(ESSENTIAL) MINERALS & ELEMENTS

INTRODUCTION

Of earth's 92 naturally occurring elements, 11 bulk elements and 15 trace elements play essential roles in the human body.

Macro (bulk) elements

Arequirement of 100 or more mg/day defines macro (bulk) elements. Carbon (C), hydrogen (H), oxygen (O), nitrogen (N), sulphur (S), phosphorus (P), calcium (Ca), magnesium (Mg), sodium (Na), potassium (K) and chlorine (Cl) belong to this group. They form more than 99.5% of the body's weight.

The first six bulk elements — C, H, O, N, S & P — form the major nutrients: protein, lipids, carbohydrates, and nucleic acids, as well as water and air. C, H, O and N are not supplemented. S is provided by the sulphur amino acids methionine, cysteine and taurine, as well as preparations of garlic. P is not usually supplemented, because it is abundant in most foods. Junk foods contain an excess of P, that removes Ca and other minerals from the body. Bulk elements make up large and definite parts of the human body, and their essentiality is obvious.

Micro (trace) minerals

Micro (trace) minerals, those required in doses of less than 100 mg/day, include arsenic (As), boron (B), chromium (Cr), cobalt (Co), copper (Cu), fluorine (F), iodine (I), iron (Fe), manganese (Mn), molybdenum (Mo), nickel (Ni), selenium (Se), vanadium (V), silicon (Si) and zinc (Zn). Without the minute quantities of trace minerals, the human body could not function.

Arsenic and nickel are not added to nutritional supplements, being so abundant in our food supply that deficiencies are virtually impossible. With arsenic, toxic levels are far more likely than deficiency. Fluorine is added to water supplies and dental preparations, but not to nutritional supplements. Silicon, whose importance to human health has been overlooked and underestimated, can be obtained from certain kinds of fibre and from bamboo extract or the horsetail herb.

Trace elements function primarily as enzyme co-factors in a wide range of biological functions. They participate in biochemical reactions as **catalysts**, as **associated factors** of **metal-containing enzymes** or as **co-factors** of **co-enzymes** (e.g. cobalt in vitamin B-12).

In spite of the fact that their requirements are so small, trace elements play profound roles in health. Essentiality for trace elements is more difficult to determine than essentiality for bulk elements and must meet certain specific criteria. Dr. W. Mertz first spelt out these criteria in 1970 as follows:

1. The element is present in all healthy tissues of all living things;
2. Its concentration from one animal to another of the same species is fairly constant;
3. Its removal from the body causes a reproducible physiological or structural abnormality;
4. Its addition reverses or prevents that abnormality;
5. Deficiency of the element is accompanied by specific biochemical changes; and
6. The biochemical changes are prevented or reversed when deficiency is prevented or reversed.

Elements, that do not meet these criteria, include aluminium (Al), cadmium (Cd), gold (Au), lead (Pb), mercury (Hg), silver (Ag), titanium (Ti) and zirconium (Zr).

Elements whose status has not been fully elucidated include barium (Ba), bromine (Br), rubidium (Rb), strontium (Sr), boron (B) and tin (Sn). None of these appear at present to need to be supplemented.

Other elements may be present in the body or in food products due to natural occurrence or environmental pollution, but are not essential because they don't meet the criteria spelled out by Dr. Mertz.

Meeting the body's need for essential elements

It may be easy or difficult to obtain adequate quantities of elements in the diet. For instance, barium, nickel, arsenic, boron and tin may have biological roles, but their distribution in the biosphere far exceeds our requirement for them. Adequate quantities are obtained from consuming minute amounts of food.

Fluorine (F), found in bones, is a trace element that is not used in supplements. Some municipalities add it to drinking water, and dentists use it in special preparations to harden the teeth of their patients. Silicon (Si), also found in bones, is now being supplemented, usually as bamboo extract or horsetail herb.

