THE ESSENTIALITY OF FATS

At last, there is a growing appreciation of the vital nature of fats to human health. Every single cell in the body has a cell membrane (which is the real intelligence of the cell). For so long the nucleus has been wrongly credited with the status of being the 'brain' of the cell but the advances in epigenetics (for more information see our research page) have clearly demonstrated that the nucleus is in fact the reproductive bit of the cell. When the nucleus has been taken out of cells, what has been found is that the cell can continue to live for several weeks but it is unable to reproduce and so it then dies. However, when the cell membrane is removed from the cell the cell dies very quickly, in many cases immediately, because it is the orchestrator of the biological events in the cell.

The clue is in the name membrane (brain). This amazing organelle is responsible for all messages coming into the cells being disseminated accurately and is equally responsible for all waste being discharged from the cell. Its range of activities is truly breath-taking. For the cell membrane to perform its miraculous range of functions, essential fatty acids (omegas 3, 6 and 9) are vital because the cell membrane is made of fats, hence the description 'essential'. Nothing can work properly without them. Their exclusion from our diets would be life threatening.

Below are two lists. For those of you interested in the quite complex science behind essential fatty acids, the first 8 points will be of particular interest. The second list of fat facts is for those who do not want to drown in the scientific jargon but just want to know how these facts impact on health.

FAT FACTS 1

1. Dietary fat includes all the lipids in plant and animal tissue that are eaten as food. Lipids, which are solid at room temperature, are called fats and those which are liquids are known as oils. In both cases approximately 95% of the fat is made up of triglycerides. The other components of dietary fat include sterols, e.g., cholesterol and phospholipids. It's worth remembering the minor components found in dietary fats include lipid soluble nutrients such as vitamins A D and E. They too are vital to our diets.

2. Lipids are hydrophobic in nature. In aqueous solution they will not disperse. Any oil floating on water demonstrates this very well. Lipids cannot be absorbed into the body when in this form so the digestive process 'solubilises' the lipid thus making it easy to assimilate.

3. Like all digestion, the digestion of lipids begins in the mouth and continues in the stomach where the action of lingual and gastric lipases (enzymes) hydrolyses the triglycerides. This produces free fatty acids and glycerol. The lingual lipase is produced by glands at the back of the mouth, whilst the gastric lipase originates from the stomach. These enzymes are vital for the assimilation of the fats. In fact, these two enzymes combined with the churning action of the stomach result in an emulsion being formed, which the body is better able to use. It should be noted that the gastric lipase operates at a low pH (acid) so if acid production in the stomach is inadequate for any reason, then fat digestion will be adversely affected.

4. Most of the fat digestion occurs in the small intestines and is facilitated by both pancreatic juice and bile. The pancreatic juice contains bicarbonate ions which neutralise the acidity from the stomach. It also produces four major enzymes: pancreatic lipase, lipid esterase, phospholipase A2 and colipase. Pancreatic lipase works in the same way as gastric lipase but works better on breaking down triglycerides with longer fatty acid chains. The bile salts are synthesised in the liver from cholesterol and are secreted into the duodenum. They are both hydrophilic (water loving) and lipophilic (lipid loving) and so one part of the bile salt molecule interfaces with the water in the gut and the other part is attracted to the fat droplets, therefore facilitating digestion. Now a high concentration of lipid can be found on the outside of the cell and a low concentration on the inside. This difference in quantity drives the process of absorption of the fatty acids, taking them where they need to go within the body.

5. Fatty acids are made up of chains. Short to medium chain fatty acids are those with less than 12 carbon atoms and these can pass straight through into the blood stream by the hepatic portal vein into the liver. The great majority of dietary fat however is composed of more than 12 carbon atoms, and these are then transported to the endoplasmic reticulum where they are reconstituted back to triglycerides. These reconstituted triglycerides combine forming what is known as a lipid globule. Along with cholesterol and phospholipids these globules attract proteins which stick to their surface. This refined structure is called a chylomicron. A protein coating

prevents the chylomicrons from sticking together. These chylomicrons are too large to enter directly into the blood capillaries of the small intestine and so they are released into the lymphatic system. They are carried by the lymph to the thoracic duct and finally released into the blood stream at the left subclavian valve. From here they are transported to the peripheral muscle and adipose tissues before being presented to the liver. The muscle and adipose tissues extract large amounts of chylomicrons from the blood, therefore preventing the liver from lipid overload.

6. In the final stages of fat absorption, lipoprotein lipases at the surface of the tissue cell hydrolyse the fatty acids from the chylomicrons and absorb them directly into the cell, where they are reassembled as triglycerides. Any chylomicron remnants are then recycled by the liver. Most fatty acids are straight chains of even numbers of carbon atoms, with the most common lengths being between 18 and 22, although these can vary greatly, with milk containing a very short chain of only 4 carbons, whilst some fish oil has fatty acids with over 30 carbon atoms.

