ESSENTIAL FATTY ACIDS (EFAs) & EFA DERIVATIVES

INTRODUCTION

Nutritional fats and oils tell a two-sided story in human health. The negative side of fats and oils (lipids), that has received most of the column inches that the press has devoted to lipids, consists of those — including hard, refined, refined tropical and chemically altered (hydrogenated) — that lower our energy levels, clog our arteries and kill us from within through conditions that involve the degeneration of our cells, tissues and organs. These degenerative conditions include cardiovascular disease, cancer and diabetes. 68% of the population dies from one of these three killers and fats play a major role in all three. That much the popular press has fairly told and warned us about. Fats also play a major part in conditions such as PMS, arthritis, fatty degeneration of inner organs, skin conditions, disorders of the digestive system and other degenerative disorders.

There is another side to the fats and oils story. Contrary to what we’ve been told, not all fats are poison and not all fats should be avoided. In fact, certain food components that are present only in lipids are absolutely essential to our health. If our foods do not supply these essential lipid substances in the required quantities, deficiency symptoms develop, just as they do when the human body obtains too little of any essential vitamin or mineral.

Our preoccupation with the so-called “killer fats” has blinded many people to the vital importance of certain oils to health. We must supply our bodies with certain lipid substances — the “healer fats”— either through foods or through supplements. Components of certain oils, these “healer fats” are more properly known as essential fatty acids.

**Essential fatty acids**

Two fatty acids are essential for human health. They must be provided by foods or by supplements because the human body cannot make them from other substances. They are an absolute requirement for life and for health. These two essential fatty acids are named **linoleic acid** (LA; or omega-6), and **alphalinolenic acid** (ALA; or omega-3).

Our consumption of LA, which is found in most common seeds and oils (safflower, corn, sunflower, soy and sesame are rich sources), has doubled in the last 150 years. Our consumption of ALA, which is rare in oils (flax is richest; soy, pumpkin, hemp and canola contain a little; most other oils contain negligible amounts), has decreased to one sixth of its level of consumption 150 years ago.

Excess dietary LA enhances tumor formation, especially if vitamin E has been removed from oil containing it during refining and processing. ALA and its relatives, on the other hand, inhibit tumor formation. The shift in our consumption toward more LA and less ALA is a shift toward greater incidence of tumors, which is corroborated by our increasing incidence of cancers over the last 160 years.

**Essential fatty acid derivatives**

From LA and ALA, the cells of most healthy individuals make several derivatives with important functions. Essential fatty acids and these derivatives are important components of cell membranes and intra-cellular membranes.

Two derivatives from LA: dihomogamma-linolenic acid (DGLA) and arachidonic acid (AA) and one derivative from ALA: eicosapentaenoic acid (EPA) is especially key, in that they serve as precursors to
prostaglandins, a group of hormone-like substances whose biological effects touch virtually every aspect of human physiology. Knowledge of the prostaglandins and their metabolism is one of the fastest developing and most exciting areas in biomedical research.

Three series of prostaglandins have been identified. Each series is made from one of the three key essential fatty acid derivatives (DGLA, AA and EPA, respectively), and each series contains about a dozen members. The diverse effects of the prostaglandins on the metabolic functions in all cells, tissues and organs are being intensively studied.

Dietary LA is a precursor for gamma-linolenic acid (GLA), which in turn is converted into dihomogamma-linolenic acid (DGLA), the parent substance from which the body makes series-1 prostaglandins. DGLA can also be converted into arachidonic acid (AA), the parent of series-2 prostaglandins.

Series-1 prostaglandins have generally beneficial effects on the body. Series-2 prostaglandins, useful in the jungle existence of “fight or flight”, are generally detrimental to people living “civilized” lifestyles high in stress and low in physical activity.

Dietary ALA is the precursor for eicosapentaenoic acid (EPA), the parent of the series-3 prostaglandins. These have generally beneficial effects on the body. In addition, EPA blocks the conversion of AA into the detrimental series-2 prostaglandins. EPA is further converted into docosahexaenoic acid (DHA), which is vital for brain development and, in adults, the functions of brain, nerves, vision, hearing, adrenal (stress) glands and sperm formation.

