Chapter 5: Balancing Dietary Fats

To a large extent, you are what you eat, especially when it comes to dietary fats. Your body fat actually reflects the types of fats that you eat. Body fat samples from around the world show significant differences in the types of fats they contain reflecting the composition of the fatty acids in the fats and oils in the diet. In this chapter, you will learn not only how the excess fat comes into the diet, but how different fatty acid sources have different effects on physiological processes.

Fats and oils provide the most concentrated source of calories of any foodstuff. The vast majority of the fats you eat and store are called triglycerides. This name comes from the fact that triglycerides are made up of three fatty acids on a carbon backbone. Fats provide two essential fatty acids (linoleic and linolenic acids). These two fatty acids are made by plants but not by humans, so we need to get them from our diet, and vegans get these by eating plant foods, which are about 10 percent fat calories. As a practical matter, nobody with an intact intestine has ever shown fatty acid deficiency. These fatty acids which are necessary to maintain life at a very small percentage (5 to 10 percent) of total calorie intake. Fats carry fat-soluble vitamins, and concentrate the tastes of foods to make them more palatable. In ancient times and wherever there is food scarcity, fats are a good thing, as they are compact calories. The body stores 95 percent of excess calories as fat and there are 130,000 to 160,000 Calories stored in the body fat of a normal weight individual.

The principal dietary sources of fat are meats, dairy products, poultry, fish, nuts, and vegetable oils and fats used in processed foods. Vegetables, fruits and grains contain only small amounts of fat, so that vegetable oils are only sources of fat as a result of the processing of plant foods. The most commonly used oils and fats for salad oil, cooking oils, shortenings and margarines in the U.S. include soybean, corn, cottonseed, palm, peanut, olive, canola (low erucic acid rapeseed oil), safflower, sunflower, coconut, palm kernel, tallow and lard. These fats and oils contain varying compositions of fatty acids that have particular physiological properties.

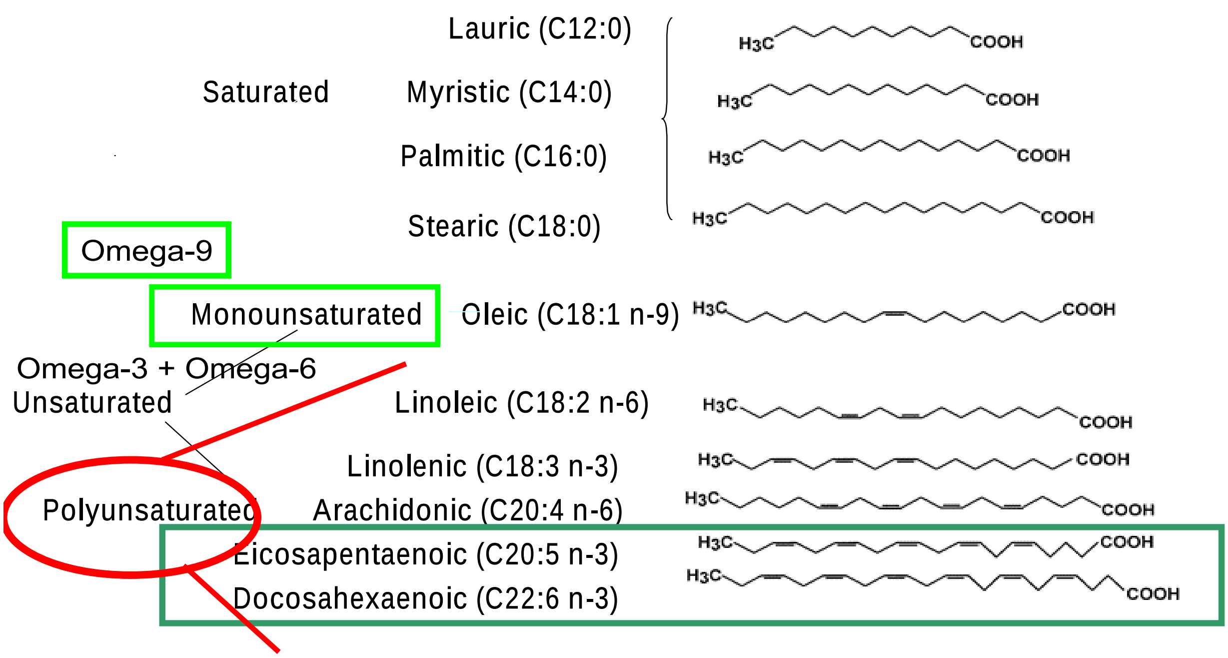
The industrialization of the food supply which began over 400 years ago accelerated in the last 50 years due to strong agribusiness subsidization by the U.S. and other governments internationally. The profit inherent in providing low-cost ingredients and the desire for populations to eat more meat products as their wealth increased also continues to play an important role in the changing food supply. Special grain varieties were developed for feeding livestock efficiently. A side product of the overproduction of grains has been the popularization of refined vegetable oils in cooking and processed foods. Even rural areas of China, where the economic boom has not yet been fully realized, have increased their intake of refined vegetable oils rich in omega-6 fatty acids and poor in omega-3 fatty acids. The ratio of omega-6 to omega-3 in corn oil is 57-to-1, while in soybean oil it is 57-to-8 (or about 7-to-1). As the public became more aware of the problem, some companies produced higher contents of omega-3 short-chain fatty acids such as canola, which has a 21-to-11 ratio (less than 2-to-1), but large amounts of omega-6 fatty acids.