7. What is the difference between fats?

a) Saturated fatty acids. Saturated fatty acids are those where all the carbon atoms are saturated with hydrogen atoms. All fatty acids have an acidic end, carboxyl, and a lipophilic (methyl) end to their chain. Numbering of the carbon atoms always begins with the acidic end being number 1.

b) Unsaturated fatty acids. Unsaturated fatty acids have one or more carbon atoms unsaturated resulting in a double bond between the carbon atoms. If there is one unsaturated double bond in the fatty acid, it is known as monosaturated (e.g., oleic acid). If there is more than one double bond in the fatty acid chain, it is called polyunsaturated (PUFA). For example, linoleic acid has 18 carbon atoms and 2 unsaturated double bonds and hence it is known as an 18:2 PUFA. Alpha linoleic acid also has 18 carbon atoms but has 3 unsaturated bonds so is called an 18:3 PUFA.

c) Omega 3 and omega 6 fatty acids. The final part of the labelling of fatty acids comes from the positioning of the last double bond at the methyl end of the fatty acid chain. Thus, alpha linoleic acid (found on linseed oil) has its final double bond 3 carbon atoms away from the methyl or omega end as it is called, hence the description omega 3 fatty acid. Similarly, gamma linoleic acid found in evening primrose oil has its final double bond 6 carbons from the methyl or omega end and so is called an omega 6 fatty acid. And applying the same logic you can now work out how omega 9 has acquired its name.

d) Trans fatty acids and hydrogenated fats. The double bonds in unsaturated fatty acids are very sensitive to chemical change. The change we need to be aware of for the benefit of human health is the one from an essential fatty acid to a trans fatty acid. At first examination this change seems only to be a minor one, simply a shift in position of the hydrogen atom. In fact, it totally alters the shape and functionality of the molecule. The 'kink' found in a fatty acid when converted to a trans fatty acid is straightened out. This could be likened to straightening of a spring, which is more desirable for cooking and food processing but is undesirable for human health because of its altered physiology. With hydrogenation the double bond is 'saturated' by the addition of hydrogen atoms. This too has the effect of straightening out the molecule. Oils are often partially hydrogenated as this makes them more desirable for cooking and food processing. Hydrogenated

fats containing high levels of trans fatty acids are now considered to be even more harmful than saturated acids in some aspects of human health care. This is why hard margarine should be avoided and the labels on soft margarine examined carefully for their levels of hydrogenated fat and trans fatty acids.

e) Essential fatty acids. The essential fatty acids are those required for normal physiological function. They cannot be synthesised in adequate amounts by the body hence linoleic acid and alpha linoleic acid are truly essential. Derivatives such as arachidonic and the fish oil fatty acid docosahexaenoic acid (DHA) are now deemed to be 'conditionally essential'. The reason for this is that although the body can synthesise these fatty acids from linoleic acid and alpha linolenic acid there are circumstances where the requirements greatly exceed the rate of synthesis. One example is the human infant where there is a high demand for DHA for normal brain and nervous tissue development. However, the synthesis rate for DHA in the infant is negligible and so the shortfall of DHA must be satisfied through dietary sources. The same can be said of EPA (eicosapentaenoic acid). Both DHA and EPA have been shown to help reduce the risk of coronary heart disease, however, it is doubtful whether the body ever produces enough of these two fatty acids from alpha linolenic acid. Therefore, the deficiency must be made up through dietary modification and/or supplementation.

8. There are 3 major functions associated with polyunsaturated fatty acids.

a) Provision of energy.

b) Formation and maintenance of cell membrane integrity.

c) Production of eicosanoids.

a) Provision of energy. Fatty acids not used for structural function or eicosanoid synthesis are either stored or used for energy. Fatty acids yield energy by beta oxidation in the mitochondria of all cells except those in the brain and kidney. Although the oxidisation of PUFAs require more steps than that of fatty acids, it is in fact a faster process. In beta oxidisation 2 carbon segments are sequentially chopped away from the fatty acid and then attached to coenzyme A to form acetyl-CoA, which feeds into the citric acid cycle (the Krebs cycle) to form ATP. For a fuller description of energy derivation from fat, see Fats That Heal and Fats That Kill, by Dr. Udo Erasmus or consult a good biochemistry text.