On the other hand, selenium, chromium, iodine and zinc are rarer in the biosphere, and obtaining sufficient quantities of these elements can be a problem. For instance, vast expanses of food bearing lands are selenium-depleted and therefore the foods grown on these lands will lack this mineral. Soil depletion of iodine, zinc and other trace elements is also a concern, because soil mineral deficiency must result in mineral deficient plants harvested from these mineral deficient soils.

Many studies, including several conducted by the U. S. Department of Agriculture (USDA), have shown that mineral content of soils and of foods have decreased steadily during this century. Zinc deficiencies in plants occur in at least thirty of the continental forty-eight states of the USA. Chromium levels in the diets of North Americans and Western Europeans are only 10 to 35% of those in the Eastern world.

Besides low concentration of minerals in raw foods grown on mineral-poor soils, processing results in mineral losses. For example, when wheat is milled to produce white flour, the germ and bran are removed (and fed to pigs or thrown away). The discarded germ and bran contain 84% of the magnesium, 60% of the calcium, 71% of the phosphorus, 77% of the potassium, 76% of the iron, 78% of the zinc, 40% of the chromium, 86% of the manganese, 89% of the cobalt, 68% of the copper, 48% of the molybdenum, 16% of the selenium and part of the boron, sulphur and iodine present in the wheat kernel. In addition 50 to 81% of both the fat-soluble and water-soluble vitamins, 100% of the essential fatty acids and 30% of the protein are also removed when wheat is processed into white flour. Similar nutrient losses occur when other foods, such as rice, corn and sugar cane are refined.

Chemical additives in our diets also decrease the mineral content of our foods. For example, EDTA, a common preservative, binds several minerals, making them unavailable to the body. Phosphates added to baked goods, ice cream, soft drinks and beer impair our absorption of iron, calcium, magnesium and zinc.

MA CRONUTRIENT (BULK) MINERALS

CALCIUM (Ca)

General: macronutrient element; the bone mineral;

- Most abundant body mineral, comprising over 1.5% of total body weight, about 1,200 grams (phosphorus content is about 680 grams);
- 99% of body's calcium is in bones & teeth; remaining 1% distributed in soft tissues;
- Calcium exchanged between bones, body fluids & soft tissues; adequate daily intake prevents calcium loss from bones (osteoporosis);

Nutrition

- **Sources:** fish flour, cooked bones, collards, kale, other green leafy vegetables, dairy, tofu, canned sardines, salmon, tuna, hard water;
- **Supplements:** amino-acid chelates**,** bone meal, dolomite, calcium salts & acid salts, multi-mineral & multi-mineral-vitamin formulations;
- **Absorption** from duodenum & upper part of small intestine; children absorb up to 75%; adults absorb 30 - 50% under best conditions, 10 - 30% under normal conditions;
- **Improved by:** body's need for calcium; vitamin D (helps make carrier protein); acidity (decreases with age); presence of lactose, fructose & ribose; phosphorus;
- **Antagonized by:** oxalates (rhubarb, spinach); phytates (bran); dietary fat (forms insoluble calcium soaps); emotional instability; increased gut motility; lack of exercise;
- **Storage:** mainly in bones & teeth; 1% in extra-cellular fluids & soft tissues;
- **Excretion:** through urine & bile;
- **Metabolism:** regulated by magnesium concentrations; balance between calcium & magnesium is important to health; pregnancy, lactation & growth requires more calcium; high intake results in lower % absorption; lower intake gets higher % absorption;
- **Interactions**: calcium carbonates neutralize stomach HCl & require increased supply of this acid for absorption; high protein diet accelerates calcium loss;

Functions of calcium

- Involved in formation of bones: calcium phosphate + calcium hydroxide (hydroxyapatite) crystals in a matrix of collagen embedded in gelatinous substance (mucopolysaccharides);
- Involved in formation of teeth: middle layer (dentin) is like bone; outer layer (enamel) is denser hydroxyapatite crystals embedded in keratin; little change once formed; teeth contain 1% of body calcium;
- Calcium is required for muscle contraction;
- Essential for nerve conduction;
- Essential for blood clotting: calcium in injured tissue stimulates release of phospholipids (thromboplastin- tp) from injured platelets; tp catalyzes conversion of a normal blood constituent (prothrombin) to thrombin (Th); Th aids in changing another blood component (fibrinogen) to fibrin, that is the clot;
- Essential to heart beat;
- Involved in energy production;
- Required to maintain immune function;

