Vitamins

Introduction

There are 13 recognised vitamins essential to the human body, 12 of which have been given an RDA (Recommended Daily Allowance). There are in addition para B vitamins, cousins to the B vitamin family which also have beneficial effects but are thought to be in plentiful supply in the diet. There has been so much research carried out on the vitamins that many books have been written about them here we shall simply look at key functions and dietary sources. The important thing to remember is to make sure you have an adequate intake. Most of us should be able to achieve this through a fresh, whole food diet with the possible exceptions of Vitamin D and Folic Acid which are discussed below. While making sure you have sufficient also be aware of taking too much. Vitamin A in particular is worth monitoring as levels above 1500mcg have been associated with an increased risk of osteoporosis.

The following tables show the suggested Expert group on Vitamins and Minerals recommendation for intakes safe to be used in long term supplementation, the RDA and UK government Reference Nutrient Intakes which are defined by age group and sex. Within these figures where available you should be able to identify a level appropriate for your needs.

Vitamin RDAs

Nutrient	Unit	EVM SUL for long-term supplementation*	RDA	RNI Adult female	RNI Adult male
Vitamin A	µg	1500 (G, T)	800	600	700
Beta-carotene	mg	7			
Vitamin D	µg	25 (G)	5		
Vitamin E**	mg	540 (800 IU)	10		
Vitamin K	µg	1000 (G)			

Nutrient	Unit	EVM SUL for long-term supplementation*	RDA	RNI Adult female	RNI Adult male
Thiamin (B_1)	mg	100 (G)	1.4	0.8	1
Riboflavin (B_2)	mg	40 (G) (43T)	1.6	1.1	1.3
Nicotinamide	mg	500 (G) (560T)	18	13	17
Nicotinic acid	mg	17			
Pyridoxine (B_6)	mg	200 (short term)† 10 (long term)	2	1.2	1.4
Vitamin B12	µg	2000 (G)	1	1.5	1.5
Folic acid	µg	1000 (G) (1500T)	200	200	200
Biotin	µg	900 (G) (970T)	150		
Pantothenic acid	mg	200 (G) (210T)	6		
Vitamin C	mg	1000 (G)	60	40	40

The individual Vitamins

Vitamin A

Function
Vitamin A can be obtained direct from animal products in the form of retinol, or from vegetables in the form of carotene. If sufficient zinc is not available, even if there is enough in the diet, it is possible to become Vitamin A deficient. Vitamin A is a key antioxidant and is essential for healthy eyes, hair, skin, teeth, the mucous membranes, such as the lining of the mouth, and good bone structure. It plays a part in good appetite, normal digestion, the making of red and white blood cells, and helps to make the male hormones concerned with reproduction.

Common dietary sources are: fish oils, especially cod liver, fatty fish, egg yolk, organ meats, whole milk, butter, cream, cheese, yoghurt and as carotene from spinach, carrots, red pepper, broccoli, tomato, apricot, marrow, butter, cream.

Vitamin B

Vitamin B is a complex of nutrients with various interactions that make them interdependent in many respects. During stress, infection and childhood there is an increased need and lack of almost any B vitamin leads to blood sugar problems in the body.

Vitamin B_1 (thiamine)

Function
This vitamin is needed to break down carbohydrate into glucose. Early symptoms of B_1 deficiency include: personality changes, sensitivity to criticism, ease to anger, hostile aggression, irritability, poor impulse control, sleep disturbance, insomnia, fatigue, listlessness, muscle weakness, aches and pain, anorexia, neuritis, digestion problems, heart problems and shortage of breath, recurrent fever of unknown cause, intermittent diarrhoea or constipation, abdominal pain, headaches and depression. Deficiency of thiamine can adversely affect inhibitory control and the normal fear of social consequences. It also contributes to sensitivity to criticism.

Poor diet, aggravated by tobacco and caffeine addiction, creates thiamine deficiency. Stress increases the need for thiamine and the greater the content of carbohydrates in the diet the more thiamine is required for metabolism. Refined foods usually lose their thiamine content and so sugar and white flour-rich foods are conducive to deficiency in thiamine.

