, but too much inflammation in the body is problematic. Eating more omega-3 fatty acids and less omega-6 fatty acids helps to favor the production of eicosanoids which decrease, rather than promote inflammation.

OMEGA-6 FATTY ACIDS

SOURCES:

vegetable oils (sunflower/safflower/corn), beef, pork, poultry, shellfish

KEY FORMS:

linoleic acid, gamma-linolenic acid (GLA), arachidonic acid

ROLES & RELATED EICOSANOIDS:

- **GLA** (borage, blackcurrant, evening primrose): Helps *mildly reduce inflammation* as indirect precursor of SERIES-1 PROSTAGLANDINS.
- **ARACHIDONIC ACID** (meats, dairy): Moderate amounts necessary for brain structure and overall health. Excess leads to overproduction of *highly inflammatory* SERIES-2 PROSTAGLANDINS and *blood vessel/bronchiole-constricting* SERIES-4 LEUKOTRIENES.

OMEGA-3 FATTY ACIDS

SOURCES:

fatty fish, walnut, flaxseed, hempseed, dark green leafy vegetables

KEY FORMS:

alpha-linolenic acid, EPA, DHA

ROLES & RELATED EICOSANOIDS:

- **EPA** (abundant in fish oils): Helps *reduce inflammation* as direct precursor of anti-inflammatory SERIES-3 PROSTAGLANDINS and SERIES-5 LEUKOTRIENES.
- **DHA** (abundant in fish oils): Required for structure of nerve, eye and brain tissue; helps *reduce inflammation*

REFERENCES

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Essential Fatty Acids: Enzyme Conversion Pathways

Enzymes convert omega-6 and omega-3 fatty acids into chemical compounds that increase or decrease inflammation. Omega-6 fatty acids and omega-3 fatty acids compete for the same enzymes (elongase, desaturases, COX, LOX). To favor the production of compounds that decrease inflammation, consume LESS omega-6 linoleic acid & arachidonic acid, and MORE omega-3 fatty acids and GLA.

OMEGA-6 FATTY ACID PATHWAY

Linoleic Acid 18:2 ω -6

SOURCES: most nut, seed and vegetable oils (safflower, sunflower, sesame, corn, soy, cottonseed)

delta-6-desaturase[†]

[†]ACTIVATED BY: vitamins C, B3 & B6, magnesium, zinc, insulin
[†]INHIBITED BY: aging, alcohol, diabetes, unsaturated and trans fatty acids, high glucose intake (carbs), low protein intake, vitamin/mineral deficiencies

Gamma-Linolenic Acid (GLA) 18:3 ω -6

SOURCES: seed oils of evening primrose, borage & blackcurrant, spirulina, breast milk

elongase

Dihomo-Gamma-Linolenic Acid (DGLA) 20:3 ω -6

cyclooxygenase (COX)

1-series prostaglandins
PGE1
DECREASE inflammation

delta-5-desaturase^{††}

^{††}ACTIVATED BY: insulin
^{††}INHIBITED BY: EPA (fish oil)

Arachidonic Acid 20:4 ω -6

SOURCES: meat, shellfish, eggs

5-lipoxygenase^{†††}
(LOX)

4-series leukotrienes
LTB4
INCREASE inflammation

cyclooxygenase^{†††}
(COX)

2-series prostaglandins
PGE2
INCREASE inflammation

^{†††}COX OR LOX INHIBITED BY: aspirin, steroids, quercetin & other bioflavonoids, ginger, turmeric (curcumin), boswellia, red pepper (capsaicin)

OMEGA-3 FATTY ACID PATHWAY

Alpha-Linolenic Acid 18:3 ω -3

SOURCES: flaxseed oil, hempseed oil, walnuts, dark leafy greens

delta-6-desaturase[†]

Stearidonic Acid 18:4 ω -3

SOURCE: blackcurrant seed oil

elongase

Eicosatetraenoic Acid 20:4 ω -3

elongase

Eicosapentaenoic Acid (EPA) 20:5 ω -3

SOURCES: cold water fish (salmon, herring, sardines), fish oil, cod liver oil

delta-5-desaturase^{††}

Docosapentaenoic Acid 22:5 ω -3

5-lipoxygenase^{†††}
(LOX)

5-series leukotrienes
LTB5
DECREASE inflammation

cyclooxygenase^{†††}
(COX)

3-series prostaglandins
PGE3
DECREASE inflammation

delta-6-desaturase[†]

Docosahexaenoic Acid* (DHA) 22:6 ω -3

SOURCES: cold water fish (salmon, herring, sardines), fish oil, cod liver oil

*A key structural fatty acid in brain, eye and other tissues

KEY

18 = TOTAL NUMBER OF CARBON ATOMS IN THE FATTY ACID

18:2 ω -6

2 = TOTAL NUMBER OF DOUBLE BONDS

ω = GREEK SYMBOL FOR OMEGA

6 = POSITION OF FIRST DOUBLE BOND (COUNTING FROM THE OMEGA END OF THE FATTY ACID), I.E. CARBON #6