- Regulates cell membrane permeability; regulates cellular activities (messenger molecule);
- Catalyst in many biochemical reactions: absorption of vitamin B- 12; activity of pancreatic lipase; secretion of insulin; formation & breakdown of neurotransmitter acetylcholine;

Quantities

- **Measurement:** in milligrams;
- **Optimum: (SONA)** ranges not yet set;
- **Individual** optimum needs to be determined for each individual; calcium requirement increases with intake of protein, fat, alcohol, phosphorus (junk diets); smokers require increased amounts of calcium;
- **Minimum: (DRI)** set at 1000/1300 mg/day;
- **Less than RDA:** 68% of population, according to a U.S. government survey;
- **Deficiency** from inadequate intake; poor absorption; excess phosphorus; excess magnesium; deficiency of vitamin D or too little skin exposure to sunlight; excess dietary protein; overuse of antacids; transfusion of citrated blood; hypo-parathyroid; chronic kidney failure;
- **High risk** in elderly, users of aluminum-containing antacids, alcohol or cortisone; inactive people, those on low-calorie diets, those eating high protein diets & those on high fibre diets; milk-intolerant people, pregnant women;
- **Symptoms include:** muscle cramping, bone & tooth malformation, anxiety, allergies, heart palpitations, insomnia irritability, seizures, loss of cognitive function, weak bones & teeth, stunted growth;
- **In infants**, rickets, described under vitamin D;
- **Chronic mild deficiency** may produce cataract; osteoporosis (10 -50% of people over 50), (higher incidence in women because women lose calcium 3x as fast as men); spontaneous bone fractures (80% in women); {osteoporosis also involves poor diet, poor absorption, poor utilization, parathyroid gland irregularity, failure to synthesize collagen matrix, immobility, loss of estrogens}; osteomalacia: lack of sunshine, anti-convulsive drugs, successive pregnancies & lactation;
- **Severe deficiency:** abnormal heartbeat, dementia, muscle spasms (tetany), convulsions;
- **Toxicity:** from acute renal failure, excess vitamin D (hypercalcaemia), too little phosphorus, lack of activity, immobilization, excess thyroid, excess parathyroid, tuberculosis, malignancies, beryllium & drugs including lithium, thiazides & others;
- **Excess** or deficiency of magnesium or imbalance in Ca-Mg ratio may form kidney stones, cause soft tissue calcification, produce magnesium deficiency & premenstrual syndrome;
- **Prevented by:** presence of magnesium in equal amounts;

Therapy with calcium

- Useful in treatment of osteoporosis;
- Important in pregnancy & lactation;
- May be helpful in PMS, with evening primrose oil, magnesium, zinc & vitamins B-3, B-6 & C;
- Helps ease "growing pains" of children & adolescents; may help relieve muscle cramps;
- May be required by vegans on diets high in vegetable protein;
- Female athletes & post-menopausal women require increased calcium (lower oestrogen);
- Useful for those intolerant to milk;
- Calcium protects against toxicity from lead (Pb);
- Along with vitamin D, calcium (1,250 mg/day) may prevent colon cancer (slows colon cell division, detoxifies bile acids);
- Useful for lowering blood pressure in some hypertensive individuals (1,500 mg/day); helps prevent cardiovascular disease; may lower high cholesterol in some individuals;

- Anecdotal reports of calcium use as natural tranquilizer, alleviation of cramps in legs of pregnant women & improved skin health (a calcium-dependent anti-oxidant enzyme is present in skin; calcium deficiency may speed skin ageing)
- **Synergists:** vitamins D and K; magnesium; phosphate; silicon; boron.

