

Minerals

Introduction

A nutrient is essential if the body cannot produce it at all or cannot produce it in sufficient quantities for its needs. The body cannot manufacture minerals at all. An essential mineral is therefore taken as one in which observable symptoms are brought about by its deficiency, and upon supplying sufficient of the mineral in the diet the symptoms are eliminated.

Such a situation is easy to bring about in the case of the bulk minerals such as calcium as many problems arise when these are not supplied in sufficient quantities in the diet. Whether a trace mineral is essential is less easy to determine. Either research has to be done to demonstrate its role in the body or it is needed as an essential component of another molecule (e.g. cobalt in vitamin B₁₂). There is some debate about which are essential and which are not but one viewpoint puts 22 as being essential. Of these 6 minerals have been given an RDA (Recommended Daily Allowance). There has been so much research carried out on minerals 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 but because the mineral content of our food is dependent upon the health of the soil in which it was grown then it is difficult to be certain that the mineral content is adequate and so many people choose a mineral supplement to make up for any shortages in the diet.

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.

Nutrient	Unit	EVM SUL for long-term supplementation*	RDA	RNI Adult female	RNI Adult male
Calcium	mg	1500 (G)	800	700	700
Phosphorus	mg	250 (G) (2400T)	800	550	550
Magnesium	mg	400 (G)	300	270	300
Boron	mg	6 (9.6T)			
Chromium (trivalent)	mg	10 (G, T)			
Cobalt	mg	1.4 (G, T)			
Copper	mg	1 (10T)		1.2	1.2
Fluoride	mg	Outside terms of reference			
Iodine	µg	500 (G) (940T)	150	140	140
Iron	mg	17 (G)	14	14.8	8.7
Manganese	mg	4 (G) (9–12T) 0.5 (G) for older people			
Molybdenum	µg	Insufficient data			
Nickel	µg	Level not set (260T)			
Potassium	mg	3700 (G)		3500	3500
Selenium	µg	350 (450T)		60	75
Silicon	mg	700 (760T)			
Tin	mg	13 (G, T)			
Vanadium	µg	Insufficient data ^{††}			
Zinc	mg	25 (42T)	15	7	9.5

Notes:

SUL = Safe Upper Limit for daily supplementation

These figures have been proposed by the UK Food Standards Agency Expert Group on Vitamins and Minerals (FSA EVM) in 2003 based upon a review of available literature. It is anticipated that these figures will form the basis of the developing European legislation. The target is to stay at or below these limits for long term supplementation.

G = Guidance level; T = Total intake; *All amounts relate to 60 kg bodyweight adult and figures in parentheses are total (T) amounts from all dietary sources.

**d- α -tocopherol equivalents/day; †Implied in the text of the EVM report; ††The available studies are inadequate to support safe use of vanadium

RDA = Recommended Daily Allowances are the average amounts of each nutrient to meet the needs of practically all members of the population.

RNI = Reference Nutrient Intake appropriate to meet the needs of practically all healthy members of different sub groups of the population. Within the Government's guidelines there are variances for Reference Nutrient Intakes based upon age, and stage of life such as pregnancy, lactation but even so on the whole the RNI levels are less than the RDA.

However both are averages over large groups of people and so should not be taken as being an exact requirement. The important thing is to bear in mind Safe Upper Levels (SUL)

Individual Minerals

Boron

Function

Boron is essential to human health and behaviour. It is important for bone metabolism, endocrine (hormones) function, regulation of calcium/magnesium metabolism, brain function, especially in enhancing memory, cognitive function, and hand-eye co-ordination.

Deficiency symptoms

Deficiency can cause fatigue, lethargy, osteoarthritis, poor attention span, poor co-ordination, drowsiness, poor memory, joint pain and osteoporosis.

Good dietary Sources

Tomatoes, pears, apples, prunes, soybean and raisins.

Calcium

Function

98% of the body's calcium is used to help form bones and teeth, but the remaining 2% is equally vital in its support of muscle function, blood balance (e.g. helping blood clot in cases of injury), nerve transmission and removal of toxic metals from the body.