This situation has been further aggravated by the corn feeding of livestock, so that the proportion of short-chain fatty acids from two competing families called omega-3 and omega-6 have been drastically changed from what they were in the plant foods on which mankind evolved 50,000 to 100,000 years ago. It has been estimated that the modern Western diet is “deficient” in omega-3 fatty acids with a ratio of omega-6 to omega-3 of 15-to-16.7, instead of 1-to-1 as is the case with wild animals and presumably ancient human beings who lived in nutritional equilibrium with plant foods (1–7).

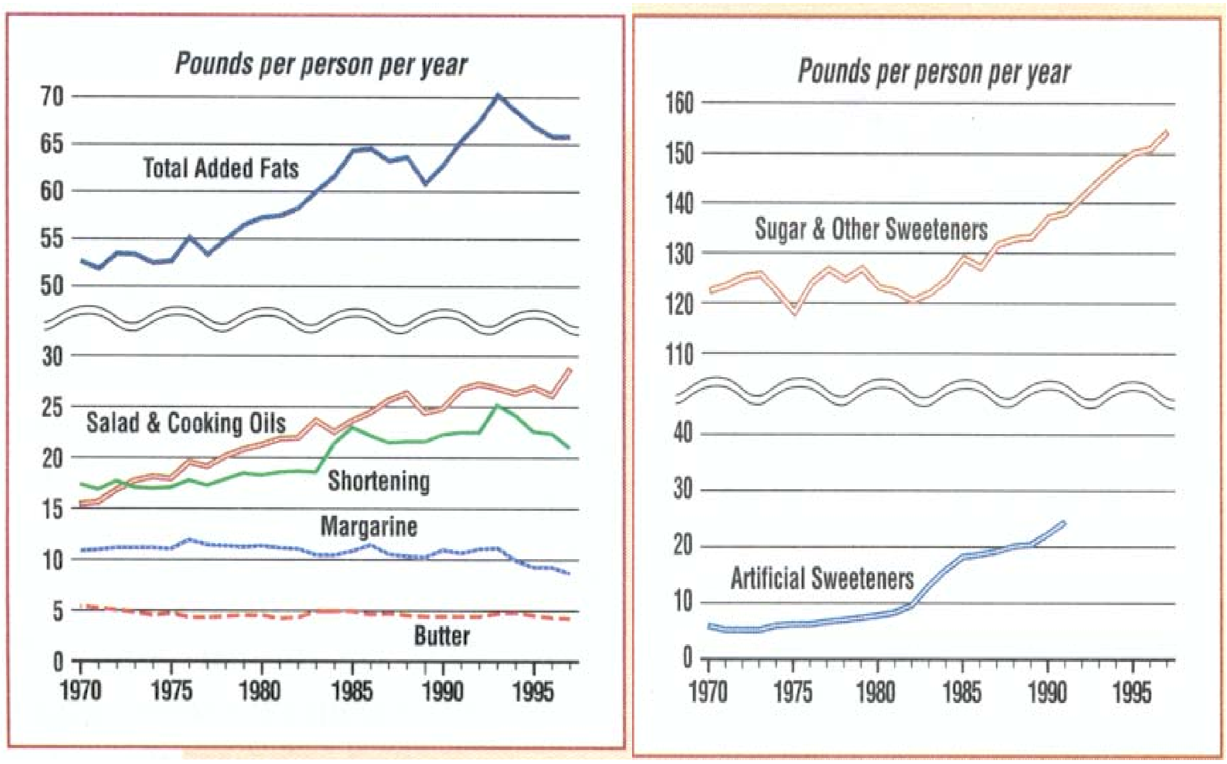
Clarifying the Nomenclature

There has been a great deal of obfuscation of the differences in fatty acid chemistry for the purpose of justifying the increase in omega-6 polyunsaturated fats in the diet over the last 50 years in order to sell processed vegetable oils and the foods that contain them. In the 1980s, the American Heart Association recommended increasing the intake of polyunsaturated oils in cooking in order to decrease blood cholesterol levels. However, we now know that increasing total polyunsaturated fat intake such as corn oil is an oversimplification when it comes to health. Classifying fats as saturated or polyunsaturated lumps together the omega-6 and omega-3 fatty acids into a single grouping and obscures the effects on the human diet of refined vegetable oils with excessive amounts of omega-6 short-chain fatty acids as shown in the figure below. Most all of the fat in the diet and stored in the body is in the form of triglycerides, which have a three carbon stem containing three different fatty acids. So there is no pure omega-3 or omega-6 fat, but the component fatty acids can be classified as omega-3 or omega-6 and result from the dietary intake of these fatty acids that cannot be synthesized by humans. In fact, there is a daily requirement of about 0.6 percent of total calories of linoleic acid, which is a tiny amount easily achieved with almost any diet.

Fatty Acids in Dietary Fats