**Supplements of essential fatty acid derivatives**

The conversion of dietary LA to the prostaglandin precursor GLA can be impeded or blocked by many dietary factors, including:

- Diets high in margarines, shortening, shortening oil and partially hydrogenated, processed & heated vegetable oils, that contain altered fatty acids known as trans-fatty acids;
- Moderate to high alcohol consumption;
- Diets high in saturated fats;
- Diets high in cholesterol;
- Diets high in sugar;
- Dietary deficiencies of biotin, vitamin B-6 (pyridoxine), calcium, zinc and/or magnesium;
- Excess ALA (flax, black currant seed oils);
- Diabetes;
- Radiation;
- Carcinogenic chemicals;
- Ageing;
- Inherited (genetic) inability to convert.

When the conversion of LA to GLA is blocked due to genetic factors or poor dietary practices, a food source such as evening primrose oil or borage oil provides the LA derivative GLA, which the body can convert into DGLA and then into beneficial series-1 prostaglandins. DGLA is not available in foods other than mother’s milk and so cannot be supplemented through the diet.

If the conversion of LA to GLA is blocked, the conversion of ALA to its derivatives is also blocked, since the same enzymes convert both essential fatty acids into their derivatives. For this reason, supplements containing derivatives of both essential fatty acids bring better results than supplements containing derivatives of only one or the other. Fish oils provide the ALA derivative EPA, which the body can
convert into beneficial series three prostaglandins. Combinations of evening primrose oil, borage oil and fish oil (*Vitex’s Omega 3-6-9*) improve many degenerative conditions, indicating widespread requirement for essential fatty acid derivatives to bypass blocks.

In order for the complex activities of essential fatty acids (EFAs), EFA derivatives, and prostaglandins (PGs) to take place, the essential fatty acids LA and ALA must be present in the diet, as well as the EFA derivatives GLA and EPA. Given an adequate supply of these, the body knows how to use them. Good Health results from this simple nutritional intervention.

• **Note:** Some manufacturers of nutritional supplements promote essential fatty acid supplements as containing omega-3, 6 and 9 fatty acids. Omega-9 is oleic acid and is non-essential in humans. Virtually all animal fats and vegetable oils contain oleic acid in varying degrees and there is no known deficiency in humans. In fact, it has been shown that excessive oleic acid along with increased copper to zinc ratio can inhibit linoleic acid & gamma linolenic acids metabolism with predictable long-term clinical consequences (1). There is also a strong correlation between the high consumption of monounsaturated fat (oleic acid) and the incidence of early stage macular degeneration. (2) It is misleading to promote essential fatty acid supplements that draw attention to omega-9 (oleic acid) as having nutritional significance and by inference, superior to those formulas that rightly do not show the oleic acid content.


**Prostaglandins**

Prostaglandins have many key functions in our bodies related to health. These include platelet stickiness, blood pressure, kidney function (sodium and water balance), inflammatory response and immune function.

**Series-1 prostaglandins** have beneficial effects on these functions. They make platelets less sticky, lower blood pressure by relaxing smooth muscles in the walls of arteries, increase loss of sodium and waters, decrease inflammation and enhance immunity.

**Series-2 prostaglandins** in excess have detrimental effects on the five functions listed above. They tend to make platelets more sticky, increase blood pressure by contracting the muscles in the walls of our arteries, decrease the loss of sodium and water by the kidneys, increase inflammation response and lower immune function.

**Series-3 prostaglandins** have beneficial effects. They block the detrimental effects of the series-2 prostaglandins, preventing these “bad guys” from being made in the body. As a result of their interference with series-2 prostaglandin production, the platelets are less sticky, blood pressure is lower because the muscles in the walls of our arteries remain relaxed, loss of sodium and water by the kidneys takes place more effectively, inflammation response is decreased and immune function is efficient. Series-2 prostaglandins are used in “fight or flight” (stress) situations — the fight against Danger, or the flight from it. In modern life styles that are high in stress but low in physical activity, continuous production of series- 2 prostaglandins results in sticky platelets, high blood pressure, increased water and sodium retention, increased inflammation and decreased immune system capabilities. The common and serious degenerative conditions of the 20th Century are closely related to essential fatty acids, essential fatty acid derivatives and prostaglandins.
**Clinical Use**

Consumption of prostaglandins is useless, because they are destroyed during digestion.