MAGNESIUM (Mg)

General: macronutrient element; the relaxation mineral; heart mineral;

- Adult body contains about 25 grams of magnesium;
- First studied in rats & found associated with neuro-muscular abnormalities;
- Human depletion of this mineral is more common than expected;
- Many interrelationships with electrolytes, messengers, hormone receptors, vitamin D metabolism, bone functions, etc.;
- Plays a major role in cell functions in all organs;
- **History:** discovered in 1859; essentiality established for mice in 1926, for rats in 1932; essentiality for humans established in 1950; magnesium deficiency first described clinically in humans in early 1950's;

Nutrition

- **Sources:** good: mineral ion in chlorophyll present in all green plants; abundant in whole foods (except milk) - soybeans, shrimp, wheat germ, whole grains, molasses, clams, cornmeal, spinach, oysters, crab, peas, liver, beef; poor: refined & processed foods;
- **Supplements:** magnesium salt, acid salt, amino acid chelate, multi-mineral, multi-vitaminmineral formulations;
- **Absorption** from small intestine; about 50% of magnesium in foods is absorbed (30% from high intake; 60% from lower intake);
- **Improved by:** body's need for magnesium;
- **Lost by:** some drugs; fasting, low phosphate, low potassium, high calcium & high magnesium; stress, disease, sweat, excess fibber; alcohol, diuretics; vomiting of gastric juice;
- **Storage:** more than 65% of magnesium found in bone; level of intracellular magnesium in muscle & liver = 7x that in blood;
- **Excretion:** excreted & regulated through kidneys;
- **Metabolism:** controlled by thyroid gland;
- **Interactions:** diuretics, drugs toxic to kidneys, corticoid-steroids; heart drug digitalis induces magnesium deficiency;

Functions of magnesium

- Catalyst in hundreds of reactions, many in energy production facilities of cells (mitochondria);
- Required in all reactions that involve release or expenditure of energy; ATP production;
- Required in almost all reactions involving carbohydrate, lipid, protein & nucleic acid metabolism;
- Involved in reactions related to synthesis, degradation & stability of genetic material (DNA);
- Fulfills vital role in nerve transmission & muscle relaxation;
- Important to maintain electrical stability of cells, membrane integrity, regulation of blood vessel tone; regulates calcium entrance into cells; regulates heartbeat;

- Necessary to maintain acid-alkaline balance of body fluids;
- Important role in bone physiology & tooth enamel formation;
- Plays part as co-factor or catalyst in at least 300 enzyme reactions;
- Necessary to transform essential fatty acids to prostaglandins;
- Plays role in cold adaptation;

Quantities

- **Measurement:** milligrams;
- **Optimum: (SONA)** set at 300 mg/day
- **Individual** optimum needs to be determined for each individual case; best balance between calcium & magnesium is about 1: 1;
- **Minimum: (DRI)** set at 300/400 mg/day;
- **Less than RDA:** 70% of population, according to a U.S government survey; imbalance in magnesium-calcium ratio is widespread because of over-consumption of magnesium-poor dairy products & calcium-rich formulations;
- **Deficiency** from inadequate diet, poor absorption, diarrhoea, inflammatory bowel disease, gluten intolerance, short bowel syndrome; impaired kidney reabsorption, hormonal disorders, genetic conditions; alcoholism, burns, trauma, protein-energy malnutrition; low phosphate, low potassium, low calcium; increased dietary requirement;
- **At risk**: elderly, people on low-calorie diets, diabetics, people taking diuretics or digitalis, alcoholics, pregnant women, those doing regular & strenuous exercise;
- **Symptoms include:** muscle ache, tremor, spasm & cramp; low blood sugar, irritability, fatigue, depression, anxiety, sleeplessness;
- **Extreme deficiency:** growth impairment, cardiovascular disturbances, calcium deposits in kidneys, heart & joints; calcium deposition in soft tissues; loss of appetite, nausea, vomiting, confusion, tremors, loss of coordination, cardiac arrhythmia;
- **Toxicity:** excess (more than 3 grams) causes diarrhoea; not toxic if kidneys are normal; in kidney failure, high magnesium can result in coma & heart failure;