Lack of calcium causes or contributes to:-

rickets (in conjunction with Vitamin D) osteoporosis, receding gums and other dental problems, osteoarthritis, hypertension, insomnia, kidney stones, muscle and stomach cramps, PMS, lumbar spine pain (lower back), Bell's palsy, tetany, cognitive impairment, delusions, depression, eczema, agitation, irritability, panic attacks, fear, nervousness, tics and twitches, hyperactivity, palpitations, uneven heart beat, indigestion, constipation, as well as lead accumulation. Use of the contraceptive pill, and high consumption of sugar and chocolate reduce calcium levels.

Calcium needs to be balanced with Magnesium in the body for them both to perform to their full potential. An imbalance of these two therefore can cause hyperparathyroidism, cardiovascular complaints (low Calcium/high magnesium).

Excess calcium

High calcium is associated with bone pains, constipation and psychiatric symptoms. Anorexia, transient aphasia, ataxia, depressions, irritability, memory impairment, muscle weakness and psychosis have also been linked with excess calcium levels. Paradoxically elevated of both Calcium and Magnesium usually prevents the effective use of Calcium within the cells

Good Dietary Sources

Kelp, cheese, carob, bone broth, green vegetables, brazil nuts, dairy foods, yoghurt. Foods containing oxalic acid (sesame seed hulls, rhubarb, spinach) and phytic acid (soda and unleavened bread) can reduce availability.

Chromium

Function

Chromium is an important component of the theoretical glucose tolerance factor (its existence has not been proved) with 2 molecules of Nicotinic Acid + 1 molecule each of Cysteine, Glutamic Acid and Glycine. Glucose tolerance factor helps support the role of insulin in the body and keep blood sugar levels in balance. Optimum chromium nutrition is essential for muscle activity, strength, supply and use of glycogen, endurance and stamina. Necessary for synthesis of fatty acids and cholesterol, chromium is not easily absorbed although readily removed from the body. Even a small deficiency may be serious.

Deficiency symptoms

Deficiency is associated with anxiety, and if it continues over the long term mental confusion. It is also linked to atherosclerosis, cardiovascular disease, diabetes mellitus, poor eyesight, fatigue, glucose intolerance, growth impairment, hypoglycaemia, hypercholesterolemia and obesity.

Symptoms of Excess

Excessive levels are linked with dermatitis, gastro-intestinal ulcers, kidney and liver impairments. Sucrose (sugar) and excessive exercise increase the excretion chromium.

Good Dietary Sources

brewer's yeast, liver, whole grains, wheat germ, vegetables, butter, beer, molasses.

Cobalt

Function

Cobalt is an essential part of vitamin B₁₂ necessary for nervous system and growth and there is a relationship with iodine. In vitamin B₁₂ it aids normal functioning of all cells, especially red blood cells.

Deficiency symptoms

Deficiency is associated with pernicious anaemia, emaciation, anorexia, anaemia, slow growth and goitre.

Symptoms of excess

There are serious toxic effects and too much cobalt is thought to cause heart failure. A high protein diet counters excess cobalt.

Good Dietary Sources

Green leafy vegetables if the soil was rich, meats, brewer's yeast, seafood, nuts, fruits and whole grains

Copper

Function

Copper aids development of the brain, bones, nerves and connective tissue. It is involved in many enzyme systems, and is essential to the body but in excess can cause severe physical and mental illness. Copper supports iron with oxygen transport. It is

needed structurally for collagen and elastin and through its enzyme functions provides antioxidant activity to the body.

Deficiency symptoms

Deficiency can cause some of the disease conditions seen in copper poisoning: hyperactivity, depression, diarrhoea, fatigue, weakness, psychosis, anaemia, porous bones, loss of hair, demyelination (nerve damage), reproductive failure, elevated blood cholesterol, cardio-vascular problems and heart damage, impaired immunity and degeneration of the nervous system. It can also be a cause of anaemia.

