MINERALS

The human body utilizes minerals for the proper composition of bone and blood, and maintenance of normal cell function. Minerals function along with vitamins as essential components in enzymes and coenzymes. If an enzyme is lacking the necessary mineral, it cannot function properly no matter how much of the vitamin is available. For example, zinc is necessary for the enzyme that activates vitamin A in the visual process. Without zinc in the enzyme, vitamin A cannot be converted to its active form. This deficiency can result in what is known as night-blindness. Only when supplied with both zinc and vitamin A, is the enzyme able to perform its vital function.

The minerals are classified into two categories: major and minor. This classification is determined by the amount of the mineral needed by the body, not by how essential it is to good health. If a mineral is required at a level greater than 100 mg per day, it is considered to be a major mineral.

Major minerals

1. Calcium
2. Phosphorus
3. Potassium
4. Sulfur
5. Sodium
6. Chloride
7. Magnesium

Minor (also known as “trace”) minerals

1. Zinc
2. Iron
3. Manganese
4. Copper
5. Boron
6. Silicon
7. Molybdenum
8. Vanadium
9. Chromium
10. Selenium
11. Iodine

Nonessential

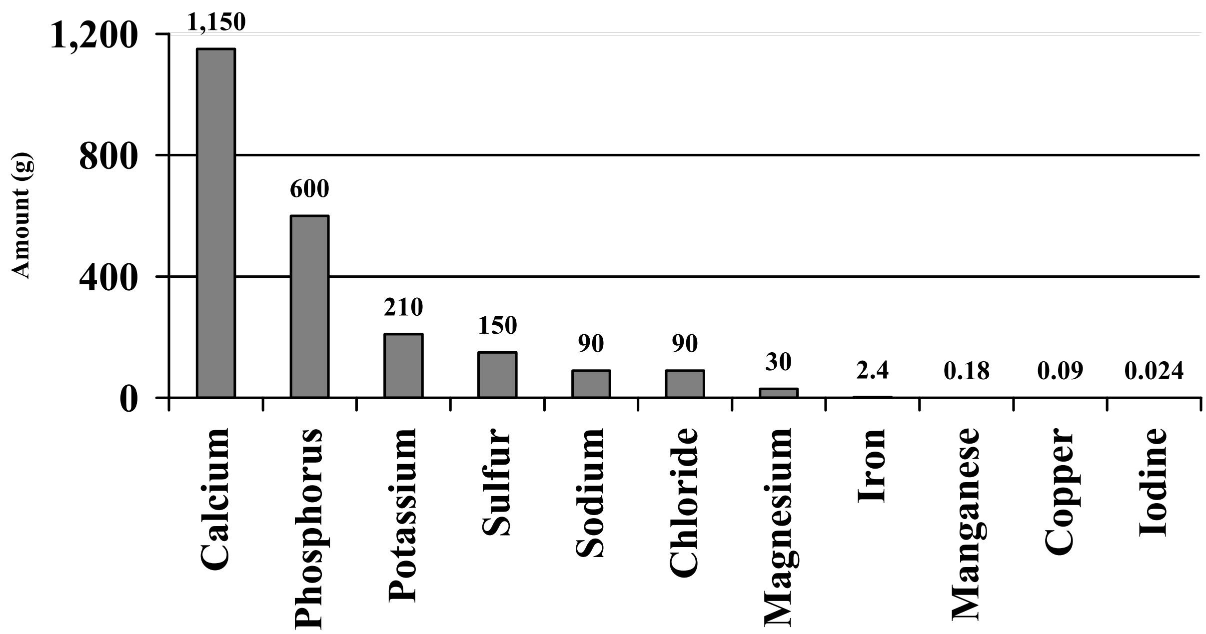
The following minerals have not been shown to be important in human nutrition. In fact, many of them are considered toxic chemicals and should be avoided.

Aluminum	Antimony	Arsenic	Barium	Beryllium
Bromine	Cadmium	Cerium	Cesium	Cobalt
Dysprosium	Erbium	Europium	Gallium	Gandolinium
Gold	Hafnium	Holmium	Indium	Iridium
Lanthanum	Lead	Lithium	Lutetium	Mercury
Nickel	Niobium	Osmium	Palladium	Platinum
Praseodymium	Rhenium	Rhodium	Rubidium	Ruthenium
Samarium	Scandium	Silver	Tantalum	Tellurium
Terbium	Thallium	Thorium	Thullium	Tin
Titanium	Tungsten	Vanadium	Ytterbium	Yttrium
Zirconium				

DIETARY SOURCES OF MINERALS

Because plants incorporate minerals from the soil into their own tissues, fruits, vegetables, grains, legumes, nuts, and seeds are often excellent sources for minerals. The minerals, as they are found in the earth, are inorganic. However in plants, most minerals are complexed with organic molecules. This usually means better mineral absorption, but there are some plant compounds, such as phytates and tannins that complex minerals so tightly that they cannot be absorbed. For this reason, juicing is thought to provide even better mineral absorption compared to the intact fruit or vegetable because juicing liberates the minerals into a highly bio-available medium and separates the minerals from some of the fiber constituents, which can interfere with absorption. The green leafy vegetables are the best source for many of the minerals, especially calcium, and this source is made more available by juicing.

Average Total Body Content of Major Minerals



Major Minerals

Calcium

Calcium is the most abundant mineral in the body. It constitutes 1.5-to-2% of the total body weight with more than 99% of the calcium being present in the bones. In addition to its major function in building and maintaining bones and teeth, calcium is also important in the activity of many enzymes in the body. The contraction of muscles, release of neurotransmitters, regulation of heart beat, and the clotting of blood are all dependent on calcium.