Therapy with magnesium

- Protective against heart disease & helpful in treatment of high blood pressure; improves survival chances after heart attack; prevents ischemic heart disease;
- May be helpful in treating PMS, along with zinc, vitamins B-6, B-3 & C;
- Appears to help prevent oxalate kidney stones, with B-6; not effective with gall stones;
- Might have positive effect on depression, through its role in neurotransmitter synthesis;
- Effective in treatment of convulsions in pregnant women, premature labour & pre-eclampsia (high blood pressure, swelling {oedema} of tissues, protein in urine) & eclampsia (convulsions, coma);
- Treats neuro-muscular & nervous disorders due to magnesium deficiency;
- Treats magnesium deficiency-induced respiratory muscle weakness;
- Can be used to induce diarrhoea (cure constipation);
- Useful, with calcium in the treatment of cramps;
- Prevents arrhythmias;
- Replenishes loss of magnesium from diarrhoea, prolonged sweating, diuretic use & alcoholism;
- Part of program to alleviate cramps & cravings of premenstrual syndrome (PMS);
- **Synergists:** vitamin B-6; calcium; phosphorus;

POTASSIUM (K)

General: macronutrient element; electrolyte; "alkalinizing" mineral;

- Electrolytes regulate fluid levels & acid-alkaline balance throughout body, both in & outside cells;
- Adult body contains about 270 grams of potassium;
- Whole foods contain 10 times more potassium than sodium; addition of table salt (NaCl) lowers K/Na ratio; body's normal Na/K ratio is about 2/1; Na/K inside cells is 1/10; Na/K outside cells is 28/1;
- Body by nature is better able to hold on to sodium than to potassium because natural foods are high in potassium but low in sodium; modern diets have high sodium & low potassium, leading to potassium depletion & sodium excess;
- Potassium mostly intra-cellular (sodium & chlorine mostly extra cellular);
- **History:** importance of potassium in blood pressure observed in 1959, confirmed in 1983;

Nutrition

- **Sources:** best: watercress, parsley, apple cider vinegar, olives, bananas; good: whole, natural, unprocessed foods; potato peels;
- **Supplements:** potassium salts (chloride, gluconate), multi-mineral, multi-mineral-vitamin supplements; (however these do not contain nutritionally significant amounts);
- **Absorption** from small intestine; 90% absorbed;
- **Antagonized by:** diuretics may result in serious loss of potassium;
- **Storage:** potassium stored mostly in muscles & nerves, but all cells concentrate potassium; increased muscle mass (athletes) increases body potassium up to 50%; aldosterone increases loss of potassium; potassium is not well conserved by body; aspirin increases loss;
- **Excretion:** through kidneys (7%/day);
- **Metabolism:** potassium intake should exceed sodium intake by 10x; blood potassium rises when there is tissue proteins & glycogen breakdown (catabolism) or potassium leaving cells (acidosis) such as during diarrhoea; blood potassium drops when tissue or glycogen is being formed (anabolism) or potassium entering cells (alkalosis); low blood sugar & stress increase potassium loss;
- **Food processing** (canning, salting, flavouring) removes potassium & adds sodium to foods;
- Magnesium helps keep potassium inside cells;
- **Interactions:** diuretics & many drugs result in potassium loss from the body; high sodium causes imbalance of potassium in cells; corticosteroid (aldosterone);

Functions of potassium

- Regulates fluid, electrolyte & acid-base balance in body;
- Required for growth (1 gram for every pound gained);
- Catalyst of many reactions inside cells, esp. protein & release of energy; high sodium levels interfere with protein synthesis (important for athletes & body builders);
- Essential to convert glucose molecules into glycogen energy reserves;
- Required to maintain the electric potential across all cell membranes; this helps protect cells against invasion by organisms & foreign chemicals;
- Potassium may be involved in bone calcification;
- Prevents sodium from entering cells & interfering with protein metabolism; prevents potassiuminduced water retention (oedema) & damage within cells of some people;

