MACROMINERALS

MAGNESIUM

Definition	▪ Magnesium is a predominantly intracellular mineral. ▪ Magnesium facilitates as many as 300 enzymatic reactions. ▪ 60% of magnesium in body is found in the bone, 25% in muscle and the remainder in the fluids and soft tissue. ▪ Found in high concentrations in the mitochondria ▪ Found in high concentrations in heart muscle
Functions	▪ Structural integrity of teeth and bones ▪ Regulates contractility of heart muscle ▪ Relaxes smooth muscle ▪ Decreases coagulation of the blood ▪ Necessary for essential fatty acid metabolism ▪ Essential for protein synthesis ▪ Used to produce urea in the urea cycle in the liver ▪ Along with vitamin B6 is useful for prevention of kidney stones
Food Sources	▪ Buckwheat flour ▪ Whole wheat flour ▪ Tofu ▪ Almonds ▪ Wheat germ ▪ Cashews ▪ Brown rice ▪ Kidney beans
Clinical Uses	▪ Constipation ▪ Muscle cramping—especially nocturnal ▪ Acute angina or after Myocardial Infarction ▪ Kidney stone prevention ▪ PMS ▪ Menstrual cramps ▪ Heart disease—arrhythmia, hypertension ▪ Migraine headaches

Deficiency	▪ Very common in the US due to:
	  ▪ Major processing of food
	  ▪ Soil depletion
	  ▪ Exogenous estrogens such as birth control pills and H.R.T.
	▪ Symptoms include:
	  ▪ Muscle spasms and tightness
	  ▪ Painful menstrual cramps
	  ▪ High blood pressure and heart arrhythmias
	  ▪ Increased blood triglycerides and cholesterol
	  ▪ Nerve conduction problems

Toxicity	▪ High levels of supplemental magnesium can cause diarrhea—about 800 mg of elemental magnesium will cause a loose stool.

	▪ Magnesium competes with calcium and can lead to calcium deficiency. ▪ People with kidney failure should be careful of taking too much magnesium, due to its potential toxicity.

PHOSPHOROUS

Definition	▪ Second most abundant mineral in the body, after calcium ▪ 80% of the phosphorous in the body is found in the form of calcium phosphate crystals in the bone and teeth. ▪ Phosphorous levels are maintained by parathyroid ▪ A 1:1 intake of calcium to phosphorous is ideal for maximum absorption of calcium. ▪ In the Western diet we consume about twice as much phosphorous as we need. ▪ Main source of phosphorous in the Western diet comes from carbonated beverages and food additives.
Functions	▪ Structural component of teeth and bones ▪ Essential component of nucleic acids of DNA and phospholipids that make up cellular membranes ▪ An essential part of ATP (Adenosine Tri-Phosphate) the major energy compound in the body ▪ An important component of many structural proteins, e.g. casein in human milk ▪ Involved in acid-base buffering as part of the calcium phosphate buffering system
Clinical Uses	▪ Useful for the treatment of acute parasympathetic symptoms particularly nausea ▪ Gallstones
Deficiency	▪ Phosphorous is so abundant in the Western diet that phosphorous deficiency is not common. ▪ May occur with: ▪ the use of antacids which may bind phosphorous ▪ alcoholism ▪ during the treatment of diabetic acidosis ▪ certain vegetarian diets
Toxicity	▪ Excess phosphorous can inhibit calcium absorption and lead to problems of osteoporosis. ▪ Can leach calcium from bones and teeth

CALCIUM

Definition	▪ The most abundant mineral in the body, making up at least 1.5-2.0% of the body by weight ▪ Most of the calcium in body is stored in bone and teeth ▪ Regulated by 2 hormones: ▪ Calcitonin—decreases serum calcium by increasing calcium deposition in bone and decreasing calcium absorption ▪ Parathyroid Hormone—raises serum calcium by causing calcium resorption & increasing calcium absorption in gut ▪ Calcium metabolism is closely related to vitamin D.
Functions	▪ Major part in structure of bone and teeth ▪ Calcium ions add hardness to bone matrix. ▪ Facilitates movement of nutrients across cell membranes ▪ Required for neurotransmitter activity ▪ Required by the heart for proper contraction ▪ Initiates the clotting process
Food Sources	▪ Dairy ▪ Leafy greens: collard greens, turnip greens, spinach, and dandelion greens ▪ Yeast ▪ Lamb ▪ Sardines ▪ Rhubarb ▪ Oatmeal ▪ Tofu
Clinical Uses	▪ Osteoporosis ▪ High cholesterol ▪ High blood pressure ▪ Blood clotting ▪ Periodontal disease ▪ Muscle relaxant ▪ Insomnia ▪ The treatment of kidney stones (particularly as calcium citrate)
Deficiency	▪ A lack of calcium can lead to osteoporosis. ▪ Muscle cramps and tetany are signs of calcium deficiency. ▪ Calcium deficiency is associated with the following: ▪ Periodontal disease ▪ Hyperactivity ▪ Anxiety ▪ Insomnia
Toxicity	▪ Excess calcium supplementation can cause imbalances with other minerals,

	particularly magnesium.

