Mineral Resources International

Guide to Minerals and Trace Minerals

An explanation of the importance of specific minerals and how their source, form, and balance affect human health.

Mineral Resources International
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Mineral Resources International's

Guide to Minerals and Trace Minerals

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The information presented in this booklet should not replace the counsel of one's physician or health care practitioner. Always seek the advice of a physician for a health-related question and concern and before taking any dietary supplement.

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The Importance of Minerals

Your body requires many essential elements—minerals—in order to support numerous critical physiological and biochemical functions.

At this very moment as you read this page, your body is using minerals or ions not only to read and comprehend the words on this page, but to assist your breathing and the beating of your heart. Your very survival, in fact, depends on the presence of minerals in your bloodstream, cells, tissues, and bones.

What are Minerals?

Minerals are naturally occurring elements found in the earth having a characteristic crystalline structure and chemical composition. Rock formations are composed of mineral compounds. As nature's processes gradually break down rock, the resulting elements are collected in the seas and soil. Plants utilize the minerals found in the soil, animals utilize the minerals found in plants as well as from the water supply and from pure mineral deposits such as salt deposits, and this paradigm continues up the food chain.[1] Minerals forge the foundation of every living being—forming blood and bone, transmitting impulses from our nervous system to our extremities and vice versa, and maintaining optimal health.

There are two categories of essential elements: major (macro) minerals and trace (micro) minerals, and a third category that includes potentially essential minerals. **Major minerals** or **macro-minerals** are minerals that the body requires more than 100 milligrams of per day in order to properly maintain health. Major minerals include calcium, chloride, magnesium, potassium, phosphorous, sodium, and sulfur.

Micro or **trace minerals** are those minerals which are essential, but of which the body requires less than 100 milligrams of per day. Trace minerals include chromium, cobalt, copper, fluoride, iodine, iron, manganese, molybdenum, nickel, selenium, silicon, tin, vanadium, and zinc.

A third and other important category of minerals is that of **potentially essential minerals**. A mineral is only officially recognized as essential when there is general consensus in the scientific community that, due to significant scientific evidence, that the mineral is necessary to maintain health and that no other nutrient can be substituted. There are many minerals for which there is a significant or growing body of research attesting to their importance for health but that are not yet recognized as "essential" and would therefore fall into the potentially essential category. Most, if not all, of the minerals that fall into this category are either trace minerals or ultra-trace minerals. This category includes boron, fluoride, nickel, tin, and many others.

Many of the minerals recognized as essential today were not recognized as essential 30 years ago. Despite the fact that they were just as important for health back then as they are today, there was not yet enough scientific evidence or consensus to officially deem the mineral as essential to human health. The minerals in this category are recognized as potentially essential because there is evidence supporting the essentiality of the element and/or its specific health benefits; however, the evidence may still be inconclusive or it may lack scientific consensus.

Some of these potentially essential minerals have significantly more evidence to support their essential status than others. For example, there is significant evidence supporting boron's importance in bone and joint health as well as cognitive function both in animals and humans. Boron is already somewhat recognized as essential by the United States Department of Agriculture; however, it has not yet been recognized as essential with a correlating RDA (Recommended Dietary Allowance) as listed by the FDA.

Some of these minerals can have a very narrow window of safety where a very small amount of the mineral in the diet is sufficient and significant quantities beyond that amount pose the risk of toxicity. Some of these minerals have evidence to support their importance in health, but due to their narrow window of safety are recognized more for potential health problems due to overconsumption. For instance, arsenic, nickel, silicon, and, again, boron are backed by substantial evidence to support the essentiality of these trace elements in animals, as discussed in the Tenth Edition of the Recommended Dietary Allowances by the Institutes of Medicine (IOM), which provides much of the basis for the FDA's RDA recommendations.[2] However, the IOM has stated that there is not yet sufficient evidence for them to make a DRI recommendation.

Lithium is another mineral backed by significant evidence as to health benefits for certain people under certain conditions that may some day prove to be essential. Tin has also made it on some lists for discussion about its possible roles as an essential nutrient.

The body is extremely complex and the roles that minerals serve in the body are not yet fully understood. It is quite possible that some of the minerals that are not yet known for serving any function in the body may some day be recognized for their essentiality for various important body functions, which are not yet known or understood.

The body uses minerals together with other minerals and vitamins to regulate pH, the level and balance of fluids in the body, conduct nerve impulses, regulate heartbeat and blood pressure. They are also used in a number of other physiological and biochemical functions that are critical to life, health, and well-being.