Symptoms of Excess

High levels have been related to zinc deficiency, stuttering, autism, hyperactivity, tinnitus, hypertension, cardiovascular disease, depression, irritability, joint pain, muscle pain, nervousness, some schizophrenias and destructive aggression in children. High levels can sensitise the body to certain pharmacological drugs especially central nervous system stimulants so that these produce exaggerated responses. Even cocaine and caffeine can produce severe reactions in copper overloaded people.

Good Dietary Sources

Shellfish, brazil nuts, organ meats, dried legumes, dried stone fruits and green vegetables

Iodine

Function

Iodine is necessary for proper thyroid function which is essential for metabolism. Iodine is the key component of the thyroid hormones, e.g. thyroxine which is necessary for growth, mental and physical development and the maintenance of health.

Deficiency symptoms

Too little iodine can cause hypothyroidism, goitre, fatigue, lethargy, cold intolerance, low blood pressure, weight gain, high blood cholesterol, muscular aches & pains, muscle cramps, brittle nails, depression, constipation, hair loss, dry skin, dry hair, poor concentration, puffy face. A deficiency can also lead to various sexual problems such as: loss of interest in sex, slow development of sex organs, and heavy menstrual periods or shortened menstrual cycles. Studies in Sicily and China have shown iodine deficiency in childhood is associated with problems in thinking processes. In addition it is now thought that iodine deficiency may cause lowered vitality and basal metabolism, inability to think clearly, poor resistance to infection, loss of control over mouth muscles, defective teeth, loss of tone in the circulatory system.

This element, which is strictly not a metal, is a historical exemplar of simple nutritional therapy. When conditions such as neck enlargement or disfigurement, bulging eyes, rough skin, brittle nails and even awkward walking were cured by administering iodine, there was a rapid reaction for prevention through iodised salt.

Symptoms of Excess

An excess of iodine can aggravate acne and produce hyperthyroidism.

Good Dietary sources

Water, iodised salt, watercress, onions, kelp, shellfish, mushrooms and dark green leafy vegetables if they are grown on soil rich in iodine.

Iron

Function

Iron is the key component in the protein haemoglobin which is used to carry oxygen around in the blood stream to all the body's organs including the muscles therefore the most common sign of deficiency is fatigue and muscle weakness. In addition iron also helps in protein digestion and respiratory function. Some forms of iron are not absorbed well without vitamin C. If it is given alone it can cause loss of other essential minerals, such as zinc, manganese, chromium, selenium and cobalt.

Deficiency symptoms

The symptoms of deficiency are similar to those of excessive levels: weakness, fatigue, depression, headache, infections, mouth soreness and inflammation, pallor, lack of appetite, anorexia, digestive upset, dizziness, fragile bones and fingernails, growth impairment, inflamed tongue, irritability, difficulty in swallowing, cold extremities, mental confusion and poor memory. After physical exertion there may be long recovery periods, palpitation, shortness of breath and dizziness. Iron deficient people may have difficulty in solving problems and assessing risk. In particular with children deficiencies can show up as a problem in mental and motor development and is also associated with behavioural problems, specifically unhappiness, tiredness and tension. Deficiency may result from a zinc imbalance, and is associated with behavioural conduct problems and learning impairment.

Craving non food items may be an indication of a deficiency.

Symptoms of Excess

There is some concern over a subgroup of the population who have a genetic abnormality which increases iron absorption potentially resulting in too high a level in the body. These people have to in particular be careful about supplementing with extra iron as excess iron can have pro-oxidant properties.

Good Dietary Sources

Organ meats e.g. liver (ensure organ meats are organic to reduce the toxic metal content), kelp, brewer's yeast, molasses, wheat germ, almonds, parsley, egg yolk, lean meats, whole grains, vegetables.