The current RDA for calcium is 1,000 mg for adults. However, there has been considerable concern that this recommendation may be inadequate to maintain the integrity of the bone. This is especially true during the periods of growth, pregnancy, and lactation. Preadolescent children may need even more calcium than an adult. The recommendation for this group is 1,200 mg of calcium per day. During pregnancy and lactation, the recommendation is also 1,200 mg per day.

Table 8.1 - Recommended Dietary Allowance for Calcium

Infants	
0-0.5 year	400 mg
0.5-1 year	600 mg
Children	
1-3 years	800 mg

4-6 years	800 mg
7-10 years	800 mg

Young Adults and Adults	
Males 11-24 years	1,200 mg
Males 25+ years	800 mg
Females 11-24 years	1,200 mg
Females 24+ years	800 mg
Pregnancy	1,200 mg
Lactating	1,200 mg

Calcium deficiency in children may lead to rickets, which results in bone deformities and growth retardation. In adults, calcium deficiency may result in osteomalacia, which is a softening of the bones. Extremely low levels of calcium in the blood may result in muscle spasms and leg cramps. It is also generally well accepted that low calcium intake contributes greatly to high blood pressure and osteoporosis.

Food high in calcium are kelp and other seaweeds, cheddar cheese and leafy green vegetables, such as collards, kale and turnip greens. Good sources of calcium are nuts and seeds, such as almonds and sesame seeds, yogurt, tofu and apricots. The table below lists the calcium content of selected foods.

Calcium Content of Selected Foods, in Milligrams per 3 ½ oz. (100 g) Serving

Kelp	1,093	Yogurt	120	Black current	60
Cheddar cheese	750	Wheat bran	119	Dates	59
Carob flour	352	Whole milk	118	Green beans	56
Dulse	296	Buckwheat, raw	114	Artichokes	51
Collard greens	250	Sesame seeds, hulled	110	Prunes, dried	51
Kale	249	Olives, ripe	106	Pumpkin seeds	51
Turnip greens	246	Broccoli	103	Beans, cooked	50
Almonds	234	Walnuts	99	Cabbage	49
Yeast, brewer's	210	Cottage cheese	94	Soybean sprouts	48
Parsley	203	Soybeans, cooked	73	Wheat	46
Dandelion greens	187	Pecans	73	Orange	41
Brazil nuts	186	Wheat germ	72	Celery	41
Watercress	151	Peanuts	69	Cashews	38
Goat's milk	129	Miso	68	Rye grain	38
Tofu	128	Romaine lettuce	68	Carrot	37
Fig's, dried	126	Apricots, dried	67	Barley	34
Buttermilk	121	Rutabaga	66	Sweet potato	32
Sunflower seeds	120	Raisins	62	Brown rice	32

Phosphorus

Phosphorus is one of the most essential minerals as it ranks second only to calcium in total body content. About 80% of the phosphorus in the human body is found as calcium phosphate crystals in bones and teeth. However, phosphorus participates in many other body functions including energy metabolism, DNA synthesis, and calcium absorption and utilization.

Phosphorus is readily available in most foods, especially high-protein foods. However, more important than the total phosphorus content of a food is its ratio of calcium to phosphorus. Too little calcium and too much phosphorus have been linked to osteoporosis. Foods low in calcium but high in phosphorus include red meats, poultry, and soft drinks. The ratio of calcium to phosphorus in red meats and poultry is generally 1-to-20 while the level of phosphorus per serving in soft drinks is typically 500 mg with virtually no calcium to offset it.

The RDA for phosphorus is equal to the RDA of calcium (See Table 8.1). Foods that are high in both phosphorus and calcium are

Magnesium

Magnesium is an extremely important mineral. Next to potassium, it is the second most predominate mineral within our cells. Magnesium also functions very closely with calcium and phosphorus. Approximately 60% of the magnesium in the body is found in bone, 26% in muscle, and the remainder in soft tissue and body fluids. The functions of magnesium primarily center around its ability to activate many enzymes. Like potassium, magnesium is also involved in maintaining the electrical charge of cells, particularly in muscles and nerves. In addition, magnesium is involved in many cellular functions, including energy production, protein formation, and cellular replication.

Magnesium deficiency is characterized by symptoms quite similar to potassium deficiency including mental confusion, irritability, weakness, heart disturbances, and problems in nerve conduction and muscle contraction. Other symptoms of magnesium deficiency may include muscle cramps, headaches, loss of appetite, insomnia, and a predisposition to stress.

Magnesium deficiency is extremely common in the geriatric population and in women during the premenstrual period. Magnesium deficiency is often secondary to factors that reduce absorption or increase secretion, such as high calcium intake, alcohol consumption, surgery, diuretic use, liver disease, kidney disease, and oral contraceptive use.

The RDA for magnesium is 350 mg per day for adult males and 300 mg per day for adult females. For pregnant and lactating women, the recommended allowance is 450 mg per day. Many nutritional experts feel the ideal intake for magnesium should be based on body weight (6 mg/kg body weight). For a 110-pound person, the recommendation would be 300 mg; for a 154-pound person 420 mg; and for a 200-pound person 540 mg.

The average intake of magnesium by healthy adults in the U.S. ranges between 143 and 266 mg per day. This is obviously far below the RDA. Food choices are the main reason. Since magnesium occurs abundantly in whole foods, most nutritionists and dieticians assume that most Americans get enough magnesium in the diet. But, most Americans are not eating whole foods. They are consuming large quantities of processed foods. Since food processing refines out a very large portion of magnesium, most Americans are not getting the RDA for magnesium. What is the result of this low dietary magnesium? Low levels of magnesium in the diet and our bodies increases susceptibility to a variety of diseases including, heart disease, high blood pressure, kidney stones, cancer, insomnia, PMS, and menstrual cramps.