Below is a table that lists some of the individual essential minerals with respect to their charge (i.e., positively charged cations and negatively charged anions along with some of their respective function(s) in the body:

Table 1.0: Role of Minerals in Human Health[1]

Cations (+):	Major Roles in the Body:
Calcium	Helps conduct nerve impulses, muscle contraction, blood clotting, bone and tooth formation, heart action.
Magnesium	Activates enzymes, nerve conduction, muscle contraction, bone and tooth formation, protein metabolism.
Potassium	Nerve conduction, muscle contraction, water balance, acid-base balance.
Sodium	Nerve conduction, muscle contraction, water and acid-base balance.

Hydrogen	Acid-base balance, component of stomach acid (hydrochloric acid).

Anions (-):	**Major Roles in the Body:**
Bicarbonate	Acid-base balance, neutralizes stomach acid.
Chloride	Acid-base balance, water balance, component of stomach acid (hydrochloric acid).
Phosphate	Acid-base balance, bone and tooth formation, protein metabolism, energy metabolism, structure of cell membranes.

The Critical Need for Mineral Supplementation

Why Foods Are No Longer the Reliable, Rich Source of Minerals They Should Be

The human body doesn't produce minerals; they are obtained only from the foods we consume. In other words, we are completely dependent on our diet to provide us with the critical essential elements we need to survive and thrive. The problem, however, is that foods are no longer the reliable, rich source of minerals and trace minerals we need. These same foods also tend to be lower in various other nutrients that require adequate mineral nutrition required by plants and animals. What accounts for the significant drop causing a widespread nutritional gap?

The first and main contributing reason why many individuals—regardless of whether they live in an industrialized or developing nation—are not getting the critical mineral nutrition they need is that the soils, in which food is grown, have become nutrient poor.

Research conducted in the U.S. and U.K. support the finding that fruits, vegetables, and meats have a much lower mineral content compared to the very same foods grown and harvested progressively over the past fifty years.

In the U.K., Dr. David Thomas, D.C., compared data from "The Chemical Composition of Food" published in 1940 by the Medical Research Council with the fifth edition "Composition of Food published in 1991" by the Royal Society of Chemistry and the Ministry of Agriculture, Fisheries, and Foods and came to the startling conclusion that there has been a significant decrease in the nutritional value of fruits, vegetables, and meats.[3]

The table below, published from Dr. Thomas' study that reflects official government statistics, clearly shows a significant drop in the mineral content of foods. According to Thomas[3]:

> *The results of my investigation demonstrate there has been a 76 percent depletion in the copper content of vegetables over a 51-year period. I have also determined that of the seven "new" vegetables introduced and analysed between 1960 and 1991 there has been a depletion of 59 percent in their zinc content. These are alarming results; especially when the essential nature of these and other trace elements to human and animal health are taken into consideration.*

Table 2.0: Summary of Changes in the Mineral Content of Vegetables, Fruit, and Meat Between 1940 and 1991, United Kingdom:[3]*

Year of Analysis	Mineral	Vegetables (27 Varieties)	Fruit (17 Varieties)	Meat (10 Cuts)
1940	Sodium			
1991	(Na)	Less 49%	Less 29%	Less 30%
1940	Potassium			
1991	(K)	Less 16%	Less 19%	Less 16%
1940	Phosphorous			
1991	(P)	Plus 9%	Plus 2%	Less 28%
1940	Magnesium			
1991	(Mg)	Less 24%	Less 16%	Less 10%
1940	Calcium			
1991	(Ca)	Less 46%	Less 16%	Less 41%
1940	Iron			
1991	(Fe)	Less 27%	Less 24%	Less 54%
1940	Copper			
1991	(Cu)	Less 76%	Less 20%	Less 24%

(* © 2000 D.E. Thomas. Published with permission. A complete copy of Dr. Thomas' full report, *A Study on the Mineral Depletion of the Foods Available to Us as a Nation Over the Period 1940 to 1991*, is available upon request from http://www.mineralresourcesint.co.uk/ . A PDF copy is also available at: www.mineralresourcesint.com/news_research)

This nutritional shortfall is not just isolated to the U.K. In the United States, Paul Bergner, author of *The Healing Power of Minerals and Trace Elements* and Director of the North American Institute of Medical Herbalism in Boulder, CO, undertook his own study using data published by the USDA (United States Department of Agriculture data (USDA's Food Handbook No. 8).