Consumption of supplements of essential fatty acids or their derivatives can bring dramatic improvements in health, through their conversion into prostaglandins in the body.

**LINOLEIC ACID (LA)**

**General** - essential fatty acid; omega-6;

• Excess of LA more likely in Western populations than deficiency;

• Precursor for several derivatives including gamma-linolenic acid (GLA), dihomo-gammalinolenic acid (DGLA parent of series-1 prostaglandins), and arachidonic acid (AA, parent of series-2 prostaglandins);
**History:** LA discovered to be essential for rats in 1929; human essentiality established in 1954; conversion of arachidonic acid to prostaglandins recognized in 1965; prostaglandin metabolism identified in 1970’s;

**Nutrition**

- **Sources:** best: sunflower and sesame seeds; good: fresh safflower, sunflower, sesame oils; poor quality: refined oils; low quantity: processed foods;
- **Supplements:** fresh encapsulated oils (protected from oxidation);
- **Absorption** from intestine;
- **Improved by:** sufficient bile;
- **Antagonized by:** lack of bile;
- **Stability:** destroyed by light (generates free radicals), oxygen (peroxides = rancidity) & heat (increases rate of spoilage by light & oxygen; above 160°C, twisted trans-fatty acids begin to form); frying & deep-frying is very destructive;
- **Storage:** in fat (adipose) cells; in cell membranes; in membranes surrounding intracellular organelles;
- **Excretion:** not excreted; excess is “burned” to generate energy;
- **Metabolism:** converted into derivatives and prostaglandins;

**Functions of LA**

- Required for cell membrane & intracellular organelle membrane integrity;
- Necessary for production of series 1 (beneficial) prostaglandins;
- Necessary for production of series two (stress-related, detrimental) prostaglandins;
- Involved in regulatory activities in all cells, tissues & organs;

**Quantities**

- **Measurement:** milligrams; grams;
- **Optimum** (SONA) average ranges not established; estimated 3 - 6% of calories (10 - 20 grams/day);
- **Individual** optimum needs to be determined for each individual case;
- **Minimum** (EC RDA) not yet established; estimated at 1 - 2% of calories (3 - 6 grams/day);
- **Less than RDA:** not common; excess far more likely;
- **Deficiency** of LA from use of fat-free & Pritikin-type diets;
- **Symptoms include:** skin disorders, loss of hair, liver degeneration & fatty deposits in liver, behavioural disturbances, kidney degeneration, glandular atrophy, proneness to infection, poor wound healing, sterility & miscarriage, arthritis, heart & artery disease, growth retardation;
- **Toxicity:** excess LA enhances tumour formation;
- **Reversed by:** vitamin E;

**Therapy with LA**

- Alleviate symptoms of LA deficiency;
- Provide material for production of LA derivatives in the body of healthy people;
- Provide starting material for series-1 & series-2 prostaglandin production;
**ALPHA-LINOLENIC ACID (ALA)**

*General* - essential fatty acid; omega-3;

- Deficiency widespread in Western populations;
- Precursor of several derivatives, including eicosapentaenoic acid {EPA, parent of series-3 (beneficial) prostaglandins, that keep series-2 (detrimental) prostaglandins from being produced};
- Often confused with gamma-linolenic acid (GLA), that is derived from the other essential fatty acid (LA);
- **History:** essentiality still subject of controversy, because deficiency symptoms not as easily identifiable as those for LA; human deficiency first identified in 1951; used in alternative (nutritional) cancer treatment in 1954; shown to decrease human platelet stickiness in 1964; shown to inhibit tumour formation (animals) in 1981;

*Nutrition*

- **Sources:** best: flax & chia seed; candle nut; good: fresh flax oil; fresh green vegetables; poor: old oils, oils made without protection from light, oxygen & heat; refined oils;
- **Supplements:** fresh encapsulated oils (protected from oxidation);
- **Absorption** from intestine; also absorbed through skin;
- **Improved by:** sufficient bile;
- **Antagonized by:** lack of bile;
- **Stability:** destroyed by light (generates free radicals), oxygen (peroxides = rancidity) & heat (increases rate of spoilage by light & oxygen; above 160*C, twisted trans-fatty acids begin to form); frying & deep-frying is very destructive;
- **Storage:** in fat (adipose) cells; in cell membranes; in membranes surrounding intracellular organelles;
- **Excretion:** not excreted; excess is “burned” to generate energy;
- **Metabolism:** converted into derivatives and prostaglandins;
- **Caution:** diabetics need to monitor insulin levels closely;