Magnesium's role in preventing heart disease and kidney stones are the most widely accepted. Individuals dying suddenly of heart attacks have been shown to have very low levels of magnesium in their heart. Magnesium is extremely important to the heart, both in terms of energy production and contraction of heart muscle. A magnesium deficiency may cause a heart attack by producing a spasm of the coronary arteries, thereby reducing the flow of blood and oxygen to the heart. Magnesium also increases the solubility of calcium in the urine, thereby preventing stone formation. Supplementing magnesium to the diet has demonstrated effectiveness in preventing recurrences of kidney stones.

The best dietary sources of magnesium are kelp and other seaweeds, nuts, whole grains, and tofu. Fish, meat, milk, and most commonly eaten fruits are quite low in magnesium.

Magnesium Content of Selected Foods, in Milligrams per 3 ½ oz. (100 g) Serving

Kelp	760	Soybeans, cooked	88	Potato with skin	34
Wheat bran	490	Brown rice	88	Crab	34
Wheat germ	336	Figs, dried	71	Banana	33
Almonds	270	Apricots	62	Sweet potato	31
Cashews	267	Dates	58	Blackberry	30
Molasses	258	Collard greens	57	Beets	25
Yeast, brewer's	231	Shrimp	51	Broccoli	24
Buckwheat	229	Corn, sweet	48	Cauliflower	24
Brazil nuts	225	Avocado	45	Carrot	23
Dulse	220	Cheddar cheese	45	Celery	22
Filberts	184	Parsley	41	Beef	21
Peanuts	175	Prunes, dried	40	Asparagus	20
Millet	162	Sunflower seeds	38	Chicken	19
Wheat grain	160	Beans, cooked	37	Green pepper	18
Pecan	142	Barley	37	Winter squash	17
English walnuts	131	Dandelion greens	36	cantaloupe	16
Rye	115	Garlic	36	Eggplant	16
Tofu	111	Raisins	35	Tomato	14
Coconut, dried	90	Green peas, fresh	35	Milk	13

Potassium, Sodium, and Chloride

Potassium, sodium, and chloride are electrolytes: mineral salts that can conduct electricity when they are dissolved in water. They are so intricately related that they are most often discussed together in nutrition textbooks and we will follow that tradition in this discussion.

Electrolytes are always found in pairs. A positive molecule, such as sodium or potassium is always accompanied by a negative molecule like chloride. Together, electrolytes function in the maintenance of:

* Water balance and distribution
* Kidney and adrenal function
* Acid-base balance
* Muscle and nerve cell function
* Heart function

Over 95% of the potassium in the body is found within cells. In contrast, most of the sodium in the body is located outside the cells in the blood and other fluids. How does this happen? Cells actually pump sodium out and potassium in via the "sodium-potassium pump." This pump is found in the membranes of all cells in the body. One of its most important functions is preventing the swelling of cells. If sodium is not pumped out, water accumulates within the cell causing it to swell, and ultimately burst.

Sodium levels are regulated by the kidney and adrenal gland. The adrenal gland produces a hormone called aldosterone that tells the kidneys to how much sodium to retain. When either sodium or potassium become unbalanced the kidney may expend the other electrolyte to maintain a balance. In kidney disease, this balancing function is lost and electrolyte balance occurs causing problems with electrical conduction throughout the body including the muscles, nerves and heart.

The sodium potassium pump is integral in maintaining acid-base balance as well as in healthy kidney function. Energy is derived from pumping of sodium out of the cell where it becomes concentrated, wanting to push its way back in. This energy is used to remove acid from the body.

The sodium-potassium pump also functions to maintain the electrical charge within the cell. This is particularly important to muscle and nerve cells. During nerve transmission and muscle contraction, potassium exits the cell and sodium enters, resulting in a change in electrical charge that causes a nerve impulse or muscle contraction. Therefore, it is not surprising that a potassium deficiency affects muscles and nerves first.

The balance of sodium, potassium, and chloride is extremely important to human health. Too much sodium in the diet can lead to disruption of this balance. Numerous studies have demonstrated that a low potassium, high sodium diet plays a major role in the development of cancer and cardiovascular diseases. Conversely, a diet high in potassium and low in sodium is protective against these diseases, and in the case of high blood pressure it can be therapeutic.

Excessive consumption of dietary sodium chloride (table salt), coupled with diminished dietary potassium, is a common cause of high blood pressure. Numerous studies have shown that sodium restriction alone does not improve blood pressure control in most people: it must be accompanied by a high potassium intake. In our society only 5% of sodium intake comes from the natural ingredients in food. Prepared foods contribute 45% of our sodium intake, 45% is added in cooking, and another 5% is added as a condiment. However, all that the body requires in most instances is the salt that is supplied in the food.