According to Bergner's findings as reflected in the table below, there has been a similar, significant decline in the mineral content of fruits and vegetables from just 1963 to 1997 in the U.S.[4]

Table 3.0: Changes in the Mineral Content of Some Fruits and Vegetables, 1963-1992, United States:[4]

Mineral	Average % Change
Calcium	-29.82%
Iron	-32.00
Magnesium	-21.08%
Phosphorous	-11.09%
Potassium	-6.48%

(©1997 Paul Bergner. Published with permission. ***The Healing Power of Minerals and Trace Elements***. *Fruits and vegetables measured: oranges, apples, bananas, carrots, potatoes, corn, tomatoes, celery, romaine lettuce, broccoli, iceberg lettuce, collard greens, chard).

Another U.S. study conducted by Donald R. Davies, Ph.D., F.A.C.N., Melvin Epp, Ph.D., and Hugh Riordan, M.D., reported declines of protein, calcium, phosphorous, iron, riboflavin, and ascorbic acid in 43 garden crops between 1950 and 1999.[5]

So, what accounts for the plunging mineral content of our crop foods? Why have the foods we have long regarded as healthy instead turned out to be such a poor source of essential minerals? There are a few factors that explain the dramatic decrease. First, according to Bergner, in today's era of large, industrial commercial farming, traditional methods farmers relied on (organic farming methods, re-fertilization with organic matter, crop rotation, etc.) to maintain optimal soil quality have been abandoned by large commercial farming ventures in favor of convenient and less costly methods to grow the largest crop possible—year after year with no respite.

That means that every inch of soil is devoted to quickly churning out cash crops without regard as to what the land can reasonably sustain. Second, organic plant matter, which is left behind by traditional farming methods to return some mineral content to the soil, is, instead, hauled off to decompose in landfills rather than left behind to fertilize farm soil. Third, soil is routinely fertilized with NPK (nitrogen, phosphorous, and potassium) fertilizer, which alters the delicate elemental balance of soil and excludes a vital balance of essential trace minerals so crucial for plant and human health. One unintended side effect of NPK fertilizer is that because it omits many of the other elements and trace elements, it negatively affects a plant's ability to naturally resist pests and funguses it may otherwise be able to fend off had there been a complete balance of *several* micronutrients. The result is that farmers rely heavily on pesticides and fungicides to produce a higher yield crop. Both in the U.S. and worldwide, farmers are increasingly planting transgenic or genetically engineered plants (e.g., bt or *bacillus thuringiensis* tomatoes or corn*)* to minimize losses due to bacteria, funguses, and pests.

Last, many commercial farms do not practice sustainable farming methods such as allowing soil to "rest" or lie fallow, which prevents the further leeching or loss of minerals and allows the soil a chance to re-establish a healthy balance of elements and moisture in preparation for the next cropping season. Rather, many commercial farms begin planting the next crop as soon as the last one has been harvested.

These are just some of the factors that have contributed to the worldwide decline in soil quality. The result is our fruits and vegetables, while they may deceivingly look the same as they always have, in reality, become increasingly inadequate sources of essential minerals and trace minerals, which people need to stay healthy.

Additional Factors Contributing to Widespread Mineral Deficiencies

Global shifts in food consumption patterns, modern food processing techniques, plus diet and lifestyle factors also factor into the "mineral gap."

It's not just poor soil quality that is to blame for the poor nutritional status of hundreds of thousands of individuals. In addition to the decreased mineral content of commercially grown foods, other factors have further contributed to the global prevalence of malnutrition.

One of the most glaring factors is that within the last twenty years there has been a massive global shift in nutrition and eating patterns among the world's populations. Obesity and lifestyle diseases, such as diabetes, have increased dramatically all over the world in the last twenty years. Dietary intake surveys consistently point to a shift in the diet to one that is higher in fat, refined carbohydrates, and sugar and lower in minerals, vitamins, carbohydrates, and fiber [6]. Individuals no longer raise and consume produce grown on the farm. Instead, we consume foods that are mass-produced, laden with fat and sugar and are poor sources of minerals and vitamins. Furthermore, refined foods are often cheaper than fruits and vegetables, which is another motivating factor as to why many people purchase processed foods rather than vegetables and/or fruit.

Globalization and urbanization have led to a worldwide over consumption of fatty, sugary foods, including fast foods, soda pop, biscuits, and snacks that are calorie-dense foods but offer no wholesome nutritional value whatsoever. Even supermarkets are not exempt. Many supermarkets offer high-fat, high-carb ready-to-eat meals for busy individuals on the go. And, finally, the magnitude to which fast-food franchises have further contributed to global undernutrition should be emphasized.[7] It seems ironic that the decline in global nutrition has been simultaneously accompanied by a rapid increase in obesity, yet the facts and figures speak for themselves. Obesity, diabetes, and heart disease are on the rise in several countries, which will plague developing nations as it has industrialized nations.