Magnesium

Function

Magnesium is a natural tranquilliser. It is involved in the action of at least 300 different enzymes in body chemicals and is concentrated 18 times higher in heart muscle than in the blood stream, which is indicative of its function in regulating heart beat. Magnesium works in conjunction with calcium, for example reducing blood clotting where calcium promotes it and relaxing muscles where calcium contracts them. This mineral is vital to energy production and nerve transmission and activates

B vitamins which also play a role in these activities. Magnesium is a carrier vehicle for the transport of Sodium into and out of Cell Membranes (i.e. it facilitates the maintenance of Sodium homeostasis).

Deficiency symptoms

Stress and diseases involving secretion of adrenalin results in losses of magnesium. Deficiencies cause involuntary muscle movements, such as spasms and twitching, convulsions, insomnia, irregular heart beat, leg and foot cramps, muscle pain, restlessness, seizures, tachycardia, bedwetting and depression. Deficiency is also implicated in mental disorders, such as: anxiety, confusion, hypothermia, apathy, confusion and disorientation, learning disability and memory impairment. Behavioural symptoms such as: hyperactivity, loss of appetite and anorexia. Physical symptoms including: weakness and tiredness, numbness and tingling, nausea, vertigo, convulsions, epilepsy, uncontrollable eye flicking, muscular in co-ordination, insomnia, constipation, hypoglycaemia, difficulty in swallowing, abnormal ECG rhythm pre-menstrual symptoms, and susceptibility to the toxic effects of digoxin.

To make the problem worse a diet high in refined and processed foods is often deficient in magnesium. This can be aggravated by the addition of bran, which binds with magnesium making it less available to the body. Also, high consumption of milk, which has an extremely low magnesium-phosphorous ratio, may be involved with hyperactivity and learning disablement. Even children with high IQ can suffer learning problems due to magnesium deficiency.

Good Dietary Sources

Nuts, kelp, green vegetables, seafood, eggs, milk, whole grains, dolomite.

Manganese

Function

Manganese is needed for enzyme reactions, bone, cartilage and connective tissue growth and development, lipid metabolism and nerve function. It is necessary in the formation of thyroxine and in blood clotting. It helps with glucose tolerance so it is an important contributor to energy. Manganese absorption is depleted by dietary calcium, zinc, phosphorous, soya protein, iron and cobalt whereas lecithin, choline and alcohol increase intestinal and liver uptake.

Deficiency symptoms

Deficiencies are generally uncommon but can be manifested in disc and cartilage problems, backaches, sore knee-joints, growing pains, glucose intolerance, reduced brain function, depression, dizziness, hearing loss, tinnitus, middle-ear imbalances, as well as; birth defects, reduced fertility, pancreatic damage and growth retardation. Severe deficiency produces convulsions, skipped heartbeats, weight loss, dermatitis and hair colour loss. Manganese levels in diabetics has been found to be about half the level in non-diabetics.

Symptoms of Excess

Elevated levels of manganese can be toxic and inhibit the absorption of iron through which learning problems can arise. High levels of manganese in hair are found in

learning disabled children. Excessive manganese can reduce appetite and lead to anorexia, impaired judgement and memory, psychiatric and neurological disorders.

Good Dietary Sources

Nuts, whole grains, seeds, leafy green vegetables, brewer's yeast, egg, liver, parsley, thyme, cloves, ginger, tea.

Molybdenum

Function

Molybdenum is involved in the breakdown of alcohol. It is also involved in several different enzymes in the body where it provide an antioxidant function. In addition it supports the utilization of Iron (due to its activation of the Xanthine Oxidase enzyme).

Molybdenum is depleted by food refining and it interacts with copper so that high copper increases excretion of molybdenum. It is suggested that sensitivity to bisulphites used as food preservatives of salad greens may be due to deficiency in molybdenum.

Deficiency symptoms

A deficiency is extremely rare but it is possible that asthma may respond to an increased intake. It is also possible that in connection with a deficiency of vitamin C a shortage of Molybdenum is involved in cancer of the oesophagus, sexual impotency gouty arthritis. There are no reports of toxic effects.