Common dietary sources are: wheat germ, rice bran, whole grains, brewer's yeast, nuts, dry beans, peas, soya beans, lentils, seeds, rice, heart, kidneys.

Vitamin B_2 (riboflavin)

Function
Deficiency in Riboflavin is manifested in trembling, insomnia, mental sluggishness and sensitivity to noise. Dark glasses will comfort the eyes in this condition Riboflavin assists in the breakdown and utilisation of carbohydrates, fats and proteins and is essential for healthy eyes, mouth, skin, nails and hair. Signs of deficiency are sensitivity to light, sore and bloodshot eyes, broken capillaries in the cheeks and nose, wrinkled or peeling lips and dry upper lips. There may be cracks at the corners of the mouth or dermatitis. Vitamin B_2 deficiency is linked with depression, hysteria, hypomania, hypochondriasis, and psychopathic deviation.

Common dietary sources are: brewer's yeast, liver, kidney, tongue, leafy green vegetables, whole milk, fish, butter, cheese, peas, soya beans, legumes, blackstrap molasses, egg yolks, nuts.

Vitamin B_3 (Nicotinamide or Niacin)

Function
Niacin aids utilisation of energy and is important for healthy skin, digestive system, normal functioning of the gastrointestinal tract and for the synthesis of sex hormones.

Deficiencies have been linked with dermatitis, diarrhoea and dementia with symptoms of fearfulness, apprehension, suspicion, worry, anger, depression, confusion, hostility, and irrational fears. There can also be a coated tongue, mouth ulcers, anorexia, dyspepsia, and intermittent constipation. Sufferers become fearful, tense, nervous, miserable, subject to dizziness, insomnia, recurring headaches and impaired memory. They may act immorally or criminally. Offenders with niacin deficiency have an impaired capacity to discern right from wrong. In some cases, individuals may have their moral attitudes negatively altered and in others it may lead to thoughtless promiscuity, pathological lying or petty stealing.

Common dietary sources are: brewer's yeast, lean meats (not pork), liver, poultry, fish, wheat germ, whole grains, nuts, especially peanuts, whole milk and whole milk products.

Vitamin B_5 (Pantothenic acid)

Function
Pantothenic acid has been called the anti-stress vitamin. It acts on the adrenal anti-stress glands and is needed for every cell in the body as without it sugar and fat cannot be metabolised. It is important for a healthy digestive tract, and essential for the synthesis of cholesterol, steroids and fatty acids, and the utilisation of choline. It can help the body to withstand stress.

Deficiency causes a wide variety of complaints. The adrenal glands do not function, leading to a paucity of adrenal hormones that regulate balances in the body. This may

cause a shortage of digestive enzymes with indigestion and constipation following as a result. It is also linked with food allergies. As with all the B vitamins, the mental symptoms of deficiency include depression, causing the sufferer to be upset, discontented and quarrelsome. Other symptoms are headaches, dizziness, fatigue, insomnia, and sullen-ness and it may be related to nervous disease and psychosis in alcoholics. These symptoms are common with low blood sugar.

Common dietary sources are: organ meats, brewer's yeast, egg yolks, legumes, whole grains, wheat germ, salmon, human milk, green vegetables.

Vitamin B_6 (pyridoxene)

Function
Pyridoxine is needed to make use of the essential fatty acids and many of the amino acids. It is essential for the balance of sodium and potassium (ratio 2:1) in the body; for nerve and muscle function and for making nicotinamide in the liver. It helps prevent tooth decay, kidney stones, atherosclerosis and heart disease if it is present in abundance.

Lack of B_6 diminishes the use of zinc, magnesium and manganese and can cause hypoglycaemia. Pyridoxine deficiency is linked with 'epileptic-like nervous symptoms and hysterical, explosive, labile, emotionally upset depression'. Other symptoms are fatigue, insomnia, headaches, halitosis, lethargy, pain and cramps in the abdomen, rash around the genitals, anaemia, anorexia, nausea, vomiting, diarrhoea, haemorrhoids, dandruff, dermatitis of the head, eyebrows, and behind the ears, sore lips, tongue, and a rash round the base of the nose. Hands can become cracked and sore. Night-time problems include insomnia, twitching, tremors, leg and foot cramps and bedwetting. Mental symptoms include fear, irritability, extreme nervousness, lethargy, and inability to concentrate.