POTASSIUM

Definition	▪ One of the major intracellular minerals and electrolytes ▪ Actively transported in and out of the cell ▪ Increasing levels of aldosterone, an adrenal hormone, cause the excretion of potassium from the body. ▪ Excreted under the influence of many diuretic drugs
Functions	▪ One of the major transport systems in the body via the sodium-potassium pump ▪ Functions to maintain proper cellular fluid levels ▪ Acid-base balance in the body ▪ Essential for nerve conduction ▪ Essential for heart function
Food Sources	▪ Avocado ▪ Apricots ▪ Potatoes ▪ Cantaloupe ▪ Lima beans ▪ Parsnips ▪ Raisins ▪ Sardines
Clinical Uses	▪ High blood pressure ▪ Abnormal heart beat ▪ Atherosclerosis
Deficiency	▪ Many people are deficient in potassium ▪ Often leached out of cooked food due to water soluble nature ▪ Some of the signs and symptoms include: ▪ Fatigue ▪ Mental confusion ▪ Muscle weakness and cramping ▪ Cardiovascular problems
Toxicity	▪ Toxicity comes mostly in the supplemental form ▪ Signs and symptoms include: ▪ Nausea ▪ Vomiting ▪ Diarrhea ▪ Abnormal heart beats may be a sign of potassium excess due to potassium's effect on the heart. ▪

MICROMINERALS

IRON

Definition	▪ 1/3rd of the body's iron is stored in the liver, spleen and bone marrow. Remaining 2/3rds is found in hemoglobin and myoglobin. ▪ Iron exists in 2 forms: heme iron and non-heme iron. ▪ Heme iron is better absorbed. It is found primarily in meat, and once digested, it can be directly absorbed into the bloodstream. ▪ Non-heme iron is found in animal and plant products. It must be removed from the food source, converted into the ferrous form of iron (a process that requires stomach acid and vitamin C), and joined to an amino acid before being absorbed
Transport, Storage, & Function	▪ Iron is transported in the body by a carrier protein called transferrin. ▪ Iron is stored in the body as ferritin, which is a marker of long term iron stores in the body. **Functions of Iron** ▪ Iron is the major component of heme, which is the main part of hemoglobin, the molecule that carries oxygen and carbon dioxide in red blood cells.
Food Sources	▪ Beef liver ▪ Molasses ▪ Amaranth ▪ Ground beef ▪ Seaweed ▪ Leafy greens—chard, collard, and mustard greens ▪ Oysters ▪ Lentils
Clinical Uses	▪ Treatment of iron deficiency anemia ▪ Decreased immune function ▪ Restless leg syndrome
Deficiency	▪ Iron deficiency causes anemia **Signs and symptoms of iron-deficiency anemia** ▪ A sense of fatigue and being overly tired or drowsy ▪ Weakness ▪ Breathlessness ▪ Coldness in extremities ▪ Pallor ▪ Swollen tongue ▪ Spooning of the nails **Causes of iron-deficiency anemia** ▪ Decreased intake of iron ▪ Insufficient levels of stomach acid ▪ Blood loss—externally and internally

	▪ Excess menstrual bleeding is a common cause of iron deficiency anemia in women
Toxicity	▪ Excess iron, beyond what your body can use, can cause iron deposition in the tissues, which can cause tissue damage. ▪ 10% of the population has a genetic problem where iron is deposited in the tissues, especially the liver. ▪ Iron toxicity is more common in men, because they do not have a regular means of excreting iron. ▪ Vitamin C can lead to excess iron because it enhances iron absorption.