- Necessary for muscle building; muscle cells contain 6x as much potassium as sodium; increases muscle strength;
- Maintains osmotic pressure & acid-base balance;
- Maintains electrical potential across cell membranes (along with sodium); particularly important in nerve transmission & muscle contraction;
- Plays role in release of insulin from pancreas;
- Along with magnesium, potassium acts as muscle relaxant (opposite to calcium);
- Helps body get rid of excess water (opposite to sodium, that leads to water retention);
- **Antagonized by:** excess sodium can interfere with potassium's functions in protein metabolism, nerve transmission, muscle contraction, glucose absorption, nutrient transport;

Quantities

- **Measurement:** milligrams, grams;
- **Optimum:** from 4,000 to 6,000 mg/day of potassium, in K/Na ratio about 10:1 Individual optimum needs to be determined for each individual case;
- **Minimum: (DRI)** for potassium is about 4,700 mg/day for adults;
- **Less than RDA:** not measured; potassium depletion increases with age by over-use of sodium salt;
- **Deficiency** from vomiting (bulimia), sweating (especially lose potassium) & diarrhea (especially in children); use of diuretics & digitalis, prolonged use of laxatives, severe proteincalorie malnutrition, surgery, wounds, burns; diabetic acidosis, GI disorders, cancer, adrenal tumours; athletes may lose up to 800 mg of potassium in sweat during 3 or 4 hours of training;
- **Symptoms** of potassium deficiency include muscle weakness, poor intestinal tone, abdominal bloating, inability to concentrate urine; heart abnormalities, irregular heartbeat (arrhythmia) & weakness of respiratory muscles; mental confusion, depression, apathy, anorexia, nervous disorders, insomnia, paralysis; poor digestion; laboured breathing; high blood pressure;
- **Sub-clinical deficiency:** lowered glycogen reserves, tendency to higher blood sugar levels, increased insulin need (even overproduction) & increased fat production & deposition;
- **Toxicity:** from excess intake (above 17 grams/day), dehydration, adrenal insufficiency or inability to concentrate urine (elderly); results in disturbed muscular co-ordination;
- Severe cases: cardiac arrest, usually from kidney failure;

Therapy with potassium

- Reverse potassium deficiency induced by diuretics & other drugs;
- Replenish potassium lost by athletes through sweat during exercise & competition; increase potassium necessary for muscle (protein) building;
- Used to treat allergies & to alleviate symptoms of rheumatic & arthritic conditions;
- Used to treat infant colic;
- Helpful in diabetes to reduce blood pressure & blood sugar levels;
- Used to treat headache due to allergy;
- Potassium helps prevent high blood pressure & strokes; may reverse high blood pressure;
- Breaks up lymph congestion;
- As part of a complete program, potassium is used in nutritional treatment of cancer;
- Potassium supplementation is not recommended for people with impaired kidney function, untreated Addison's disease or taking digitalis-type drugs;

CHLORINE (Cl) & SODIUM (Na)

General: macronutrient elements; electrolyte minerals;

- Electrolytes regulate fluid levels & acid-alkaline balance throughout body; both in & outside cells;
- Body contains about 140 grams of chlorine; 140 grams of sodium;
- Chlorine & sodium mostly extra-cellular;

Nutrition

- **Sources:** sodium & chlorine in table salt, soy, tamari, salted foods, most prepared foods;
- **Supplements:** betaine HCl, amino acid HCl, not usually included in multi-mineral & multi-mineral-vitamin supplements; excess sodium greater problem than deficiency, due to overuse of table salt;
- **Absorption** from stomach & small intestine;
- **Improved by:** sodium absorption triggered by aldosterone (adrenal steroid hormone);
- **Antagonized by:** vomiting (especially loss of chlorine); water loss in diarrhoea;
- **Storage:** sodium & chlorine mostly stored & concentrated in extra-cellular fluids;
- **Excretion:** excess excreted in urine;
- **Metabolism:** must balance sodium & chlorine intake; concentrations regulated by kidneys, under influence of adrenal steroid hormone (aldosterone);

