Fats: the good, the bad and the ugly. And don't forget cholesterol.

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The good	Polyunsaturated fats	Oils from corn, soy, canola, safflower, cotton seed, fish
	Monounsaturated fats	Olives, oils from olives, canola, peanuts and nuts of most types
The bad	Saturated fats	Dairy products, red meat, chocolate, coconuts (oil, milk and flesh) and palm oil.
The ugly	Trans fats	Many margarines and partially hydrogenated cooking oils, commercially fried foods, many fast foods, most commercially baked goods
Of concern	Cholesterol	Eggs, offal, many animal products

The good: These are the plant derived oils, particularly olive and canola oils which are rich in unsaturated fats. Fish oils containing longer chain omega 3 fatty acids are also good. The only real consideration is the amount of calories they contain. All fats from any source have 9Kcal/g compared to 4Kcal/g from carbohydrate or protein. Hence oils and fats are very fattening.

Terminology. The terms fats and oils are very closely related, and in some contexts are interchangeable. Fatty acids are a basic component of oils and fat. In general parlance, fatty acids in their various complexes with other molecules which are solid at room temperature are called fats and fatty acids that are liquid at room temperature are called oils. Generally saturated and trans fats are more likely to be solid at room temperature compared to unsaturated fats of the same carbon number. For more on this see the section at the end. As a general guide, fats which are solid at room temperature are much less likely to be good for your health. Heating them to make them liquid does not change their adverse health effects.

In general there is widespread evidence that diets which have substantial intakes of plant-based foods will improve your health. Such diets provide limited amounts of saturated fats and much greater amounts of plant derived unsaturated fatty acids, which are either mono-unsaturated such as oleic acid or polyunsaturated such as linoleic acid (omega 6) or a-linoleic acid (omega 3). Difficulties in interpretation arise when individual components of these plant or fish based fatty acids are examined for their specific health effect.

The general overall effect of unsaturated fats on cardio-vascular disease is positive. Switching from saturated to unsaturated fats also improves insulin sensitivity, glucose tolerance and improves diabetes, provided that fat intake is less than 37% of energy (Vessby 01). A very good summary of the effect of these various fatty acids on health can be found at http://www.health.gov/dietaryguidelines/dga2005/report/ under the section on fats. Rather than be concerned with individual components, we should concentrate on the overall package provided by diets such as the Mediterranean diet. See the section What to eat.

Specific issues:

Are fish derived long chain omega 3 polyunsaturated fatty acids such as EPA and DHA useful? Whether taken as fish oil or consumed as fish, they appear to have an extra beneficial effect on cardio-vascular health. However, a significant environmental arises: are there enough fish left in the sea to provide everyone with the two serves of fish per week that is recommended? The answer to this is clearly no. At current levels of fishing, which only supply a fraction of this amount, the world's fisheries are already in serious decline. By 1995, 60% of the world's fisheries were beyond peak production (Future of farming 03).

What about fish farming? This simply adds to the problem of lack of sustainability since the fish with higher levels of these good fatty acids are carnivores, meaning that they have to be fed other fish, a process is which is highly inefficient. In the end, the recommendations are probably impractical and potentially highly damaging to the world's ecology and not worth the damage considering the limited positive effect overall. Another concern is the level of toxic substances in them. Mercury is a particular problem. Most fish, particularly oily fish, caught in North American waters have high levels, to the point where pregnant women are advised to limit their intake (Nestle 06).

Plant based sources of omega three fatty acids: are these as good as those longer chained omega 3s from fish sources? There is limited evidence on this, but probably not but none-the-less are still positive in their effects. Canola oil in particular has lots of **a**-linoleic acid. This is converted into the longer chain omega threes EPA and DHA in the body but the conversion is relatively slow and does not supply the sort of levels that can be achieved from fish sources.

What about the balance between omega 6 and omega 3 fatty acids? There is even less information on this. The argument goes that since both linoleic and a linoleic acid use the same elongase and desaturase enzymes, if omega 6 linoleic is present in substantial excess, the body's production of the long chain omega 3 fatty acids, EPA and DHA may be impaired. This concept has been used against the feedlot producers, since cattle raised this way have a much higher 6 to 3 ratio. There is not a lot of evidence either way.

The bad: These are saturated fats which come predominantly from animal sources although there are saturated plant oils, such as palm and coconut oil, which are equally bad.

There is a huge literature on the adverse effects of saturated fats. By and large such saturated fats adversely affect the blood lipid profile, increasing low density lipoprotein (LDL) levels as well as cholesterol. In the west, the association of saturated fats/dietary cholesterol and coronary artery disease became well known in the 1970s. This led to a campaign to reduce animal sourced saturated fats and cholesterol and replace them with carbohydrates. There has been a dramatic drop in the incidence of heart attacks, strokes and associated deaths over the past 30 years in the west, partly due to dietary change (about a quarter of the improvement) but also due to reduction in smoking (about a third of the improvement) and better medical therapies. In the US average cholesterol levels have decreased in both sexes from 220mg/100mL (5.7mmol/L) in 1960-2 to 203mg/100mL (5.2mmol/L) in 1999-2002.