*Functions of ALA*

- Required for cell membrane & intracellular organelle membrane integrity;
- Necessary for production of series-3 (beneficial) prostaglandins, that regulate platelet stickiness, blood pressure, inflammation response, sodium & water excretion through kidneys & immune function;
- Necessary to limit production of series-2 (stress-related, detrimental) prostaglandins;
- Involved in regulatory activities in all cells, tissues, & organs;
- ALA is found in much lower levels in the cells and tissues of the body as compared to EPA and DHA, as dietary ALA is inefficiently converted to the longer chain and biologically active DHA and EPA. Recent research suggests that only 4% of ALA is converted into the longer chain DHA in adults and less than 1% in infants.

*Quantities*

- **Measurement:** milligrams; grams
- **Optimum** (SONA) average ranges not set; estimated optimum: 1 - 2% of calories (3–6 grams/day);
• **Individual optimum:** to be determined for each individual case; much higher quantities (up to 70 grams/day) may help in treatment of degenerative conditions;

• **Minimum** (EC RDA) not yet established; estimated at 0.54% of calories (1 - 2 grams/day);

• **Less than RDA:** no official figures; estimated over 95% of population;

• **Deficiency** of ALA from lack in diet — refined foods, choice of omega-3 poor foods; increased requirement;

• **Symptoms include:** visual disturbances, motor incoordination, tingling sensations in arms & legs (multiple sclerosis-like), failure of growth; dry skin, lack of energy & stamina, increased blood triglycerides, proneness to tumors, increased platelet stickiness; excess series 2 prostaglandins in tissues;

• **Toxicity:** excess energy (sleeplessness); nausea (from weak liver);

• **Reversed by:** lowering intake;

**Therapy with ALA**

- Therapeutic dose: 15 to 35 grams/day or even more;
- Alleviates symptoms of ALA deficiency;
- Increases energy level & stamina; increases metabolic rate; shortens time necessary for fatigued muscles to recover from exercise; speeds wound healing; may improve visual function, colour perception & mental acuity in older people; may induce feeling of calmness; may improve behaviour of delinquents resistant to counseling;
- Softens dry skin; makes hair & nails strong; enhances beauty of show animals;
- Decrease platelet stickiness; lower blood triglycerides; lower high cholesterol in some;
- Lowers amount of insulin required by diabetics (close monitoring required);
- May be helpful in allergies, asthma; may improve liver function;
- Decrease water retention (edema); decrease inflammation & arthritis pain;
- Enhances immune function; helps fight strep and malarial infections;
- Reverses & inhibit tumor formation; transformed human cancer cells in tissue culture are killed by ALA;

**GAMMA-LINOLENIC ACID (GLA)**

**General** essential fatty acid derivative; omega-6;

- Rarely found in oils; best studied source is evening primrose oil;
- **History:** identified in 1949 in oil of evening primrose; studies of effects of GLA on health began in 1959; first GLA-containing evening primrose oil marketed in 1972;

**Nutrition**

- **Sources:** best: evening primrose oil; fair: borage, black currant seeds, hemp seeds; poor: all commercial food oils;
- **Supplements:** encapsulated 10% GLA cold-pressed (no solvent) evening primrose oil, evening primrose oil and borage oil blends.
- **Absorption** from intestine; also absorbed through skin;
- **Improved by:** sufficient bile;
- **Antagonized by:** insufficient bile;
- **Stability:** destroyed by light (generates free radicals), oxygen (peroxides = rancidity) & heat (increases rate of spoilage by light & oxygen; above 160*C, twisted trans-fatty acids begin to form); frying & deep-frying is very destructive;
• **Storage:** in fat (adipose) cells; in cell membranes; in membranes surrounding intracellular organelles;

• **Excretion:** not excreted; converted to other important substances;

• **Metabolism:** converted into derivatives and prostaglandins;

• **Caution:** may worsen temporal lobe epilepsy & manic depressive symptoms;

**Functions of GLA**

- Precursor from which body makes DGLA, the parent of beneficial series-1 prostaglandins;
- Through prostaglandins, lower blood pressure, make platelets less sticky, decrease inflammation, enhance sodium & water excretion by kidneys; enhance immune function;
- Lower cholesterol & triglycerides;