Good Dietary Sources

Wheatgerm, rice, lentils, split peas, liver, cauliflower, brewer's yeast, oats

Nickel

Function

Nickel counters the blood-pressure raising effects of adrenaline. High levels are found in the blood of burn, heart attack and stroke victims whereas low levels occur in conditions of cirrhosis of the liver and chronic kidney failure. Some people are nickel-sensitive which produces dermatitis and shows up in high levels of nickel in sweat tests. These people also tend to have food allergies and intolerance.

Deficiency symptoms

Nickel deficiency results in poor growth, anaemia, depressed oxidative liver function, dermatitis, delayed puberty and poor zinc absorption.

Phosphorus

Function

Phosphorus is the second most abundant mineral in the body, being found in every cell, and along with calcium forms a major part of bones. It plays a part in almost every chemical reaction in the body, in the utilisation of carbohydrates, proteins and fats, in muscle and nerve function, digestion, kidney function and proper skeletal growth. It is found in important substances called phospholipids, which break up and

transport the fatty acids (see EFAs). Among their many functions are the promotion and the secretion of glandular hormones.

Deficiency symptoms

Deficiency is rare, since it is found in the readily used artificial fertilisers. It is also a common ingredient in many food additives and soft drinks, which are thought to contribute the excess seen in some young people today. If blood phosphorous rises too high in relation to calcium then extra calcium has to be found to balance it back out again. That calcium is taken from the bones, resulting in a loss of bone structure and potentially leading to osteoporosis or 'brittle bones'. The right way to ensure balancing it with calcium and other minerals is to obtain it from whole foods.

Good dietary Sources

Brewer's yeast, whole grains, bread, cereals, meat, fish, poultry, eggs, seeds, nuts.

Potassium

Function

Potassium is needed to regulate blood glucose and pH balance, to acidify urine and for proper nerve and muscle functioning, particularly in the heart. It is involved in the utilisation of enzymes. Potassium is necessary for growth. Together with sodium, it maintains the fluid balance in the body and may help in the transportation of nutrients into the cells. Blood and hair levels of potassium can be normal despite considerable potassium depletion in the body and so these tests need to be taken together with other factors to give an indication of the potassium levels within the body.

Deficiency symptoms

Deficiency of potassium can produce poor appetite, acne, cognitive impairment, mental apathy, depression, constipation, nervous irritability, insomnia, oedema, headaches, irregular heart beat, bone and joint pain, cramping of muscles, muscular weakness and fatigue. Low levels can predispose to high blood pressure.

Symptoms of Excess

Excessive amounts of potassium can produce cognitive impairment, weakness and can even stop the heart beating. Kidney failure, severe dehydration and severe adrenal insufficiency can raise blood levels to toxic degree.

Good Dietary Sources

Brewer's yeast, wheat germ, whole grains, vegetables, fruits, nuts.

Selenium

Function

Like Vitamin E, with which it is associated in some functions, selenium is an anti-oxidant helping to prevent chromosomal damage in tissue culture, which is associated with birth defects and cancers. It is a vital part of an important enzyme that helps the body to fight infections. It combines with toxic metals, such as cadmium, so it is useful for detoxification. It is suggested that hypersensitivity to chemicals is due to oxidation and so selenium and other anti-oxidants may minimise the ill effects of chemical exposure.

Deficiency symptoms

Deficiency is associated with growth impairment, hypercholesterolemia, pancreatic insufficiency, infections, liver impairment, age or liver spots, myalgia (muscle pain) scoliosis (spine curvature), palpitations, irregular heart rate, infertility and sterility in males.

Deficiency is a real concern these days since the largest contributor of selenium to the diet is wheat. Since the UK stopped importing wheat from North America when it joined the EU the selenium content of the diet has dropped from the recommended 75mcg to about 35mcg on average per day. Although an RDA has not been established it is important to take care over selenium content.