As a result, most Americans have a potassium-to-sodium (K:Na) ratio of less than 1:2. This means that most people ingest twice as much sodium as potassium. Researchers recommend a dietary potassium-to-sodium ratio of greater than 5:1 to maintain optimal health. This is ten times higher than the average intake. However, even this may not be optimal. A natural diet rich in fruits and vegetables can produce a K:Na ratio greater than 100:1, as most fruits and vegetables have a K:Na ratio of at least 50:1. For example, here are the average K:Na ratios for several common fresh fruits and vegetables:

apples	90:1	oranges	260:1
bananas	440:1	potatoes	110:1
carrots	75:1		

Potassium/Sodium Content of Selected Food in Milligrams per Serving

FOOD	**PORTION SIZE**	**POTASSIUM**	**SODIUM**
FRESH VEGETABLES			
Asparagus	½ cup	165	1
Avocado	½	680	5
Carrot, raw	1	225	38
Corn	½ cup	136	TRACE
Lima beans, cooked	½ cup	581	1
Potato	1 medium	782	6
Spinach, cooked	½ cup	292	45
Tomato, raw	1 medium	444	5
FRESH FRUITS			
Apple	1 medium	182	2
Apricots, dried	¼ cup	318	9
Banana	1 medium	440	1
Cantaloupe	¼ melon	341	17
Orange	1 medium	263	1

Peach	1 medium	308	2
Plums	5	150	1
Strawberries	½ cup	122	TRACE
UNPROCESSED MEATS			
Chicken, light meat	3 ounces	350	54
Lamb, leg	3 ounces	241	53
Pork	3 ounces	219	48
Roast beef	3 ounces	224	49
FISH			
Cod	3 ounces	345	93
Flounder	3 ounces	498	201
Haddock	3 ounces	297	150
Salmon	3 ounces	378	99
Tuna	3 ounces	225	38

Although sodium and chloride are important, potassium is the most important dietary electrolyte. In addition to functioning as an electrolyte, potassium is also essential for the conversion of blood sugar into glycogen, which is the storage form of blood sugar found in the muscles and liver. A potassium shortage results in lower levels of stored glycogen. Because glycogen is used by exercising muscles for energy, a potassium deficiency will produce great fatigue and muscle weakness. These are typically the first signs of potassium deficiency.

A potassium deficiency is also characterized by mental confusion, irritability, weakness, heart disturbances, and problems in nerve conduction and muscle contraction. Dietary potassium deficiency is typically caused by a diet low in fresh fruits and vegetables, but high in sodium. It is more common to see dietary potassium deficiency in the elderly. Dietary potassium deficiency is less common than deficiency due to excessive fluid loss, such as sweating, diarrhea or urination, or the use of diuretics, laxatives, aspirin, and other drugs.

The amount of potassium lost in sweat can be quite significant, especially if the exercise is prolonged in a warm environment. Athletes or people who regularly exercise have higher potassium needs. Because up to 3 g of potassium can be lost in one day by sweating, a daily intake of at least 4 g of potassium is recommended for these individuals.

The estimated safe and adequate daily dietary intake of potassium, as set by the Committee on Recommended Daily Allowances, is 1.9g to 5.6g. If body potassium requirements are not being met through diet, supplementation is essential to good health. This is particularly true for the elderly and the athletic. Potassium salts are commonly prescribed by physicians in the dosage range of 1.5g to 8.0g per day. However, potassium salts can cause nausea, vomiting, diarrhea, and ulcers. These effects are not seen when potassium levels are increased through the diet only. This highlights the advantages of using juices, foods or food-based potassium supplements to meet the human body's high potassium requirements.

Can you take too much potassium? Of course, but most people can handle any excess of potassium. The only exception is people with kidney disease. These people do not handle potassium in the normal way and are likely to experience heart disturbances and other consequences of potassium toxicity. Individuals with kidney disorders usually need to restrict their potassium intake and follow the dietary recommendations of their physicians.

Sulfur

Sulfur is a component of four amino acids: methionine, cysteine, cystine, and taurine. As par of ths sulfur containing amino acids, it performs a number of important functions, such as providing a place these amino acids to bond together, solidifying a protein structure. It is found in high concentrations in the protein structure of the joints, hair, nails, and skin. In the case of arthritis, cartilage can be repaired by adequate sulfur intake through supplementation.

The hormone insulin is a protein based hormone rich in sulfur-containing amino acids. The detoxifying compound glutathione is also a sulfur containing compound, where sulfur, as cysteine, is a beneficial nutrient in liver disorders. As part of taurine, it aids in digestion as taurine a bile acid component. As a part of methionine and cysteine, it is utilized in the metabolism of homocysteine.

Although there is no official RDA for sulfur, it is a critical nutrient. Daily intake is usually 800-to-900 mg of sulfur per day. Certain health conditions, such as arthritis and liver disorders, may be improved by increasing the intake of sulfur to 1500 mg per day in supplemental form. Sulfur rich foods include eggs, legumes, whole grains, garlic, onions, Brussels sprouts, and cabbage.

TRACE MINERALS

Boron

Vegetarians are at a lower risk for osteoporosis because, jn addition to vitamin K1 and the high levels of many minerals found in plant foods, their increased consumption of the trace mineral boron helps reduce their risk. Boron has been shown to have a positive effect on calcium and active estrogen levels in post-menopausal women, the group at highest risk for developing osteoporosis. In one study, supplementing the diet of post-menopausal women with 3mg of boron per day reduced urinary calcium excretion by 44% and dramatically increased the levels of 17-beta-estradiol, the most biologically active estrogen. It appears boron is required to activate certain hormones, including estrogen and vitamin D. Both estrogen and vitamin D are important for building and maintaining healthy bone structure.

Boron has also been shown to be of benefit in arthritis although the mechanism of action is not yet understood, although it appears to play a role in calcium metabolism similarly to that seen in osteoporosis prevention.

No RDA is set for boron and requirements vary from 1-to-6 mg per day, although most diets only provide 1-to-3 mg per day. Since fruits and vegetables are the main dietary sources of boron, diets low in these foods may be deficient in boron. Apples, pears and grapes are good sources of boron, as are leafy greens, legumes and nuts.