ZINC

Definition	▪ Zinc is a major part of hundreds of enzyme systems in the body. ▪ No functional stores of zinc exist, a small amount is locked in muscle, spleen, bone marrow, liver and enzyme complexes. ▪ Red and white blood cells have a high concentration of zinc. ▪ Zinc requires adequate stomach acid for absorption. ▪ Absorption inhibited by iron, copper, and phytates. ▪
Functions	▪ Essential for production of stomach acid ▪ Important for synthesis of cholesterol, fats and proteins ▪ Regulates release of vitamin A from liver ▪ Critical for cell growth and cellular replication of DNA ▪ Essential for protein synthesis and skin and bone integrity ▪ Necessary for health of prostate ▪ Immune system needs zinc for optimal function. ▪ Essential cofactor in essential fatty acid metabolism and synthesis ▪ Needed for taste perception
Food Sources	▪ Oysters ▪ Beef ▪ Wheat germ ▪ Turkey ▪ Cheese ▪ Swiss chard ▪ Lima beans ▪ Potato ▪ Oats
Clinical Uses	▪ Skin disorders ▪ Acne ▪ Prostate problems ▪ Infertility ▪ Macular degeneration ▪ Immune enhancement

Deficiency	▪ A widespread problem ▪ Signs and symptoms: ▪ Growth retardation ▪ Loss of smell and taste perception ▪ Reduced immunity ▪ Delayed wound healing ▪ Reproductive difficulties ▪ Loss of appetite ▪ Skin disorders ▪ White spots on the fingernails
Toxicity	▪ Zinc supplementation in doses greater that 20 mg on an empty stomach may lead to nausea and stomach upset. This is more common in those with low stomach acid. ▪ Long term zinc supplementation in doses greater than 50 mg/day may lead to copper deficiency.

COPPER

Definition	▪ A constituent of brain, bone, heart, teeth, kidneys and liver ▪ Absorbed through the stomach and small intestine ▪ About half of the ingested copper gets absorbed. ▪ Copper is excreted from the body in bile.
Functions	▪ A cofactor in a number of enzyme complexes ▪ Needed for the conversion of dopamine into the neurotransmitter norepinephrine ▪ Essential for repair and synthesis of connective tissue ▪ Used for breakdown of estrogen in liver ▪ Anti-inflammatory activity ▪ Needed for mobilization of iron from the liver ▪ Required for adrenal function
Food Sources	▪ Beef ▪ Rye ▪ Beans ▪ Brazil nuts ▪ Cashews ▪ Peas ▪ Molasses ▪ Sunflower seeds
Clinical Uses	▪ Anemia ▪ Enhancing immunity ▪ Prevention of aneurysms

Deficiency	▪ Signs and symptoms include: ▪ Breakdown of blood cells ▪ Anemia ▪ Lowered white blood cell count ▪ De-pigmentation of the skin ▪ Copper deficiency can be caused by a genetic inability to absorb copper in the intestines ▪ Adrenal hypo-function
Toxicity	▪ Copper supplementation may cause nausea and vomiting ▪ Long term supplementation may cause liver cirrhosis ▪ Copper cookware and old copper plumbing may increase chances of copper toxicity

CHROMIUM

Definition	▪ Found in an inorganic and organic form ▪ Inorganic forms are poorly absorbed. Only 25% of organic chromium is absorbed ▪ Uses amino acids and other nutrients for absorption ▪ Transported to liver by transferrin ▪ An intake of refined sugars can increase levels of chromium in blood
Functions	▪ An essential nutrient for blood sugar regulation ▪ An essential component of Glucose Tolerance Factor (GTF), which helps insulin bind to the appropriate receptor on the cell surface ▪ Functions in fat, protein and carbohydrate metabolism
Food Sources	▪ Brewer's yeast ▪ Oysters ▪ Liver ▪ Seafood ▪ Whole grains ▪ Cheese ▪ Potatoes ▪ Chicken
Clinical Uses	▪ Blood sugar dysregulation ▪ Prevention of atherosclerotic plaques ▪ Increased cholesterol levels ▪ Acne
Deficiency	▪ Common in the US, due to poor availability and difficulty in absorption ▪ Can lead to blood sugar dysregulation

	▪ Large intake of sugar and refined carbohydrates can increase chromium needs
Toxicity	No toxicity for chromium has been established