Symptoms of Excess

Toxic levels are difficult to achieve through the diet, as the average diet generally contains far too little selenium rather than too much. However, symptoms of excess are linked to alopecia, arthritis, brittle nails, diabetes mellitus, garlic breath odour, gastro-intestinal disorders, irritability, kidney and liver impairments, lassitude, metallic taste, pallor, skin eruptions, and yellowish skin

Good Dietary Sources

Butter, smoked herring, wheat germ, brazil nuts, brewer's yeast, whole grains, garlic and liver. For babies, human milk is an excellent source so long as the mother's levels are plentiful.

Sodium

Function

Sodium is related to potassium with an optimal ratio of 2:1 and affects blood pressure and electrolyte activity.

Deficiency symptoms

Deficiency is rare but leads to abdominal cramps, anorexia, nausea, vomiting, confusion, depression, dermatosis, fatigue, flatulence, hallucinations, headache, illusions, infections, lethargy, memory impairment, muscular weakness, taste impairment, weight loss, emotional ability, fatigue, dizziness, cramps, exhaustion, apathy and circulatory problems. Endurance exercise can cause excessive loss as can vomiting and diarrhoea.

Symptoms of Excess

Toxic levels of sodium are associated with intense thirst, anorexia, cognitive dysfunction, hyperactivity, irritability, renal failure, seizures, tremors and weight gain.

Good Dietary Sources

Sodium is present in all fruits and vegetables where it is well balanced with potassium. It is also present in animal products and is particularly high in dairy products such as cheese. It can of course always be added to the diet through the use of extra salt, but an average diet will generally supply enough without the need for added salt.

Vanadium

Function

Vanadium is thought to exert some influence in growth and on fat metabolism by inhibiting cholesterol formation. It is part of the natural circulatory regulating system, helps in treating atherosclerosis and is thought to protect against heart disease. In addition it can work independently from insulin to help regulate blood sugar levels.

Deficiency symptoms

Deficiency results in increased blood cholesterol and triglycerides, neurological, skeletal and thyroid problems.

Symptoms of Excess

Raised levels have been noted in manic-depressive patients and those suffering from bi-polar disorder.

Good Dietary Sources

Buckwheat, parsley, soya bean, eggs, sunflower seed oil, olive oil, olives, oats, rice, green bean, vegetables.

Zinc

Function

Zinc associates with copper and minute amounts are needed in metabolic processes. Zinc is essential for the production, storage, secretion and utilization of Insulin and facilitates the binding of Insulin to Insulin Receptors. Zinc is also a brain sedative as well as a facilitator for learning. It is commonly deficient in the elderly and alcoholics. Adequate levels cause reaction to alcohol so that a person with a good supply will become drunk much quicker than one who is a regular drinker.

Deficiency symptoms

Those who are deficient in zinc are also likely to be lethargic and apathetic. Zinc deficiency is associated with many congenital birth defects such as cleft lip and palate, Down's syndrome and Spina bifida. Deficiency results in loss of sense of smell and/or taste, infertility, poor wound healing, depressed immune function, poor growth, late puberty, anaemia, alopecia or hair loss, diarrhoea, depression, paranoia, anorexia/bulimia, prostate enlargement and foul body odour.

Zinc has been linked to a wide range of physical and mental ill health and disease conditions, such as pica (craving for peculiar foods including dirt or tar), impotence, impaired concentration, nystagmus (flickering eyes), speech impairment, 'jitteriness', photophobia or night blindness, skin lesions and stretch marks, acne (some types), compulsive states and poor nail growth.

Symptoms of Excess

High doses of zinc can cause nausea and stomach upset. This can be reduced by taking zinc supplements with food.

Good Dietary Sources

Oysters, whole grains, meat, brewer's yeast, wheatgerm, fruit, vegetables, nuts, offal, fish, poultry and shellfish

Toxic or Heavy metals

Aluminium

Common Sources

Ant-acid tablets, cooking utensils, food cans.