Further, as part of the world's reliance on mass-produced foods, food processing techniques itself—which are designed to make food safer, tastier, more shelf-stable, etc.—have further contributed to the poor nutritional quality of foods.[7] It is known that the bioavailability of key minerals like zinc, iron, and calcium are affected by the fiber, phytic acid, and tannin content of foods. Food-preparation processes like blanching vegetables, for instance, results in leaching losses of vitamins and minerals. Milling and extrusion further removes valuable minerals and trace minerals during processing. Other factors such as the time and temperature of processing, product composition, and storage also impact the mineral and vitamin status of foods.[8]

Finally, there are numerous other diet and lifestyle factors that each factor into people's undernutrition. Stress, coffee and alcohol consumption, cigarette smoking, the use of certain medications—statins, diuretics, birth control pills—further deplete precious minerals, antioxidants, etc. from the body, altering homeostasis and increasing one's vulnerability to disease.

The result of all of these factors—continual soil depletion, a global shift in eating patterns to calorie-dense, micronutrient-poor foods, modern food processing techniques—have left people deficient in critical minerals and trace minerals. From all outward appearances, the majority of people are, indeed, eating more than sufficient quantities of food. Obesity is no longer a chronic health condition relegated to the U.S. Over 300 million adults *worldwide* are obese, according to latest statistics from the WHO and the International Obesity Task Force.[9] In that respect, most people are not malnourished. However, we are not receiving the proper nourishment from our foods, and, in that sense, most people are malnourished. Many individuals may have deficiencies of critical minerals (and vitamins) and, as a result, their health may be far more vulnerable than they believe.

There is a substantial body of research and data demonstrating the link between an adequate intake of minerals and trace minerals and a reduced risk of a variety of chronic, degenerative conditions.

The table below (as well as the mineral monographs in Section Two) illustrates just a few of the important roles minerals and trace minerals play in our health and well-being:

Table 4.0: Minerals, Trace Minerals, and Their Role in Certain Health Conditions

Element	Health Conditions It May Treat
Boron	Osteoporosis, Osteoarthritis
Calcium	Osteoporosis; Arthritis, Colon Cancer Prevention, Insomnia, High Cholesterol
Chloride	Hypertension
Chromium	Diabetes, High Cholesterol, Hyper & Hypoglycemia
Iron	Anemia, Menorrhagia
Lithium	Mental disorders
Magnesium	Cardiovascular disease, Muscle Cramps, Pre-eclampsia
Potassium	Hypertension, Muscle Cramps, Stroke
Selenium	Arthritis, Cancer Prevention, Male Infertility
Zinc	Acne, Immunodepression, Anorexia, Benign Prostatic Hyperplasia, Macular Degeneration, Wound Healing

Mineral Forms and Balance

The Four Main Types of Mineral Supplements

Just as important as ensuring an optimal intake of minerals is the form of mineral. When purchasing a quality mineral supplement, form and balance are critical. In this section, we explain the four main types of mineral supplements, the advantages and disadvantages of these mineral forms, and special considerations consumers should be aware of when purchasing a mineral supplement:

Mineral Salts

The most common and typically the least expensive form of a mineral is a mineral salt. A mineral salt is typically completely or almost completely made up of just two minerals, a positively charged mineral and a negatively charged mineral. They are usually found in large deposits or are created through specific large-scale chemical crystallization processes. A mineral salt provides very targeted and, therefore, not a very balanced form of nutrition. Mineral salts vary in their absorption and in how well the body tolerates them. Sodium chloride is the most common mineral salt and is highly absorbable, but its lack of balance can pose a number of health problems when consumed in large quantities. Some mineral salts, such as magnesium sulfate, pair a mineral that is needed in large quantities with a mineral needed in much smaller quantities, and can pose problems in how well it is tolerated when it is consumed in sufficient quantities to provide necessary amounts of the mineral that is needed in larger quantities.