Common dietary sources are: meats, whole grains, organ meats, brewer's yeast, blackstrap molasses, wheat germ, legumes, peanuts.

Vitamin B_{12} (cobalamin)

Function
Vitamin B_{12} is needed for the production and regeneration of red blood cells, and carbohydrate, protein and fat metabolism. It helps with iron function and is used with folic acid in the synthesis of choline.

Deficiency can produce schizophrenic symptoms and apathy, mood swings, poor memory, confusion, paranoia, psychosis, hearing noises and learning disabilities. Folic acid works with cobalamin and is the most common vitamin deficiency with symptoms of apathy, withdrawal, irritability and poor memory.

Common dietary sources are: organ meats, fish, pork, eggs, milk, cheese, yoghurt.

Betaine

Function
Betaine, similar to choline and inositol is a lipotropic agent which simply means that it helps prevent fat accumulation in the liver by helping convert dietary fats into phospholipids. The principle benefit that betaine brings to the body is as a supplier of methyl groups. Methyl groups are essential to the functioning of the nervous system, the immune system, the heart, blood vessels, the kidneys and liver. Methyl groups are a simple combination of carbon and hydrogen but even so the body cannot synthesise these itself and so needs a dietary supply to maintain production of RNA, DNA creatine for energy, a strong immune system, stress hormones, phospholipids and neurotransmitters that affect mood. One feature of betaine is that the methyl groups help the body neutralise levels of homocysteine which is a good thing as high levels of this compound are an indicator of increased risk of heart disease.

Common dietary sources are: Broccoli, beetroot, spinach, prawns, shrimps and eggs. The body can also derive methyl groups from supplies of choline, methionine, vitamins $B_{6,}$ $B_{12,}$ and Folic acid.

In supplemental form Betaine is often supplied as Betaine hydrochloride where it is used as a digestive aid. In this form it is best taken on a full stomach although avoided by people with excess stomach acid.

Biotin

Function
Biotin is necessary for the body's fat production, making fatty acids and for the oxidation of fatty acids and carbohydrates. It also helps in the utilisation of protein, folic acid, pantothenic acid and Vitamin B_{12}. It is useful in the treatment of candidiasis.

Deficiency is linked with depression, panic attacks, extreme fatigue, muscle pain, nausea, pain around the heart, dry peeling skin, hair loss, conjunctivitis, loss of appetite, pallor of skin and mucous membranes and lowered haemoglobin.

Common dietary sources are: egg yolks, liver, unpolished rice, brewer's yeast, whole grains, sardines, legumes. raw egg-white destroys biotin.

Choline

Function
Choline is a member of the B vitamin group and is essential for transmitting nervous impulses through the body and for making nucleic acid in the centre of the cell. It is used to make phosphatidyl choline (the main component of lecithin) and is involved in nerve functioning through its role in Acetyl choline.

Lack of choline can lead to headaches, dizziness, strokes, haemorrhage in the eye, noises in the ear, high blood pressure, awareness of heartbeat, oedema, insomnia,

constipation and visual disturbances. Because of its role in the neurotransmitter, acetylcholine, deficiency is linked with mental disorders.

Common dietary sources are: egg yolks, organ meats, brewer's yeast, wheat germ, soya beans, fish, legumes, green vegetables.

Inositol

Function
Similar in some ways to choline, inositol is also mainly functional as a phopholipid, Phosphatidylinositol and so helps to transport fat appropriately around the body

Common dietary sources are: It is often found together with choline in foods.