Symptoms of Excess

Aluminium can accumulate in the liver to interfere with its working. An overload of aluminium seems to affect the central nervous system and the parathyroid gland. It is believed by some researchers to be involved with pre-senile dementia, Alzheimer's or Parkinson's disease. Other indications are that it contributes to hyperactivity and non-specific joint problems as well as colic and gastrointestinal irritation. In the longer term it can also cause muscle twitching, numbness and paralysis.

Cadmium

Common Sources

Cadmium is a neurotoxin linked to intellectual performance. Zinc and cadmium have similar chemical structures. In the refining of grains such as wheat, zinc is processed out, leaving the cadmium. If grains are left whole the zinc is absorbed into the body and the cadmium is excreted. Cigarette smoking is a major source of cadmium but other sources are rubber tyres, plastics, pigments, plated-ware, alloys, insecticides, solders and dental amalgams. Food sources are oysters, some instant coffees and teas, some canned foods, gelatine, some cola drinks and pig kidneys where the pig has been given worm-killers. Interestingly cannabis is thought to concentrate cadmium.

Symptoms of Excess

The earliest sign of toxicity is raised blood pressure, but other toxic associations are alopecia, anorexia, kidney and liver damage, osteoporosis, sore joints and dry, scaly skin. Immune suppression is typical with this as with other heavy metals.

Lead

Common Sources

Old paint, water pipes and petrol are historically the main polluters of lead into the environment and some may still be present in the solder in food cans.

Symptoms of Excess

Lead is highly toxic and increases abnormal behaviour including hyperactivity, learning difficulties and reduced intelligence. Studies of children found those with high lead toxicity were significantly poorer on measures of distractibility, persistence, independence, impulsiveness, frustration, daydreaming, and ability to follow directions. Higher than 20 parts per million of lead in teeth were significantly associated with poor school performance, increased truancy, lower vocabulary and IQ scores, poorer hand-eye co-ordination, longer reaction times and slower finger-tapping. Exposure to lead in childhood was associated with deficits in central nervous system functioning that persist into young adulthood. Exposure to lead during the first

seven years of life is associated with cognitive deficits that seem to persist into adulthood. A California study of 20 juvenile delinquents found 70% were learning disabled and 60% had high lead levels. Lead toxicity is associated with abdominal pain, anorexia, anxiety, constipation, fatigue, headache, impaired co-ordination, indigestion, irritability, malaise, muscle pain, poor concentration, poor memory, restlessness and tremors. Low level exposure can cause problems of stillbirth, development abnormalities, learning, behavioural and nervous system problems, cancer, heart disease, kidney and metabolic disease, lethargy, depression, muscle aches and pains, frequent infections and immune dysfunction.

Mercury

Common Sources

Common sources are amalgam tooth fillings, seafood, medicines, cosmetics and fungicides and pesticides.

Symptoms of Excess

Mercury is highly toxic and can damage the brain and nervous system. It is an antagonist to vitamin C but vitamin E protects against it. The main symptoms are mental and neurological which can mimic multiple sclerosis. Psychic disturbance was noted in the felt-hat industry using it in the manufacture of felt, hence the term, *mad hatter*. Such disturbance is characterised by self-consciousness, timidity, undue embarrassment, anxiety, indecision, poor concentration, depression, irritability, headache, fatigue, weakness, drowsiness and insomnia. This can then progress into numbness and tingling and in severe cases there may be hallucinations, loss of memory and intellectual deterioration. Mercury excess can also lead to emotional lability and loss of libido and gastric upset.

Rubidium

Common Sources

Some fruits and vegetables depending upon the level of rubidium in the soil may contribute this toxin to the diet.

Symptoms of Excess

Rubidium has been used as a treatment for nervous disorders, epilepsy and depression. It appears to have a role in transporting minerals across defective cell membranes such as those in cancer and it has been successful in reducing tumours in laboratory mice. Human populations in countries with low cancer rates have higher rubidium concentrations in their diets. Rubidium at high level is thought to cause nausea whilst low levels have been found in those with anorexia nervosa. There is a high concentration of rubidium in the brain and the level decreases with age. It may have a tranquillising or hypnotic effect.