Chromium

Chromium functions in the "glucose tolerance factor," a critical enzyme system involved in blood sugar regulation. A lack, as well as an excess, of blood sugar (glucose) in the body can be devastating. For this reason, the body strives to maintain blood sugar levels within a narrow range with the help of hormones, such as insulin and glucagon. Considerable evidence now indicates that chromium levels are a major determinant of insulin sensitivity. If chromium levels are low, blood sugar levels may remain high due to a lack of sensitivity to insulin. Insulin promotes the absorption and utilization of glucose by the cells. Insulin insensitivity is a classic feature in obesity and diabetes.

Reversing a chromium deficiency by supplementing the diet with chromium has been demonstrated to lower body weight yet increase lean body mass, and improve glucose tolerance as well as decrease total cholesterol and triglyceride levels. All these effects appear due to increased insulin sensitivity.

Although there is no RDA for chromium, it appears that we need at least 200 mcg each day in our diet. Chromium levels can be depleted by refined sugars, white flour products, and lack of exercise.

Chromium Content of Selected Foods, in Micrograms per 3 ½ oz. (100 g) Serving

Yeast, brewer's	112	Green pepper	19	Carrots	9
Liver, calf's	55	Apple	14	Navy beans, dry	8
Whole-wheat bread	42	Butter	13	Orange	5
Wheat bran	38	Parsnips	13	Blueberries	5
Rye bread	30	Cornmeal	12	Green beans	4
Potatoes	24	Banana	10	Cabbage	4
Wheat germ	23	Spinach	10		

Copper

Copper functions as an important factor in the manufacture of hemoglobin; collagen structures, particularly joints and arteries; and energy. Copper deficiency is characterized by anemia, fatigue, poor wound healing, elevated cholesterol levels, and poor immune function.

Since a deficiency of copper produces marked elevation of cholesterol, copper deficiency has been suggested to play a major role in the development of atherosclerosis. There is additional evidence to support this as recent surveys indicate that less 25% of Americans appear to be meeting the RDA of 2 mg of copper. However, there is also evidence that because of copper lined water pipes, many Americans are getting too much copper in their diets. Excessive copper levels have been linked to schizophrenia, learning disabilities, premenstrual syndrome, and anxiety.

Many of the problems of copper can be offset by zinc because zinc and copper compete for absorption sites. If there is too much zinc, copper absorption will be decreased and vice versa. In nature, foods rich in copper are typically even higher in zinc. Nuts and legumes are a good example of this.

Copper Content of Selected Foods, in Milligrams per 3 ½ oz. (100 g) Serving

Brazil nuts	2.3	Butter	0.4	Corn oil	0.2
Almonds	1.4	Rye grain	0.4	Ginger root	0.2
Hazelnuts	1.3	Barley	0.4	Molasses	0.2
Walnuts	1.3	Olive oil	0.3	Turnips	0.2
Pecans	1.3	Carrot	0.3	Green peas	0.1
Split peas, dry	1.2	Coconut	0.3	Papaya	0.1
Buckwheat	0.8	Garlic	0.3	Apple	0.1
Peanuts	0.8	Millet	0.2		
Sunflower oil	0.5	Whole wheat	0.2		

Iodine

The thyroid gland adds iodine to the amino acid tyrosine in order to create thyroid hormones. A deficiency of iodine results in the development of an enlarged thyroid gland commonly, referred to as a goiter. When the level of iodine is low in the diet and blood, it causes the cells of the thyroid gland to become quite large, and eventually the entire gland will swell at the base of the neck.

Goiters are estimated to affect over 200 million people the world over. In all but 4% of these cases, the goiter is caused by an iodine deficiency. Iodine deficiency is now quite rare in the U.S. and other industrialized countries due to the addition of iodine to table salt. Adding iodine to table salt began in Michigan, where in 1924, the goiter rate was an incredible 47%.

Few people in the U.S. are now considered iodine deficient, yet the rate of goiter is still relatively high (5%-to-6%) in certain high risk areas. The goiters in these populations are probably a result of the excessive ingestion of foods which block iodine utilization. These foods are known as goitrogens and include cabbage, cassava root, millet, mustard, peanuts, pine nuts soybeans, and turnips . Cooking usually inactivates goitrogens.

The RDA for iodine in adults is quite small, 150 micrograms. Seafood, including clams, and seaweeds, such as kelp, are nature's richest sources of iodine. However, in the U.S., the majority of iodine is derived from the use of iodized salt which consists of 70 micrograms of iodine per gram of salt. Sea salt, in comparison, has little iodine. Due to the high salt intake in the U.S., the average intake of iodine is estimated to be over 600 micrograms per day.

However, too much iodine can actually inhibit thyroid gland synthesis. For this reason, and because the only function of iodine in the body is for thyroid hormone synthesis, it is recommended that dietary levels or supplementation of iodine not exceed 1 milligram (1,000 micrograms) per day for any length of time.

Iron

Iron is critical to human life. It plays the central role in the hemoglobin molecule of our red blood cells (RBC), where it functions in transporting oxygen from the lungs to the body's tissues, and also transports carbon dioxide from the tissues to the lungs. In addition, iron also functions in several key enzymes in energy production and metabolism including DNA synthesis.

Iron deficiency is the most common nutrient deficiency in the United States. The groups at highest risk for iron deficiency are infants under two years of age, teenage girls, women of childbearing age, pregnant women, and the elderly. Studies have found evidence of iron deficiency in 30-to-50% of people in these groups. For example, some degree of iron deficiency occurs in 35-to-58% of young, healthy women of childbearing age. During pregnancy, the number is even higher.