**Quantities**

- **Measurement:** milligrams; grams;
- **Optimum** (SONA) average ranges not established; estimated optimum: 300 to 500 mg/day (from 3000 - 5000 mg. of evening primrose oil/borage oil);
- **Individual** optimum needs to be determined individually;
- **Minimum** (EC RDA) not yet established; healthy body can convert LA into GLA;
- **Less than RDA:** no official figures;
- **Deficiency** of GLA from lack of omega-6 oils in diet; inability to convert LA to GLA due to faulty diet, lack of necessary minerals & enzymes, slowed enzyme activity due to age or genetic inability to convert;
- **Symptoms** might include: dry skin; PMS; atopic eczema;
- **Toxicity:** rare, usually due to traces of solvents in GLA-containing oil;
- **Reversed by:** changing to oil not solvent extracted;

**Therapy with GLA**

- Treatment of PMS (combined with vitamins C & B-6 & minerals zinc & magnesium);
- Treatment of atopic eczema;
- Improve skin texture & smoothness; useful in skin moisturizer creams;
- Prevent alcohol hangover;
- Reduces both high blood pressure (hypertension) and platelet aggregation, as well as decreasing cholesterol and triglyceride levels, reducing risk of heart attack;
- May relieve symptoms of rheumatoid arthritis. About two-thirds of patients suffering from moderate cases of the disease reported complete freedom from symptoms;
- Infants who develop eczema when switched from mother’s milk (rich in DGLA) to cow’s milk (no DGLA) respond extremely well to GLA supplementation;
- Hyperactive children, who generally exhibit low levels of PGE1 and GLA, respond positively to oral administration of GLA;
- Transformed human cancer cells in tissue culture, that lose their capacity to transform LA into GLA & to make series-1 prostaglandins, are killed by GLA;
- Useful for losing weight;
- Used successfully to treat fibrocystic (benign) breast disease;
- Helpful in Sjogren’s syndrome in which tear & salivary glands dry up;
- Patients with multiple sclerosis, a disease characterized by faulty metabolism of unsaturated fatty acids, benefit from GLA supplementation; most MS patients receiving GLA supplements report feeling better & show objective improvements

**EICOSAPENTAENOIC ACID (EPA)**

**DOCOSAHEXAENOIC ACID (DHA)**
**General:** Essential fatty acid derivatives; omega-3;

- Found in cold water fish oils and certain micro-algae; 20% (EPA) found in certain snake oils;
- **History:** Eskimo consuming traditional diet high in fat & proteins found free of most degenerative conditions in 1972; EPA (& DHA, that may convert back to EPA) found to be key protective ingredient by 1978; EPA research goes wild in 1980 & continues;

**Nutrition**

- **Sources:** best: meat along belly, around fins & behind gills (shoulder) of cold water, high fat fish; good: cold water, high fat fish; fair: low fat, cold water fish; poor: warm water fish;
- **Supplements:** encapsulated fresh fish body oils (cold water, high fat); fish liver oils; best fish oils contain about 18% EPA & 12% DHA (omega-3s);
- **Absorption** from intestine; can also be absorbed through skin;
- **Improved by:** sufficient bile;
- **Antagonized by:** insufficient bile;
- **Stability:** destroyed by light (generates free radicals), oxygen (peroxides = rancidity) & heat (increases rate of spoilage by light & oxygen; above 160°C, twisted trans-fatty acids begin to form); frying & deep-frying is very destructive;
- **Storage:** in fat (adipose) cells; in cell membranes; in membranes surrounding intracellular organelles;
- **Excretion:** not excreted; excess is “burned” to generate energy;
- **Metabolism:** converted into series-3 prostaglandins in the body, according to need;
- **Interactions:** fish oils contain no vitamin E (in nature not necessary at low temperature in ocean); this needs to be added when oil is used in warm human body; uses up vitamin E in human body;

**Functions of EPA**

- Part of membranes of all cells & of membranes around intracellular organelles;
- Blocks formation of detrimental series-2 prostaglandins; decreases blood pressure, inflammation; increases sodium & water loss; enhances immune function;
- Makes platelets less sticky; increases bleeding time (by about 60%);
- May be helpful in arthritis & other inflammatory disorders;
- May be helpful in certain kinds of cancer;
- May be helpful in kidney disease;
- Lowers insulin requirements in diabetics;