There are some interesting paradoxes however: the French for example have a high intake of saturated fat and cholesterol yet have low incidence of cardio-vascular disease. The exact cause of this has been widely discussed without a clear answer. Despite this, in the French, the higher the cholesterol, the greater the risk of cardio-vascular disease and hence everyone will benefit from a diet that will reduce LDL and cholesterol (Kuller 06 - This is a really excellent review of this complex subject.)

Most of this saturated fat comes from animal sources. The best way to deal with this is to limit consumption of them. As an example, hard cheese is about 20% saturated fat so that 30g (1oz) will supply 6g of saturated fat, representing 54Kcal of energy or just under a third of the recommended maximum daily intake of 20g saturated fat in a 2000Kcal intake. Most dairy food and much of the red meat contains considerable amounts of saturated fat. Very lean red meat still

has around 3g/100g of saturated fat, while ordinary meat has about 6.5g/100g. 250mL (1 cup) of low fat milk has 1.5g of saturated fat with regular milk having three times that (US Dietary Guidelines 05). Despite the fact that meat and dairy are promoted as health foods, the best advice is to limit their intake. Remember also that the red meat and dairy industries are very harmful to the environment - see the section on environmental damage.

Don't be fooled about palm or coconut oil because they come from plants. They contain considerable amounts of saturated fats similar to animal derived saturated fats, particularly those with 12 to 16 carbon atoms with myristic (14:0) being more potent than either lauric (12:0) or palmitric (16:0). Stearic acid (18:0) is converted in vivo to oleic acid and is probably neutral in its effect of blood lipids at intakes of 3.5g/day. (Hajri 98)(Khor 04) In an informative but unintended natural experiment on the Indian Ocean island of Mauritius where cardiovascular disease became epidemic in the 1980s, the government banned the use of palm oil for cooking substituting soy oil. This dropped the amount of saturated fat dramatically, with a subsequent marked drop in the incidence of cardio-vascular disease (Kuller 06).

Note that these oils have been used extensively in commercial food production because they prolong shelf life and improve taste because of their lower potential to go rancid, very similar to the use of partially hydrogenated oils. (Nestle 06) It pays to read the food label. In addition, much palm oil is produced in ecologically sensitive areas of SE Asia.

The ugly: These are the trans fats produced by partially hydrogenating vegetable oils to make them more resistant to spoiling in cooking or more solid for margarines. These are even worse for your arteries.

Where do they come from and how much can you have? As noted with saturated vegetables oils, partially hydrogenated cooking fats are very attractive commercially because of their long shelf life, stability in deep-frying and the potential to increase palatability of baked goods and sweets. Up until recent times, trans fatty acids comprised around 2 to 3% of calories consumed. There are small amounts of trans fats in meat and diary products.

There has been a major push to identify foods containing trans fats by appropriate food labelling as in the US or to eliminate their use altogether as in Denmark. Many commercially prepared foods have significant quantities of trans fats such as French fries (around 5g/serve), pies (3g/serve), or cakes (1.5g/serve). Many restaurant and fast food meals contain between 5 and 10g of trans fats. For a person on a 2000Kcal energy intake, as little as 2g/day can have adverse effects. There is really no safe level of intake but consumption of less than 1/g per day is acceptable (Mozaffarian 06).

What do trans fats to do you and how good is the evidence? Trans fats increase LDL, cholesterol, triglycerides and reduce HDL along with other adverse effects on blood lipids. (See below for an explanation of these terms.) They also promote an increase in inflammation promoting molecules such as TNF**a** and CRP, known to be involved in the damage of arterial lining. The effect of trans fats is worse than that of saturated fats in all these measures and they are probably the most damaging of all nutrients, conferring risk at 1 to 3% of energy intake.

In a meta analysis, a 2% increase in energy intake from trans fatty acids is associated with a 23% increase in the incidence of coronary heart disease (Mozaffarian 06). A comparative study of patients with their heart attack had higher levels of trans fatty acids in the bodies than did the normal matching controls. (Clifton 04) In the Nurses Health Study 2005 of around 85,000 individuals, trans fats were associated with the development of type II diabetes, with a 39% increase in risk in the highest intake group as well as an overall increased relative risk of coronary artery disease of 1.33 times expected. Most other investigations have shown similar increases in risk (Mozaffarian 06).

What can you do about this? First read the food composition labels. Many will list the trans fat levels. Avoid anything that has more than 0.5g/100g of trans fat, preferring foods that have none.