SELENIUM

Definition	▪ Once thought toxic, selenium has many uses in human metabolism. ▪ More accessible to humans in plant form, than animal form ▪ Found in organic and inorganic forms, which have different properties ▪ Organic selenium is used by the body to synthesize glutathione peroxidase, an essential antioxidant.
Functions	▪ Essential for the production of glutathione peroxidase ▪ Has been shown to inhibit certain types of cancer ▪ Necessary for sexual function
Food Sources	▪ Brazil nuts ▪ Seafood ▪ Chard ▪ Oats ▪ Orange juice ▪ Wheat germ ▪ Molasses ▪ Sunflower seeds
Clinical Uses	▪ Prevention of cancer ▪ Arthritis ▪ Allergy desensitization ▪ Detoxification ▪ Cardiovascular disease ▪ Heavy metal toxicity ▪ Eye disorders: cataracts, macular degeneration ▪ Prevention of viral illness
Deficiency	▪ Becoming widespread due to depletion of selenium in soil and thus in food supply ▪ Diseases associated with low soil selenium include Cardiomyopathy and arthritis. ▪ Other symptoms of deficiency include: ▪ Painful muscles ▪ Anemia ▪ Growth retardation ▪ Cardiovascular disease
Toxicity	▪ May be toxic in prolonged doses above 800 mcg/day ▪ Has a narrow therapeutic dosage range and margin of safety. Symptoms of

	toxicity include: ▪ A metallic taste in the mouth ▪ Damage to fingernails ▪ Depression, nervousness and mental instability ▪ Garlic smell to sweat and breath ▪ GI irritation ▪ Hair loss

IODINE

Definition	▪ Stored primarily in the thyroid gland ▪ Easily absorbed and found in the serum in a protein bound form and a free form ▪ Iodine bound to another compound or molecule is called iodide. ▪ Free and unbound iodine is called iodine.
Functions	▪ Iodine is essential for the synthesis of thyroxine, the active hormone produced by the thyroid gland. ▪ Important for estrogen metabolism in breast tissue ▪ Helps in the conversion of various types of estrogen
Food Sources	▪ Availability of iodine in food source is dependent on soil quality, fertilizer use and food processing techniques ▪ Commercially available table salt has been iodized but iodine deficiency is still a problem ▪ Seaweed: kombu, dulce, and kelp ▪ Seafood: haddock, cod, shrimp
Clinical Uses	▪ Treating goiter ▪ Hypothyroidism ▪ Fibrocystic breast disease ▪ Lymph stasis ▪ Antiviral, bacterial and fungal activity ▪ Estrogen metabolism ▪ Calcium mobilization
Deficiency	▪ Usually takes the form of a swollen thyroid gland, called goiter, which is more common in women ▪ A worldwide problem. Despite availability of iodized salt it remains a problem in the US too. ▪ Certain foods block absorption and utilization of iodine. These foods are known as goitrogens: ▪ Broccoli ▪ Cabbage ▪ Peanuts ▪ Turnips

	▪ Iodine deficiency is associated with: ▪ Delayed development or cretinism ▪ Hypothyroidism
Toxicity	▪ Iodine toxicity is known as iodism and may be brought on by topical or ingestion of iodine ▪ Symptoms include: ▪ Increased heart rate ▪ Skin irritation ▪ Thinning of secretions ▪ Nervousness ▪ Headache ▪ Generally a wide range of safety but high doses for a long period of time (20-30 mg/day) may suppress thyroid function.

BORON

Definition	▪ Not considered an essential nutrient, even though it is used in many bodily functions ▪ Concentrated in thyroid gland and has low levels in the serum
Functions	▪ Essential for the process of hydroxylation in the body, a process in bone metabolism ▪ Enhances the metabolism of steroid hormones including testosterone, estrogen and DHEA ▪ Essential for conversion of vitamin D into its active form of 1.25 dihydroxycholecalciferol ▪ May be useful in cell membrane function
Food Sources	▪ Tomatoes ▪ Fruit: pears, apples, dates, prunes, raisins ▪ Soy meal ▪ Peanuts ▪ Dates ▪ Filberts
Clinical Uses	▪ Osteoporosis ▪ Osteoarthritis
Deficiency	▪ May be associated with certain types of arthritis
Toxicity	▪ Very little toxicity is associated with Boron.

MANGANESE

Definition	▪ Found in highest concentrations in the mitochondria ▪ Not easily absorbed with less than 1% of dietary intake being absorbed ▪ Dependent on biliary function (Gallbladder) for uptake
Functions	▪ Used in a number of different enzyme complexes ▪ Needed for connective tissue and bone development especially skin, skeleton and small bones of the ear ▪ Used during situations of bone remodeling e.g. after fracture ▪ Important for healthy pancreatic function ▪ Used in synthesis of cholesterol and fatty acids ▪ Aids in utilization of choline
Food Sources	▪ Nuts: pecans, peanuts, filberts ▪ Whole grains ▪ Dried fruits: raisins, apricots, prunes ▪ Green leafy vegetables: chard, mustard greens Meat, poultry, seafood and dairy are considered poor sources
Clinical Uses	▪ Non-toxic goiter ▪ Ligament and disc support ▪ Viral infection ▪ Immune support ▪ Carbohydrate sensitivity ▪ Bone repair ▪ Arthritis
Deficiency	▪ Not a commonly deficient mineral ▪ Symptoms include: ▪ Fat and carbohydrate synthesis problems ▪ Glucose intolerance ▪ Impaired growth ▪ Reproductive difficulties ▪ Skeletal abnormalities ▪ Weak ligaments
Toxicity	▪ Few associated toxicities ▪ Over 100 mg/day may cause nausea or gastric upset