Functions of chlorine & sodium

- Sodium & chlorine regulate fluid, electrolyte, & acid-base balance in body;
- Chlorine: part of stomach acid (HCl), that begins digestion of proteins & kills bacteria; allows blood to carry carbon dioxide; necessary for growth of bone & connective tissue;
- Sodium: main extra-cellular ion; determines water balance;
- Along with potassium, sodium maintains the electric charge of membranes surrounding all cells;
- Keeps minerals dissolved in body fluids, preventing their deposition;
- Necessary for HCl production in the stomach;
- Along with chlorine, sodium keeps blood & lymph fluids healthy;
- Sodium helps keep calcium in solution;

Quantities

- **Measurement:** milligrams, grams;
- **Optimum** K/Na ratio about 10: 1; Na & Cl: optimum ratio = 1: 1;
- **Individual** optimum needs to be determined according to individual condition;
- **Minimum** (US RDA) 115 mg/day of sodium maintains sodium balance (average intake is 3,000 to 7,000 mg/day); recommended chlorine intake suggested as 1,700 mg for adult (275 - 1,400 for children, depending on age);
- **Less than minimum:** not usual; over-use of sodium salt much more common;
- **Deficiency** from vomiting, sweating & diarrhoea;
- **Symptoms include:** for sodium & chlorine, thirst; weakness, nausea, confusion; chlorine deficiency unlikely unless sodium also deficient;
- **Toxicity:** overuse of NaCl (table salt) associated with stomach cancers in Japan & other cancers according to clinical observations; sodium toxicity associated with high blood pressure

- (hypertension) & water retention (oedema), especially when combined with potassium deficiency; may lead to heart disease;

Therapy with sodium & chlorine

- Replace chlorine lost by vomiting & bulimic regurgitation;
- Sodium may help prevent & treat cramps & heat strokes;
- Low sodium diets used clinically to prevent or relieve symptoms of bacterial poisoning (toxaemia), water retention (oedema), protein in urine (proteinuria) & blurred vision;

MICRONUTRIENTS (TRACE) MINERALS

BORON (B)

General: trace mineral;

- Long known to be essential for plants; recently recognized as essential for humans;
- Found in antibiotic molecules made by Streptomyces species;
- **History:** boron discovered in 1910; confirmed essential for plants in 1923; indications of essentiality for humans between 1981 & 1984;

Nutrition

- **Sources:** best: vegetables, fruit, seeds, nuts; poor: dairy, fish, meat, fowl, refined & processed foods;
- **Supplements:** boron salts, multi-mineral, multi-mineral-vitamin;
- **Absorption** rapid from intestinal tract; little known about mechanism of absorption; average adult intake of boron varies between 1.7 & 7 mg/day;
- **Storage:** highest concentration in bone; high concentrations also in thyroid & parathyroid glands;
- **Excretion:** through urine (90% of single dose within 1 week);

Functions of boron

- Not yet fully elucidated;
- Known to be important for growth of plants;
- Thought to be important for growth & development of animals;
- Thought to have important role in bone construction & density;
- Thought to influence action of parathyroid hormone, indirectly influencing metabolism of calcium, potassium, magnesium & vitamin D-3
- Important in trace quantities for calcium uptake;
- Complexes with sugars, polysaccharides, adenosine-5-P, vitamins B-6, B-2, C & genetic material (pyrimidine nucleotides);
- Inhibits B-6 & B-2 requiring enzymes (oxido-reductases); by binding to active site, inhibits digestive enzyme (chymotrypsin) & 2 other enzymes;
- May play a direct role in the functioning of membranes;