Iron deficiency may be due to an increased iron requirement, inadequate dietary intake, diminished iron absorption or utilization, blood loss, or a combination of these factors. Increased requirements for iron occur during the growth spurts of infancy and adolescence, and during pregnancy and lactation. Currently, the vast majority of pregnant women are routinely given iron supplements during their pregnancy as the dramatic increased need for iron during pregnancy cannot usually be met through diet alone. In infants and adolescents, inadequate dietary iron would necessitate iron supplementation as well.

Inadequate dietary intake of iron is common in many parts of the world, especially in populations which consume primarily vegetarian diets. Typical infant diets in developed countries, which are high in milk and cereals, are also low in iron. The adolescent consuming a "junk food" diet is at high risk for iron deficiency, too. However, the population at greatest risk for a diet deficient in iron is the low-income elderly population. This is complicated by the fact that decreased absorption of iron is extremely common in the elderly. Decreased absorption of iron is often due to a lack of hydrochloric acid secretion in the stomach, an extremely common condition in the elderly. Other causes of decreased absorption include chronic diarrhea or malabsorption, the surgical removal of the stomach, and antacid use.

Blood loss is the most common cause of iron deficiency in women of childbearing age. This is most often due to excessive menstrual bleeding. Interestingly enough, iron deficiency is a common cause of excessive menstrual blood loss. Other common causes of blood loss include bleeding from peptic ulcers, hemorrhoids, and donating blood.

The negative effects of iron deficiency are due largely to the impaired delivery of oxygen to the tissues and the impaired activity of iron-containing enzymes in various tissues. Iron deficiency can lead to anemia, excessive menstrual loss, learning disabilities, impaired immune function, and decreased energy levels and physical performance.

Anemia refers to a condition in which the blood is deficient in red blood cells or the hemoglobin (iron containing) portion of red blood cells. As noted, the primary function of the red blood cell (RBC) is to transport oxygen from the lungs to the tissues of the body in exchange for carbon dioxide. The symptoms of anemia, such as extreme fatigue, reflect a lack of oxygen being delivered to tissues and a build-up of carbon dioxide.

Iron deficiency is the most common cause of anemia, however, it must be pointed out that anemia is the last stage of iron deficiency. Iron dependent enzymes involved in energy production and metabolism are the first to be affected by low iron levels. Serum ferritin is the best laboratory test for determining body iron stores.

Several researchers have clearly demonstrated that even slight iron-deficiency anemia leads to a reduction in physical work capacity and productivity. Nutrition surveys done in the U.S. have indicated that iron-deficiency is a major impairment of health and work capacity and as a consequence of this, an economic loss to the individual and the country. Supplementation with iron has shown rapid improvements in work capacity in iron-deficient individuals. Impaired physical performance due to iron deficiency is not dependent on anemia. Again, the iron-dependent enzymes involved in energy production and metabolism will be impaired long before anemia occurs.

In the developing child, these aforementioned affects of iron deficiency, even slight iron deficiency, can lead to learning disabilities. The developing nervous system is undergoing significantly more energy consuming activity than a mature nervous system. Adequate iron is imperitive to provide adequate energy to the growing nervous system.

The RDA for iron is 10 mg for males and 15 mg for females. It must be pointed out that there are two forms of dietary iron, "heme" iron and "non-heme" iron. Heme iron is iron bound to hemoglobin and myoglobin. It is found in animal products and is the most efficiently absorbed form of iron. Non-heme iron is found in plant foods. Compared to heme iron it is poorly absorbed.

Content of Selected Foods Milligrams per Serving

Food	Serving size	Iron (mg)
Clams, cooked	3 oz	23.8
Sirloin steak, cooked	3 oz	2.9
Shrimp, cooked	3 oz	2.6
Turkey breast	3 oz	0.9
Chicken breast, skinless	1/2 breast	0.9
Soybeans, cooked	1 cup	8.8
Lentils, cooked	1 cup	6.6
Tofu, firm	4 oz	6.6
Tofu, regular	4 oz	0.7-6.6
Blackstrap molasses	2 Tbsp	6.4
Beef liver, fried	3 oz	5.3
Quinoa, cooked	1 cup	5.3
Kidney beans, cooked	1 cup	5.2
Chickpeas, cooked	1 cup	4.7

Pinto beans, cooked	1 cup	4.5
Black-eyed peas, cooked	1 cup	4.3
Swiss chard, cooked	1 cup	4.0
Tempeh	1 cup	3.8
Black beans, cooked	1 cup	3.6
Turnip greens, cooked	1 cup	3.2
Prune juice	8 oz	3.0
Spinach, cooked	1 cup	2.9
Potato	1 medium	2.8
Beet greens, cooked	1 cup	2.7
Soy yogurt, plain	1 cup	2.7
Sesame seeds	2 Tbsp	2.6
Tahini	2 Tbsp	2.6
Peas, cooked	1 cup	2.5
Lima beans, cooked	1 cup	2.3
Sunflower seeds	1/4 cup	2.3
Figs, dried	5 medium	2.1
Cashews	1/4 cup	2.0
Apricots, dried	10 halves	2.0

Manganese

Manganese functions in many enzyme systems, including enzymes involved in blood sugar control, energy metabolism, and thyroid hormone function. Manganese also functions in the antioxidant enzyme superoxide dismutase, or SOD. This enzyme is responsible for preventing the deleterious effects of the super oxide free radical from destroying cellular components. Without SOD, cells are quite susceptible to damage and inflammation. Manganese supplementation has been shown to increase SOD activity, indicating increased antioxidant activity. Clinically, manganese is used for strains, sprains, and inflammation. There is evidence that patients with rheumatoid arthritis and presumably other chronic inflammatory diseases have an increased need for manganese. No trials have yet been done with manganese and rheumatoid arthritis, but supplementation appears to be indicated.