Colloidal Minerals

Colloidal minerals refer to minerals within a particular delivery form. Colloids are tiny forms of minerals—colloidal metal hydroxides—suspended in a liquid medium. The source for these mineral products is usually humic shale deposits or aluminosilicate-containing clays that are 60 million years old.[9]

Colloidal mineral marketers claim that due to their form, colloids are "organic," better absorbed, contain a better balance of elements, and are safer. However, there are no studies to verify that colloidal mineral products are absorbed any better or faster than other mineral forms. Chris Meletis, N.D., Dean of Naturopathic Medicine and Chief Medical Officer at the National College of Naturopathic Medicine in Portland, Ore., disputes such claims stating, "Colloidal minerals are not readily absorbed by the body due to the absence of an electrical charge and their relatively large size, unlike other minerals forms." [10]

Further bolstering Meletis' doubts regarding the marketing claims of colloidal mineral products, the *Physicians' Desk Reference for Nutritional* Supplements states the following: "There is no credible research showing benefits from colloidal minerals. Claims that they are more absorbable are also unsubstantiated." [11] The PDR cautions consumers that, "Those who require mineral supplementation should be aware of the great variability of minerals in these supplements from batch to batch." [11]

In addition to the questionable absorption rate of colloids, there may be safety concerns as well. According to the PDR, "Some [products] have been found to contain varying levels of mercury, lead, aluminum, cadmium, and arsenic, among other substances." [11]

Several years ago Alexander Schauss, Ph.D., director of natural and medicinal products research at American Institute for Biosocial and Medical Research in Tacoma, WA, oversaw a study that analyzed five brands of colloidal mineral supplements[12] (see Table 5.0). This study divulged two findings: First, the average of the five colloidal mineral supplements tested uncovered an average of 15 elements—well below manufacturer's claims that these products contain 70 or more elements. Second, many products contained high levels of sodium, aluminum, and strontium. Especially alarming, however, is that three of the five brands contained very high levels of

aluminum, a toxic element. Based on these findings, consumers should exercise caution when considering using a colloidal mineral product.

Table 5.0: Minerals Present in Five Colloidal Mineral Products (Content in Parts per Million) [12]

Element	Product A	Product B	Product C	Product D	Product E
Sodium	22995.8	81	328	55.3	218.8
Potassium	97.4	13	339	ND	26.4
Calcium	ND	505	1180	488	517.6
Magnesium	ND	500	245	402	694.6
Lithium	0.218	5.564	ND	ND	5.7

Trace Elements	A	B	C	D	E
Antimony	ND	ND	ND	ND	ND
Berylium	ND	0.368	ND	ND	ND
Boron	18.8	2.31	ND	ND	8.5
Chromium	ND	0.841	ND	ND	0.132
Cobalt	ND	4.167	ND	ND	2.1
Copper	1.3	2.71	0	2.63	0.554
Germanium	ND	ND	ND	ND	ND
Iodine	ND	ND	ND	ND	0.006
Iron	1.3	958.2	330	329	50.3
Manganese	ND	12.42	ND	ND	20.1
Molybedenum	ND	1.921	ND	ND	1.3
Nickel	ND	9.044	ND	ND	2.6
Phosphorous	9.7	ND	ND	ND	10.5
Selenium	ND	ND	ND	ND	ND
Silver	ND	ND	ND	ND	ND
Vanadium	ND	1.232	ND	ND	0.602
Zinc	ND	32.81	3.8	27.4	13.7

Toxic Trace Elements	A	B	C	D	E
Aluminum	18.2	2,741	338	2,290	4,339.4
Arsenic	ND	1.18	ND	ND	2.2
Barium	ND	ND	ND	ND	ND
Cadmium	ND	0.71	ND	ND	ND
Lead	ND	0.955	ND	ND	0.006
Mercury	ND	ND	ND	ND	ND

Other Trace Elements	A	B	C	D	E
Bromide	ND	ND	ND	ND	3.4
Silicon	146.9	23.8	42.2	26.2	2.6
Strontium	0.2	1.011	ND	ND	18297.8
Sulphur	98.1	5908	ND	ND	ND
Tin	0.002	ND	ND	ND	0.09
Zirconium	ND	0.18	ND	ND	ND

Fluoride	ND	ND	ND	ND	ND
Total Number of Elements	**12**	**24**	**8**	**8**	**24**

***ND = Not detectable at ppm

Chelated Minerals

Chelates are another form of minerals. A chelate is mineral mixed with various amino acids or oligopeptides.[12] A chelated mineral is one that has been bound with a protein or amino acid. The bonding process is referred to as chelation, and the bond is a chelate. This process happens naturally within the body (the liver by and large does the process of chelation), and it chelates minerals to specific proteins or amino acids in order to direct minerals to specific places for specific functions. Some chelates within the body are actually used to direct minerals out of the body. The recognition of this function has led to the medical practice of chelation therapy, which is the injection of specific amino acids or proteins that "lock on" to certain toxic minerals and flush them from the body.