Folic acid

Function
Folic acid forms red blood cells in the bone marrow, the making of antibodies and the utilisation of sugars and amino acids. Essential for zinc metabolism, it helps the digestive processes and works with B_{12} in making haemoglobin in the blood. It is linked with an absence of fear of social consequences and causes poor memory. Medically its most respected function is in preventing neural tube defects in babies and so it is widely recommended to women planning a conception to include 400mcg of Folic Acid per day. As all the research has bene performed on the supplemental form Folic Acid rather than the food form Folate (which unusually for a food is much less bioavailable) a Multivitamin and mineral supplement with this level of folic acid is recommended to help prepare the Mother's body.

Common dietary sources are: green leafy vegetables, brewer's yeast, organ meats, whole grains, wheatgerm, milk, salmon, root vegetables, nuts.

Vitamin C

Function
Vitamin C is relatively well known for its preventive qualities in health but it is lost under stress. It is necessary for metabolising iron to prevent anaemia; keeps collagen (connective tissue) healthy and resists penetration by viruses, poisons, toxins such as lead, dangerous drugs, allergens, and foreign matter. It promotes healing after surgery, infection or injury, including broken bones and is important for mental health.

Deficiency symptoms include scurvy, dandruff, haemorrhages on the thighs, buttocks and abdomen, swollen and bleeding gums, leading to infection, ulceration and loss of teeth. Children short of vitamin C are prone to infections, have poor teeth and gums. Their bones break easily, they bruise easily and quickly tire and become irritable.

Common dietary sources are: citrus fruits, rose hips, sprouted alfalfa seeds, tomatoes, green peppers, broccoli and other green vegetables, blackcurrants,

strawberries and other soft fruits, bananas, apples, pears, carrot, cauliflower, new potatoes eaten with their skins, parsley. It is lost in storage and processing.

Vitamin D

Function
Vitamin D is necessary for the growth and maintenance of bones and teeth. It also aids calcium and phosphorus metabolism. From deficiency, rickets and tooth decay may be present and there may be other bone deformities. Girls with insufficient Vitamin D during childhood may have narrow pelvic development that may make child birth difficult.

The main source is the sun acting on oils in the skin but dietary sources include fish oil and fatty fish with small amounts in whole milk, free range eggs and butter.

Darker skin less readily forms vitamin D, although historically, as darker skins were exposed to more sun this was a good trade off. Anything that screens UV light such as glass or sunscreen will reduce or block this formation and leave us with a lower production of active vitamin D_3. Another problem is that as age increases, production decreases and so to get a similar level of D_3 production we would need longer in the sun. A healthy, young, fair skinned person can theoretically produce sufficient by exposing the hands and face to sunlight for 10-30 minutes, 3 times a week (depending on the intensity of ultra violet rays), although within the northern hemisphere this can be difficult during the autumn and winter months.

Vitamin E

Function
Vitamin E is an important fat soluble vitamin that helps to prevent the oxidation of Vitamin A and helps recycle Vitamin C in the body, it is also needed for the utilisation of essential fatty acids and selenium. It can help reduce the likelihood of scarring after burns, surgery and injury and is important in wound healing.

Common dietary sources are unrefined (cold pressed) vegetable oils, whole grains, wheat germ, nuts, whole milk, egg yolk, green leafy vegetables and avocado.

Vitamin F or Essential Fatty Acids (EFAs)

Function
These often over looked nutrients are important because they form a large part of the structural membranes of all cells, which are so important in maintaining good cell to cell transport. In addition they are the starting materials for the manufacture of prostaglandins that help the body deal with pain and inflammatory responses, and produce immediate hormone like responses wherever the body needs them which affects and supports all systems in the body. EFAs help in the absorption of nutrients and activate many enzymes.

Deficiency Symptoms
Deficiencies have been reported in hyperactive children, alcoholics and drug addicts. The Hyperactive Children's Support Group has demonstrated the association between EFAs and hyperactive behaviour. Recent research has shown that children with attention-deficit hyperactivity disorder (ADHD) had significantly lower EFA levels than a control group. One of the most important functions of the essential fatty acids is in brain and eye development during gestation making them vitally important during pregnancy and during the early years in particular.

Essential fatty acids
There are two families of Essential Fatty Acids which are polyunsaturated and known as the Omega 3 and the Omega 6 families. As with all things it is important that we take in a balance of both groups as these families share the same enzymatic pathways. This basically means that if one family is taken in excess it can block the body's metabolism of the other family.