The big problem is restaurant and fast food meals. They won't tell you. Most go for what sells the most and is most economical to produce. This usually means high salt, sugar, saturated fat and trans fat. The best way is to have as little as possible of this food. Make you own lunch, limit restaurant meals and see the money you save. Pressure the government to outlaw trans fats. Denmark did, and surprisingly the restaurant industry did not suffer.

Cholesterol: This comes mainly but not exclusively from animal-based foods. While we manufacture our own, dietary cholesterol, despite what the egg marketers would tell you, has adverse effects cannot entirely be ignored.

A major source of cholesterol in our diet is eggs accounting for around a third of daily intake, with the rest from meat and dairy foods. A large egg has around 215mg cholesterol in its yolk. The current recommended intake of cholesterol is 300mg/d for those with a normal cholesterol level and 200mg/d for those with an elevated level. The extra dietary cholesterol is added mainly to the LDL fraction, about 80%. As example, a 2mg/dl increase in cholesterol will increase the risk of coronary heart disease by 1%. Essentially the more you consume, the greater the adverse effect (US Dietary Guidelines 05).

The anatomy of lipids. A brief explanation is required as to how all these things fit together in the body. Fats in the form of triglycerides (three molecules of fatty acid bound to on of glycerol) are digested to there basic constituent molecules and then reassembled, being transported to the liver in large particles of triglycerides and protein, called chylomicrons. These carry all types of fatty acids, from polyunsaturated through monounsaturated to saturated as well as trans fatty acids. It is the saturated fatty acids and trans fatty acids that are particularly damaging. The liver then re-exports the triglycerides containing the various fatty acids, being made water soluble by complexing with a protein carrier to become low density lipoprotein (LDL). This also carries cholesterol because it too is insoluble in water. (Much of the cholesterol is made by the body itself.)

This outgoing movement of fat and cholesterol from the liver is the so-called bad cholesterol (LDL) , bound for the tissues where if it is present in higher amounts or containing saturated or trans fatty acids, causes damage particularly to the walls of the arteries. Cholesterol is also returned to the liver in high density lipoprotein (HDL) where much of this is excreted in the bile. Some cholesterol is reabsorbed. Hence the HDL is the so-called good cholesterol since it is cholesterol bound for excretion. The total amount of cholesterol in the blood approximates to the sum of that in LDL plus HDL, but as LDL levels are generally higher than HDL, the total cholesterol reflects the basically bad LDL. To overcome this difficulty, the ratio of LDL to HDL is usually given, and higher the value the worse the effect on the health.

In much of the earlier literature on disease induced by fats, only cholesterol was able to be measured at the time, hence this became the single yardstick of assessment and today still has validity. However, in more recent literature the fuller range of measurements are usually given. It should be noted that this is a very simplified explanation and there are many much more complex aspects.

The role of the obesity epidemic. Unfortunately, with the soaring intake of carbohydrates, the obesity epidemic became a major problem. This has led to a re-emergence of cardiac disease mediated by metabolic syndrome (syndrome X) associated with all the complications of insulin resistance or outright type II diabetes. These will likely halt the fall in mortality from cardiac disease in the near future. In many people this has added to the problem rather than replaced one for another since the intake of saturated and the more recently recognized trans fatty acids from partially hydrogenated oils remains distressingly high. These problems are progressively overtaking many of the developing world's countries as they adopt the typical western diet, with rapidly rising rates of cardio-vascular disease.

References:

(Clifton 04) Peter M. Clifton, Jennifer B. Keogh, and Manny Noakes. *Trans* Fatty Acids in Adipose Tissue and the Food Supply Are Associated with Myocardial Infarction. J. Nutr. 2004;134: 874–879.

(Future of Farming 03) Tim Lang, Geof Rayner, Editors. Why Health is the Key to the Future of Food and Farming. A Report on the Future of Farming and Food. 2003. Downloadable from the internet.

(Hajri 98) Tahar Hajri, Pramod Khosla, Andrzej Pronczuk and K. C. Hayes. Myristic Acid-Rich Fat Raises Plasma LDL by Stimulating LDL Production without Affecting Fractional Clearance in Gerbils Fed a Cholesterol-Free Diet. J. Nutr. 128: 477–484, 1998.

(Kuller 06) Lewis H. Kuller. Nutrition, Lipids, and Cardiovascular Disease. Nutrition Reviews. 2006; 64:S15-S26.

(Mozaffarian 06) Dariush Mozaffarian, Martijn B. Katan, Alberto Ascherio, Meir J. Stampfer, Walter C. Willett. Trans Fatty Acids and Cardiovascular Disease. N Engl J Med 2006;354:1601-13.

(Nestle 06) Marion Nestle. What to Eat. North Point Press 2006.

(Vessby 01) Vessby B et al. Substituting dietary saturated for monounsaturated fat impairs insulin sensitivity in healthy men and women: The KANWU study. Diabetologia 2001: 44:312-319.