Low manganese has also been linked to epilepsy. This link was first suggested in 1963 when ito was observed that manganese deficient rats were more susceptible to seizures than manganese-replete animals, and that manganese deficient animals exhibit epileptic-like brain wave tracings. This prompted researchers to look at manganese concentrations in epileptics. Low whole blood and hair manganese levels have been found in epileptics, and those with the lowest levels typically have the highest seizure activity.

Manganese plays a significant role in cerebral function as it is a critical metal for glucose utilization within the neuron, adenylate cyclase activity, and neurotransmitter control. For optimal central nervous system function, proper manganese levels must be maintained. A high manganese diet or manganese supplementation may be helpful in controlling seizure activity for some patients.

Although there is no specific RDA for manganese, it is estimated that most people require between 2-to-5 mg per day. This can easily be met by regularly consuming nuts and whole grains as these are the best sources of manganese.

Manganese Content of Selected Foods, in Milligrams per 3 ½ oz (100 g) Serving

Pecans	3.5	Walnuts	0.8	Brussels sprouts	0.3
Brazil nuts	2.8	Spinach, fresh	0.8	Oatmeal	0.3

Almonds	2.5	Peanuts	0.7	Cornmeal	0.2
Barley	1.8	Oats	0.5	Millet	0.2
Rye	1.3	Raisins	0.5	Carrots	0.16
Buckwheat	1.3	Turnip greens	0.5	Broccoli	0.15
Split peas, dry	1.3	Rhubarb	0.5	Brown rice	0.14
Whole wheat	1.1	Beet greens	0.4	Whole-wheat bread	0.14

Molybdenum

Molybdenum functions as a component in several enzymes, including those involved in alcohol detoxification as the cofactor for aldehyde oxidase. In uric acid formation, molybdenum is the cofactor for xanthine oxidase. In sulfur metabolism, molybdenum plays a role in the metabolism of the sulfur containing amino acids cysteine and methionine as well as sulfites. A molybdenum deficiency has been suggested as a cause for sulfite sensitivities since the enzyme that detoxifies sulfites, sulfite oxidase, is molybdenum dependent. However, molybdenum deficiency is rare, likely only due to a genetic sulfite oxidase defect or during long term total parenteral nutrition therapy, where nutrients are administered intravenously only.

The average diet contains between 50–to-500 mcg of molybdenum per day. Legumes and whole grains are the richest sources.

Molybdenum Content of Selected Foods, in Micrograms per 3 ½ oz (100 g) Serving

Lentils	155	Rye bread	50	Molasses	19
Slit peas	130	Corn	45	Cantaloupe	16
Cauliflower	120	Barley	42	Apricots	14
Green peas	110	Whole wheat	36	Raisins	10
Yeast, brewer's	109	Whole wheat bread	32	Butter	10
Wheat germ	100	Potatoes	30	Strawberries	7
Spinach	100	Onions	25	Carrots	5
Brown rice	75	Peanuts	25	Cabbage	5
Garlic	70	Coconut	25		
Oats	60	Green beans	21		

Selenium

Selenium, as a component of the antioxidant enzyme glutathione peroxidase, works with vitamin E in preventing free radical damage to cell membranes. Low levels of selenium render people at higher risk for cancer; cardiovascular disease; inflammatory diseases, such as asthma; and other conditions associated with increased free radical damage, including premature aging and cataract formation. Selenium supplementation of 100-to-250 mcg or more per day is often used in the treatment of these disorders.

Although there is no specific RDA for selenium, a daily intake of 200 mcg is often recommended. Whole grains, fish, meat, and eggs are the richest sources, However, be aware that daily intake in excess of 2,000 mcg can produce toxicity.

Selenium Content of Selected Foods, in Micrograms per 3 ½ oz (100 g) Serving

Wheat germ	111	Salmon	37
Brazil nuts	103	Pork loin, lean	35
Bread, whole wheat	66	Top sirloin, lean	33
Tuna, canned in water	65	Turkey, breast, without skin	32
Wheat bran	63	Egg, whole	30

Calf's liver	57	Ground beef, lean	29
Swiss chard	57	Chicken, breast	27
Oats	56	Lamb, lean	26
Loin chops	47	Garlic	25
Brown rice	39	Barley	24

Silicon

Silicon is responsible for crosslinking collagen strands, thereby contributing greatly to the strength and integrity of the connective tissue matrix of bone. Since silicon concentrations are increased at calcification sites in growing bone, this process may be dependent upon adequate levels of silicon. It is not known whether the typical American diet provides adequate amounts of silicon. In patients with osteoporosis, or where accelerated bone regeneration is desired, silicon requirements may be increased.

Although no official RDA for silicon has been set, 20-to-50 mg per day has been recommended to meet fundamental requirements. An increased need for silicon is best met by increasing the consumption of unrefined grains, as they are a rich source of absorbable silicon (silicic acid).

Vanadium

Vanadium was named after the Scandinavian goddess of beauty, youth, and luster. It is a controversy as to whether vanadium is an essential trace mineral in human nutrition. Although it has been suggested to function in hormone, cholesterol, and blood sugar metabolism, no specific deficiency signs have been reported. Some researchers have speculated that a vanadium deficiency may contribute to elevated cholesterol levels, and faulty blood sugar control manifesting as either diabetes or hypoglycemia. Making things more difficult is the fact that vanadium exists in five different forms, with the most biologically significant being either vanadyl or vanadate.