There are good fats and there are bad fats. Artificially produced trans-fatty acids are bad in any amount and saturated fats from animal products should be kept to a minimum. The best fats or oils rather, since they are liquid at room temperature, are those that contain the essential fatty acids so named because like vitamins and minerals we cannot manufacture them ourselves and must take them in from our diet to live.

Seemingly minor differences in their molecular structure make the two EFA families act very differently in the body. While the metabolic products of omega-6 acids promote inflammation, blood clotting, and tumor growth, the omega-3 acids act entirely opposite. Although we do need both omega-3s and omega-6s it is becoming increasingly clear that an excess of omega-6 fatty acids can have dire consequences. Many scientists believe that a major reason for the high incidence of heart disease, hypertension, diabetes, obesity, premature aging, and some forms of cancer is the profound imbalance between our intake of omega-6 and omega-3 fatty acids. Our ancestors evolved on a diet with a ratio of omega-6 to omega-3 of about 1:1. A massive change in dietary habits over the last few centuries has changed this ratio to something closer to 20:1 which is not conducive to good health.

Sources and requirements
The main sources of omega-6 fatty acids are vegetable oils such as corn oil and soy oil, as well as the supplementary sources Evening Primrose and starflower (borage) oils which contain a high proportion of linoleic acid. The supplemental oils are also sold on the back of their Gamma Linolenic Acid (GLA content) which is an important nutrient in the metabolic pathway of the omega 6 fatty acids (see diagram). Another major source of one of the key members of the omega 6 fatty acid family is meat and animal products which are generally rich in Arachidonic acid. As can be seen on the EFA pathway it is Arachidonic acid which is the starting point for the prostaglandin 2 series. The realisation that it is the series 2 prostaglandins that create inflammation leads many people with a high meat containing diet and joint pain to put 2 and 2 together and cut down on the concentrated arachidonic acid, when combined with an increase in the omega 3 oils which reduce inflammation a reduction in pain is the positive result.

Omega-3 acids are found in flaxseed oil, walnut oil, and marine plankton and fatty fish. The main component of flaxseed and walnut oils is alpha-linolenic acid, while the predominant fatty acids found in fatty fish and fish oils are eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). The most beneficial and active of these fatty acids are EPA and DHA. Alpha-linolenic acid can be converted to EPA and DHA in the body, but the conversion is quite inefficient especially in older people.

Scientists were first alerted to the many benefits of EPA and DHA in the early 1970s when Danish physicians observed that Greenland Eskimos had an exceptionally low incidence of heart disease and arthritis despite the fact that they consumed a high-fat diet. Intensive research soon discovered that two of the fats (oils) they consumed in large quantities, EPA and DHA, were actually highly beneficial. More recent research has established that fish oils (EPA and DHA) play a crucial role in general health and many people tend not to consume enough in their diet.

Vitamin K

Function

Vitamin K was discovered through its role as a cofactor in the blood clotting process from which it takes its name (Koagulation). For many years its only recognised function was to help prevent excess bleeding by promoting proper clotting of blood. More recently vitamin K has become recognised as an important calcium partner in the body helping to ensure calcium is not deposited in the arteries where it can lead to cardiovascular problems through the development of hardened blood vessels but rather is deposited in the bone. Vitamin K therefore helps support cardiovascular health and helps bone growth.

Sources

There are two main forms of vitamin K: phylloquinone (vitamin K1) which is particularly found in leafy green vegetables, some legumes and cold pressed vegetable oils; and menaquinones (vitamin K2), which are synthesised in the gut by friendly bacteria and supplied through animal products and fermented soya in the diet There are many different phylloquinones and menaquinones which all have vitamin K activity so it is easier to just think of them as Vitamin K_1 and Vitamin K_2.

Currently there is a lot if interest in which of these forms are the most active. The bulk of this interest seems to be focussing on Menaquinone 7 (MK7) as the most biologically active Vitamin K2 for cardiovascular and bone health.