b) Formation and maintenance of cell membrane integrity. It is now generally recognised that the structure of mammalian cells is formed as a lipid protein bilayer. The lipids in the bilayer combine with phosphate to form phospholipids. This phospholipid bilayer provides a flexible embedding structure for the proteins, which perform many of the membrane functions. These proteins may be enzymes hormones, antigen receptors or be part of the transport system responsible for most of the molecular transfer in and out of the cell. The amounts of protein and lipid in the membrane vary according to tissue type. For example, cell membranes of the central nervous system (myelin) are particularly rich in lipids, whilst mitochondrial membranes are very rich in protein. The composition of the lipid protein bilayer, which is heavily influenced by diet, largely determines the physical properties of the membrane, which in turn influence function. This is why increased concentrations of PUFAs impart much greater flexibility and fluidity in the

membrane. This flexibility and fluidity is facilitated by the 'kinked' molecules of PUFAs which pack together much less densely than either saturated or trans fatty acids. PUFAs also impart greater stability to the membrane. When there is PUFA deficiency, the following symptoms can be found; dry flaky skin, fatigue, aching and sore joints, PMS, low sperm count, mal-absorption, skin legions etc.

c) Production of eicosanoids. The third major function of the omega 3 and omega 6 fatty acids in the phospholipids bilayers of cell membranes is in their role of precursors to eicosanoids. These are complex molecules of 20 carbons. They were first discovered in the 1930s. The synthesis of eicosanoids leads to the production of a variety of prostaglandins, thromboxanes and leukotrienes. Prostaglandins are very potent in their ability to contract smooth muscle, inhibit or stimulate the aggregation of blood platelets and they can either cause constriction or dilation of blood vessels. Because of these functions prostaglandins and other eicosanoids are critically important in the regulation of heart function, blood pressure and clotting, nerve impulse transmission, inflammation, hormone synthesis, intestinal tract function etc.

Eicosanoids have what may appear at first glance to be opposing functions. Some eicosanoids inhibit blood aggregation, reduce inflammation, and improve blood flow - these eicosanoids are formed from linoleic acid and the alpha linolenic acid pathways. Other eicosanoids promote aggregation of blood platelets, constrict blood flow, and enhance inflammatory reactions. These eicosanoids are produced from the arachidonic pathway. When you look more closely you can see that these seemingly opposing functions have a different part to play at different times in the story of health and healing as there are times when the aggregation of blood platelets is imperative, such as in wound healing, and in the 'fight or flight' states of being. When dietary consumption of essential fatty acids is in balance then eicosanoid production can respond to the body's needs. However, the high levels of animal fats consumed in most western diets lead to high levels of arachidonic acid which in turn means that this pathway is disproportionately influencing our health. This situation can be corrected with dietary modification and or supplementation, ensuring the correct proportion of omega 3 and omega 6 fatty acids. This will ensure that the eicosanoids take the necessary pathway responding to the body's needs at any given moment. The importance and incredible influence of essential fatty acids in the maintenance of health, as well as their ability to limit the progression of disease, cannot be overestimated.

FAT FACTS 2

1. The more you become a student of diet the more you will understand the essentiality of fats. The important balance to strike is one of decreasing one's overall intake of fat to about 30% of total energy intake, whilst increasing those fats that are essential; omega 3 and 6. Having said this, the deficiency seems to lie most of all in the omega 3 family in the developed world. To make these adjustments one needs to modify one's diet and look to appropriate supplementation. Omega 3 fatty acids and its derivatives (EPA, DHA and alpha linolenic acid) require a substantial increase in fish, beans and green vegetables, for most people, as well as some supplementation. Although, as previously stated, omega 6 essential fatty acids are more abundantly found in westernised diets, the quite rare omega 6 gamma linolenic acid (GLA) is actually quite difficult to obtain from dietary sources, and so supplementation is advantageous e.g., evening primrose oil and borage oil supplements are rich sources of GLA, and depending on one's symptoms, may be

necessary. For those wanting a more comprehensive understanding of the subject, read Udo Erasmus's book Fats that Heal and Fats that Kill which is a useful reference on the subject of oils.

2. Lipids are essential components of immune function, with many aspects such as antigen recognition and reception, production of antibodies as well as insuring membrane integrity and correct functioning of immunologically active cells. The role of essential fatty acids in immune function is complicated and seemingly confusing but the following facts are quite clear; high fat diets where the fat constitutes more than 40% of the energy suppresses many immune functions. This includes depressing T and B lymphocyte activity, therefore leaving us vulnerable. Low fat diets tend to have a mildly immunostimulatory effect, and such diets, supplemented with increased levels of plant derived omega 3 fatty acids positively enhance T cell responses and interleukin production (Meydani et al. 1993).

3. The crippling disease multiple sclerosis is characterised by the demyelination of the neuron cells, brought about by autoimmune dysfunction. The lipid changes associated with demyelination have been correlated with a deficiency in PUFAs (Bernsohn and Stephanides 1967). Millar et al. (1973) showed that the lymphocyte level of linoleic acid in MS patients was lower than normal, and this could be corrected with dietary supplementation of sunflower oil. This correction was correlated with an improvement in the clinical symptoms of patients, who presented less frequently and had less severe relapses. Both Offner et al. 1974 and Utermohlen et al. 1981, have shown improved immune response in MS patients when their diets have been supplemented with evening primrose oil and sunflower oil (omega 6 fatty acids).