MOLYBDENUM

Definition	▪ Primarily an enzyme cofactor in the following enzyme systems: ▪ **Sulfite oxidase:** responsible for breaking down methionine and cysteine, both sulfur containing amino acids

	▪ **Aldehyde oxidase:** responsible for breakdown of alcohol in the liver ▪ **Xanthine oxidase:** responsible for breakdown of purines into uric acid ▪ Utilized body in detox pathways of the liver
Food Sources	▪ Lentils ▪ Split peas ▪ Green peas ▪ Brown rice ▪ Spinach ▪ Potatoes ▪ Oats ▪ Whole wheat ▪ Corn
Clinical Uses	▪ Asthma, especially due to sulfite sensitivity ▪ Muscle pain ▪ Low uric acid levels ▪ Liver detoxification problems ▪ Allergies ▪ Cardiovascular disease ▪ Sensitivities to chemicals
Deficiency	▪ Molybdenum deficiency is uncommon
Toxicity	▪ Molybdenum increases excretion of copper. Doses greater than 500 mcgs/day may lead to lower copper levels in the body.

LITHIUM

Definition	▪ Chemically similar to sodium and can displace sodium in many bodily reactions ▪ Involved in sodium transport across cell membranes. This probably accounts for lithium's therapeutic support of people with manic disorders. ▪ Only 2-3 mg of lithium exists in our body. ▪ Easily absorbed from the intestine—70-90%. People with mania often have very good absorption of lithium. ▪ Excess lithium is eliminated in urine and feces. ▪ Recent researches indicates that lithium may be an essential trace element.
Functions	▪ Specific therapeutic function of lithium, which may make it essential nutrient, is yet known. ▪ It is thought to: ▪ Stabilizes serotonin transmission in the nervous system. ▪ Influences sodium transport. ▪ Increases white blood cell proliferation and depress the suppressor cell activity.

Food Sources	▪ Therapeutic influence of lithium intake from food is not confirmed. ▪ Following food have shown to contain lithium. ▪ Some mineral waters ▪ Sugar cane ▪ Seaweed
Clinical Uses	▪ Manic-depressive disorders ▪ Depression ▪ Manic symptoms of insomnia ▪ Hyperactivity ▪ Hyperthyroidism ▪ Talkativeness ▪ Gout ▪ Juvenile behavior problems ▪ Grandiose thinking ▪ Delusions ▪ Alcoholism
Deficiency	▪ Influence of lithium deficiency is not known, or yet proven.
Toxicity	▪ Too much lithium can interfere with iodine uptake by the thyroid gland, and may block thyroxin release or thyroid stimulating hormone. ▪ Anyone with kidney disease must take lithium with caution. ▪ Therapeutic doses (500-1,500 mg/day) are only prescribed by doctors along with close blood lithium level monitoring. ▪ Symptoms of lithium toxicity include nausea, vomiting, diarrhea, thirst, increased urination, tremors, drowsiness, confusion, delirium, skin eruptions, and hair loss. With further toxicity, staggering, seizures, kidney damage, coma and even death may occur.

RUBIDIUM

Definition	▪ Our body contains 350 mg and is found throughout the body ▪ Chemically resembles potassium and can replace potassium in certain functions ▪ Can be potassium antagonist in absorption and utilization ▪ Absorbed easily from the intestines—90% ▪ Excess rubidium is mainly eliminated in urine.
Functions	▪ There are currently no known essential function of rubidium. ▪ In animal studies, rubidium has helped: ▪ Decrease tumor growth ▪ Tranquilizing effect
Food Sources	▪ Have not been researched intensively

	▪ Some vegetables and fruits have shown to contain rubidium. ▪ May also be found in some water sources
Clinical Uses	▪ Thyroid hypo function ▪ Because of its possible tranquilizing effect, it could help the treatment of nervous disorders or epilepsy. May be useful in: ▪ Chronic fatigue ▪ Short term memory loss ▪ Chronic hypotension
Deficiency and Toxicity	▪ There is no known deficiency or toxicity for rubidium.