An absolute and relative change of omega-6/omega-3 balance in the food supply of Western societies has occurred over the last 100 years. A balance existed between omega-6 and omega-3 for millions of years during the long evolutionary history of mankind based on the distribution of these fatty acids in the plant world and in the animals that ate those plants. When modern mankind evolved from prehuman hominids millions of years ago, omega-3 fatty acids were found in all foods consumed: meat, wild plants, eggs, fish, nuts and berries. Modern studies of animals living in the wild confirm the significant differences from what is found in grain-fed animals today (8,10). The introduction of much higher fat foods especially in fast foods accounts for up to one-third of all food intake in nearly half of all Americans. In the late 1970s and early 1980s, there was an increase in the intake of hidden fats followed in about 1985 by a significant increase in total sugar intake from table sugar and high fructose corn syrup (see figure below) (11–15). These amounts of sugar and fat were never previously in the human diet anywhere in the world, since they were a product of the modern industrialization of the food supply.



The above charts obtained from the Center for Science in the Public Interest (CSPI).

Genetically speaking, humans today live in a nutritional environment that differs from the one in which our genes evolved. Linoleic acid (LA) and α-linolenic acid (ALA) and their long-chain derivatives are important components of animal and plant cell membranes. These two classes of essential fatty acids (EFA) are not interconvertible, are metabolically and functionally distinct and often have important opposing physiological functions. The balance of EFA is important for good health and normal development. When humans ingest fish or fish oil, the Eicosapentaenoic Acid (EPA) and Docosahexaenoic Acid (DHA) from the diet partially replace the omega-6 fatty acids, especially arachidonic acid (AA), in the membranes of cells. This change in membrane composition affects the function of platelets, red blood cells, white blood cells and liver cells (reviewed in Ref. [4]). Whereas cellular proteins are genetically determined, the PUFA composition of cell membranes is, to a great extent, dependent on dietary intake.