4. Of the polyunsaturated fatty acids (PUFAs) the types contained in fish oil are the most potent in suppressing inflammation. Interestingly they have also been found to suppress various immune functions, including the reduction of pro-inflammatory cytokines, interleukin production, decrease T- helper cell production, and the increased proliferation of T cells (Hubbard et al. 1991; Fujikawa et al. 1992; Meydani et al. 1993). What can be concluded from this is that a high intake of fish oil (PUFAs) would be beneficial in individuals suffering from autoimmune disease, where a mild suppression of the immune system would be beneficial and reduced inflammation is considered to be vital. Having said this, in immunosuppressed people, a very high intake of fish oil may have a negative effect on the immune system, to the point where impairment of a host responses to infection or injury could be a possibility. So, the nature of one's condition when selecting oils must be considered.

5. Epidemiological evidence now clearly demonstrates that the higher the overall fat intake in a given population, the greater mortality rate from cancer of the breast, colon, rectum, prostate, ovary and pancreas in that population (Hursting et al. 1990). The correlation of a high-fat diet with colon and breast cancer is the most consistent. Populations who change from a low-fat diet to high-fat, quickly show increased rates of cancer. This was particularly noted in colon cancer, which can express itself relatively quickly after such a dietary change (Willett 1989). It's

interesting to note that this link between fat and cancer exists irrespective of the type of fat. This clearly indicates that a dietary modification is advisable, namely reducing the overall intake of fat.

6. The role of fats in cancer and other diseases can at times seem contradictory but on closer inspection what you find is this relates to the different functions of the oils as they strive to maintain balance in the body. For example, omega 6 PUFAs, notably linoleic acid, may have a promotional effect on some types of tumour formation, such as in breast cancer. This is likely to be the case because of the over consumption of omega 6 PUFAs in the western world. This over consumption has led to an imbalance in how our immune function and inflammatory responses work, which is why it is interesting to note omega 3 fatty acids (where we have greater deficiency in the West) have an inhibiting effect on tumour formation. There is powerful epidemiological evidence supporting this position when looking at the incidence of breast cancer in Japanese women, native American Indians, and the Eskimo Inuits (Lanier et al 1980; Norsted and White 1989). These populations had a notable rise in breast cancer incidence as they adopted a more westernised diet. In fact, over a twenty-year period from 1955 to 1975 breast cancer doubled in Japanese women (Hirayama 1978). Gamma lenolenic acid (GLA), also an omega 6, seems to buck the trend and does not appear to have any promotional effect on cancer tumours and may actually exert an inhibiting effect (van der Merwe 1984; Dippenaar et al. 1982).

7. Our total fat intake should be reduced to provide approximately 30% of the total energy intake. According to the various studies, current consumption of fat is somewhere between 38 and 42% and still rising. This 30% of total energy intake assumes a reasonable activity level for both men and women. When reducing fat to 30% the extra energy requirement one may have should come from complex, fibrous carbohydrates, such as fruit and vegetables.

8. Plant oils are generally more beneficial in human health but are not always more beneficial than animal fats e.g., coconut and palm oils contain higher levels of saturated fats than most animal fats. In fact, most of the commonly used vegetable oils are poor sources of omega 3 and one should increasingly use soya and linseed (flax oils) in one's diet as either salad dressing or as stir fry oils. It is worth noting that animal fats contain significant amounts of cholesterol. This is not the case with vegetable oils.

As one busies oneself collecting the facts about fats it can seem like a daunting subject which simply numbs the mind and with that the interest, but is should be stressed this is a subject none of us can afford to avoid. The changes required are generally quite simple. Every cell in the body needs oil to perform its functions, so make sure you're getting the essential fatty acids omega 3 and 6. As already stated, omega 3 is where most people are deficient. As far as omega 6 goes, for most there appears to be adequate amounts in the diet, but a shortage of GLA, and for many some supplementation would make a difference. Finding a good all-round oil is probably the easiest way to address this. Oil on the spoon is infinitely better than capsules but for those who struggle with taking the oil, it is better to be having capsules than none at all.

Once one has chosen a good all-round oil, then depending on specific health needs or disease states, it may be necessary to look at the inclusion of other oil derivatives (those substances that may not be being properly synthesised by the person's body for one reason or another e.g., EPA and DHA). These substances, when the omega 3 pathways are working optimally, do not need any further supplementation but there are a variety of conditions where this may be necessary. Seek advice from an appropriately qualified nutritional therapist, naturopath, or holistic practitioner. None of the information here is to be viewed in isolation. The very philosophy of the Reach Approach is 'synergy is the answer'.