Since vanadium can be a relatively toxic mineral, and there is no obvious role yet discovered in humans, it appears there is no need at this time to supplement the diet despite the fact that vanadium supplementation is demonstrating impressive results in rats with diabetes. Until more is known about this mineral, consumers should be wary of supplements containing vanadium. The major concern is that excessive levels of vanadium have been suggested to be a factor in manic depression as increased levels of vanadium are found in hair samples from manic patients, and these values fall towards normal levels with recovery. Vanadium, as the vanadate ion, is a strong inhibitor of sodium-potassium pump. Lithium, the drug of choice for manic depression, has been reported to reduce this inhibition, too.

There is no established RDA for vanadium and no consistent recommendation for the vanadium content of the diet. Although the table below lists the vanadium content of some selected foods, it is not known how meaningful this data is as some studies have shown that most ingested vanadium (greater than 95%) is not absorbed.

Vanadium Content of Selected Foods, in Micrograms per 3 ½ oz. (100 g) Serving

Buckwheat	100	Corn	15	Onions	5
Parsley	80	Green beans	14	Whole wheat	5
Soybeans	70	Peanut oil	11	Beets	4
Safflower oil	41	Carrots	10	Apples	3
Sunflower seed oil	41	Cabbage	10	Plums	2
Oats	35	Garlic	10	Lettuce	2

Olive oil	30	Tomatoes	6	Millet	2
Sunflower seeds	15	Radishes	5		

Zinc

Zinc is a component in over 200 enzymes in our bodies. In fact, zinc functions in more enzymatic reactions than any other mineral. Although severe zinc deficiency is very rare in developed countries, many individuals in the United States have marginal zinc deficiency. This is particularly true in the elderly population. Marginal zinc deficiency may be reflected by an increased susceptibility to infection, poor wound healing, a decreased sense of taste or smell, low sperm count, prostate enlargement or skin disorders.

Adequate zinc levels are necessary for proper immune system function and zinc deficiency results in an increased susceptibility to infection. As such, zinc appears to be vital for normal thymus gland functioning in the synthesis and secretion of thymic hormones, and in the protection of the thymus from cellular damage. Several defects in immune function related to aging are reversible upon zinc supplementation, again highlighting the importance of this nutrient for the elderly. As well as stimulating the immune system, zinc has displayed virus inhibiting activity. In one double-blind clinical study, zinc supplementation significantly reduced the average duration of colds by 7 days.

Zinc is also required for protein synthesis and cell growth, and therefore for wound healing. Zinc supplementation has been shown to decrease wound healing time, while a zinc deficiency leads to prolongation of the wound. A high zinc intake is indicated to aid protein synthesis and cell growth following any sort of trauma, including burns, surgery, and wounds,

Zinc is essential for the maintenance of vision, taste and smell, too. Zinc deficiency would result in impaired functioning of these special senses and night blindness is often due to a zinc deficiency. The loss of the sense of taste and/or smell is a common complaint in the elderly. Zinc supplementation has been shown to improve taste and/or smell acuity in some individuals.

Zinc may be critical to healthy male sex hormone and prostate function, as well. Male infertility may be caused by a decreased sperm count due to zinc deficiency, and zinc supplementation may increase sperm count and motility, particularly in men with low testosterone. Zinc deficiency may be a contributing factor in the high rate of prostate enlargement in this country. It is estimated that 50-to-60% of the men between the ages of 40 and 59 have prostate enlargement. Zinc supplementation has been shown to reduce the size of the prostate in the majority of the patients.

The importance of zinc in normal skin function is well known. Typically serum zinc levels are lower in 13-to-14 year old males than in any other age group. This group is also the most susceptible to acne. During puberty there is an increased requirement for zinc due to increased hormonal production. One group of researchers believes that low levels of zinc are responsible for acne during puberty. Several double-blind studies have confirmed this hypothesis, as zinc supplementation has been shown to be as effective as tetracycline for the treatment of acne, but without the side effects. It appears that zinc is able to normalize some of the hormonal factors responsible for acne.

Optimal zinc levels must be attained if optimal health is desired. Although severe zinc deficiency is quite rare in this country, many individuals consume a diet that is low in zinc. The RDA is 15 mg for men and 12 mg for women. In addition to oysters, shellfish, fish, and red meat, zinc is found in good amounts in seeds, nuts, legumes, and whole grains.

Zinc Content of Selected Foods, in Milligrams per 3 ½ oz. (100 g) Serving

Oysters, fresh	148.7	Oats	3.2	Turnips	1.2
Pumpkin seeds	7.5	Peanuts	3.2	Parsley	0.9
Ginger root	6.8	Lima beans	3.1	Potatoes	0.9
Pecans	4.5	Almonds	3.1	Garlic	0.6
Split peas, dry	4.2	Walnuts	3.0	Carrots	0.5
Brazil nuts	4.2	Buckwheat	2.5	Whole-wheat bread	0.5
Whole wheat	3.2	Hazel nuts	2.4	Black beans	0.4
Rye	3.2	Green peas	1.6		

Minerals function along with vitamins as essential components in many metabolic processes as well as to maintain the structure and integrity of the body, comprising up to 5% of our body weight. Although vitamin deficiencies were common until recent times, mineral deficiencies are common with the consumption of the average diet that is high in refined carbohydrates, devitalized oils and animal based foods. In turn, ideal mineral intake can be easily achieved by eating a whole foods diet as many whole foods contain a variety of minerals in abundant amounts.