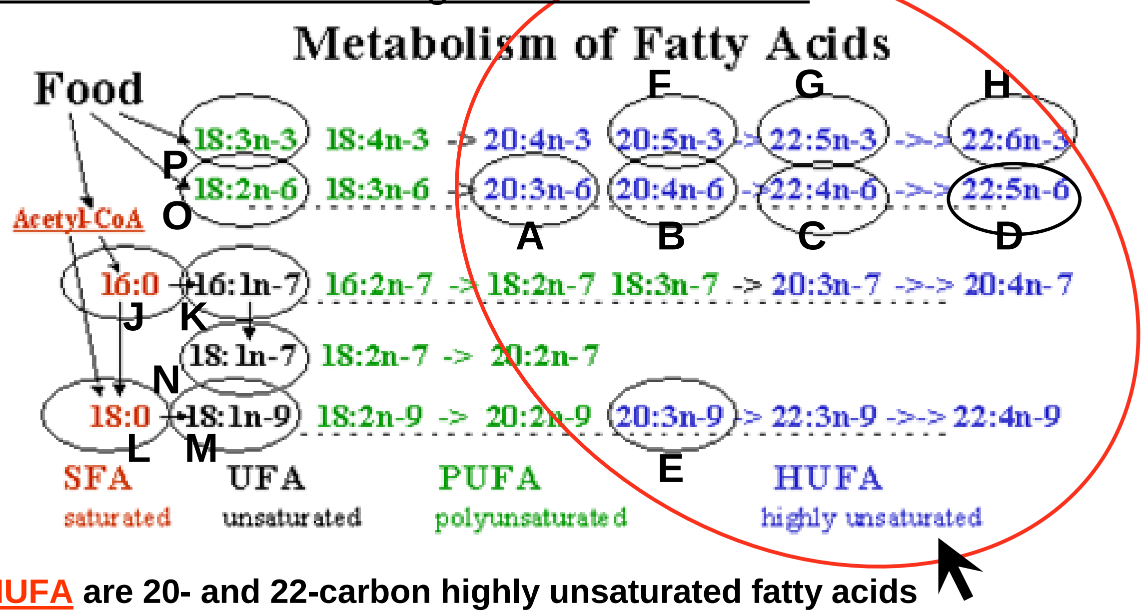
Arachidonic acid and EPA are the parent compounds for eicosanoid production. Eicosanoids are small molecules such as prostaglandins and thromboxanes that are either pro-inflammatory, anti-inflammatory or neutral. The normal situation is to have a balance of omega-3 and omega-6 so that a brisk inflammatory response is possible to defend against infection and injury. For this reason, a key enzyme in the inflammatory pathway cyclo-oxygenase 1 has a 10-fold preference for omega-6 over omega-3. However, the amounts of omega-6 are so large in the typical modern diet as to outweigh the normal modulating effects of omega-3. In fact, short-chain omega-3 fatty acids are poorly converted to EPA and DHA due to the excess of omega-6, providing the rationale for supplementation of EPA and DHA to the diet even when that diet is otherwise low in fat through the consumption of low-fat corn-fed poultry and the avoidance of added omega-6 fats in margarine, cooking oils, cakes, pastries, cookies and many processed foods containing hidden fats.

Cleland et al. (6) showed that the amounts of linoleic omega-6 fatty acid in the modern diet inhibit EPA incorporation into red cell membrane from consumption of dietary fish oil supplements in human subjects. Thirty healthy male subjects were randomly allocated into one of two treatment groups. One group was on a high LA and low saturated fatty acid diet, whereas the other group was on a low LA and low saturated fat diet. The difference in the low LA and low saturated fatty acid diet was made up with monounsaturated fatty acids (olive oil). After a three-week run-in period, the subjects consumed a fish oil supplement containing 1.6 g EPA and 0.32 g DHA per day. After four weeks of fish oil supplementation, the incorporation of EPA in neutrophil membrane phospholipids was highest in the lowest LA group, indicating that the ingestion of omega-6 fatty acids within the diet is an important determinant of EPA incorporation into neutrophil membranes. This study also shows that monounsaturated fatty acids, in this case olive oil, do not interfere with EPA incorporation.

Therefore, the approach of reducing dietary linoleic acid intake while supplementing the diet with EPA and DHA should have a major effect as predicted by the “Keep It Managed-2” computer program developed by Dr. Williams Lands with funding from the U.S. National Institutes of Health (17). This significant physiological impact of supplementation of 2 grams or more of EPA and DHA on the proportions of omega-6 fatty acids can be demonstrated and measured in individuals as a short-term feedback of their success in changing their dietary fat quantity and quality.

The proportions of n-3 and n-6 highly unsaturated fatty acids (HUFA) in tissue HUFA are useful biomarkers that characterize an individual’s average daily dietary intake of essential fatty acids. The proportions vary predictably from 20 to 80 percent depending on the voluntary food choices of each individual (see figure below). To help individuals identify and select specific food choices that meet each person's preferences in taste and maintain their tissue proportions of n-3 and n-6 HUFA at a personally desired level of risk aversion, an interactive menu planning program with an interactive USDA nutrient database of nearly 12,000 food servings is downloadable from [http:// efaeducation.nih.gov/sig/kim.html](http://efaeducation.nih.gov/sig/kim.html).

#2. HUFA result from elongation & desaturation



HUFA are 20- and 22-carbon highly unsaturated fatty acids with >3 double bonds

Biomarkers of n-6HUFA status in tissues are:

%n-6 HUFA in HUFA = 100*(A+B+C+ D)/(A+B+C+D+E+F+G+H)

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