**Functions of DHA**

- Part of membranes of all cells & of membranes around intracellular organelles;
- Needed for the regulation of all bodily functions and the breakdown of dietary fats within the body;
- Essentials for the growth and functional development of the brain in infants;
- Essential for visual and neurological in infants.
- Required for maintenance of normal brain function in adults;
- Low levels linked to Alzheimer’s disease;
- Low levels linked to learning disorders (ADD);
- Low levels linked to depression in humans;
Quantities

- **Measurement**: milligrams; grams;
- **Optimum** (SONA) average ranges not yet established; estimated requirement: perhaps 1% of calories (2 - 3 grams/day);
- **Individual** optimum needs to be determined individually;
- **Minimum** (EC RDA) not yet established;
- **Less than RDA**: no official figures; suggested: more than 95% of population is getting less Omega-3s from their foods than minimum required for health;
- **Deficiency** of EPA and DHA from lack of omega-3s in diet;
- **Symptoms** might include: skin afflictions, high blood pressure, high cholesterol, high triglycerides, joint problems, tumours, kidney malfunctions;
- **Toxicity**: not likely, except if diet lacks vitamin E & selenium;
- **Reversed by**: addition of vitamin E & selenium to diet;

Therapy with EPA/DHA

- Therapeutic dose: 2 to 4 grams of EPA/DHA per day;
- Reduces both high blood pressure (hypertension) and platelet aggregation, reducing the risk of heart attack;
- Reduce total cholesterol & detrimental LDL & increase beneficial HDL;
- Reduce triglyceride levels by up to 60% or even more;
- Transformed human cancer cells in tissue culture are killed by EPA;
- Used in treatment of psoriasis;
- May be helpful in kidney disease;
- Counteracts some of detrimental effects of immunosuppressive drugs used to prevent rejection of tissue & organ transplants;
- May be useful in diabetics; lowers insulin requirements; close monitoring of insulin requirement is important;
- Protects against age-related macular degeneration;
- DHA may be helpful in neurological disease and Alzheimer’s disease;
- May help to reduce the symptoms of rheumatoid arthritis;
- High doses may help with Raynaud’s phenomenon;
- High doses (20 grams of fish oil daily) may help with lupus;
- When taken along with calcium, EFAs may help prevent osteoporosis;
- Regular use of fish oil may reduce the pain of menstrual cramps;
- EPA/DHA has a positive effect on diseases such as hypertension, arthritis, atherosclerosis, depression, adult-onset diabetes, myocardial infarction, thrombosis and some cancers.
- Randomized controlled trials in term infants given infant formula lacking DHA (as is the current North American situation) versus milk formula supplemented with 0.35% DHA, indicated that early dietary supply of DHA was a major determinant of improved performance on the mental development index for the latter group.
- Synergists: vitamin E, selenium;
Balanced ratio of GLA - EPA / DHA

As this article illustrates, both omega-3 and omega-6 fatty acids are essential for optimal health and a lack of either one or both can lead to many disease conditions. While there is no clear-cut scientific consensus as to the correct balance between the omega-3 and omega-6 fatty acids, we can look to nature to obtain guidelines on this important question. All of the comparative data from various species show a predominance of the omega-6 fatty acids over the omega-3. Since the omega-3 fatty acids are preferentially metabolized in the body, a ratio of 4-1 in favour of the omega-6 fatty acids will insure a balanced composition at the cellular level. Such a ratio recommendation would be applicable when the parent acids, linoleic acid (w6 series) and alpha-linolenic acid (w3 series) are the predominant constituents in the diet. On the other hand, the longer chain derivatives such as gammalinolenic acid (GLA), dihomogamma-linolenic acid (DGLA), arachidonic acid (AA) and eicosapentaenoic acid (EPA) are biologically more active and are incorporated into cell structure more effectively. Also, EPA is preferentially incorporated into cell membranes at the expense of AA. In situations where these longer chain polyunsaturated fatty acids are provided in the diet as food supplements, a ratio of 1:1 between GLA and EPA\DHA would be desirable to ensure a correct balance at the cellular level.