One leading chelate mineral manufacturer claims to have developed a proprietary process of chelating the minerals in such a way as to ensure the bond is not broken down during the digestive process, thus ensuring "superior" assimilation. This company claims that chelated minerals from other companies do not have a true chelation bond and are therefore easily broken down in the digestive system. This claim raises an interesting side issue; that is, chelated minerals are generally more expensive than other mineral forms. If, as some chelate manufacturers claim—that the bond of most chelated minerals are broken before the minerals are assimilated—this would be a waste of money for the consumer.

Addressing claims that chelates are "better" absorbed than other mineral forms, the *Physicians' Desk Reference* states the following: "There may be certain minerals, *e.g.*, trivalent chromium and zinc, where this is possibly the case. However, in most cases, chelated and non-chelated minerals are absorbed with equal efficiency."[13]

Parris Kidd, Ph.D., in MRI's audiotape *Ions—The Elemental Spark of Life*, maintained that claims by chelated mineral companies did not add up. Many chelate products, he believed, are poorly defined and validated.

Specifically, asserts Kidd, some chelates are amino acids that are so tightly bound to a mineral so as to prevent the minerals from being released in ionic form. It is highly unlikely that certain chelates can actually target parts of the body as some of their proponents claim. Kidd goes on to state that even if the chelate makes it as far as the blood, it still has to make it through the liver, where the liver takes the mineral, frees it up, sorts it out, adds it onto new amino acids and does whatever the liver decides is best to do with that particular element. From the liver, the mineral can then go on to any number of different amino acids depending on what part function is required.

According to Dr. Kidd, it is better to administer the mineral in an ionized form and allow liver, which is the first port of call for the blood, to either convert it into a storage form or transfer it onto cysteine, methionin, histadine or other forms of amino acids, which are then routed to the blood, deposited into bone, or directed to particular enzymes sites. The liver, he believed, is far better equipped to decide what to do with a free mineral than we are equipped to tell the body what particular amino acid to carry the mineral in on.

To summarize, the complex process of assimilation is best left to the body to work out on its own, which it is quite capable of doing if minerals are digested in their free ionic state, flow naturally to the liver, and are chelated on an as-needed basis to serve essential physiological and biochemical roles most needed at that time. There are also numerous roles for essential minerals that are only served when the elements are in a free ionic state and are not bound to another substance.

Ionic or Ionized Minerals

An **ion** is a particle (either an atom or a group of atoms) that carries an electrical charge; positively charged ions are called cations (*e.g* calcium, magnesium, potassium, sodium, and hydrogen) and negatively charged ions are referred to as anions (*e.g.*, bicarbonate, chloride, phosphate).

Every body process is dependant on ions. The fluids of the body are largely ionic solutions. The body uses the movement of ions through these fluids and across cell membranes as an integral part of many vital body processes. Table 1.0: The Role of Minerals in Human Health on page one of this booklet lists anions and cations and their respective functions in the body.

Electrolytes have significant overlap in definition with ions. Electrolytes are mineral salts which dissociate or split in water into their respective positive and negative parts, thus becoming capable of conducting electrical activities. All electrolytes are ionic or made up of ionic minerals, but not all ions are electrolytes. Electrolytes help generate and carry electrical currents through the body. There is a great deal of evidence that the healthy function of the body is based on electrical impulses. That is, our bodies use electrical impulse pathways, and electrolytes and ions are the conductors of these currents that keep everything running smoothly in the body. Ions provide the necessary charge of both positive and negative molecules that keep the electrical component of the human battery “charged” and working in top form.

The Health Solu+ions mineral products from Utah’s Great Salt Lake, in both liquid and tableted forms are naturally balanced electrolytes in soluble ionic form, which means they provide a range of essential nutrition and the ionic minerals easily dissociate or come apart in a watery environment, *i.e.,* the stomach, and become positively and negatively charged and are thus able to assist the body in conducting electrical energy.

A secondary benefit of ionic minerals, according to Parris Kidd, Ph.D., is that they are selectively absorbed and directed to the areas of the body where they are needed most[14]:

> *The body is very discriminatory. [It] knows when it needs minerals in greater amounts and when that happens, the body reaches out for those minerals. The density of the*

transporter proteins goes up on the intestinal cell surface and the body is actually looking for those minerals.

Now those transporters bind those minerals tightly but they need to be ionized. The transporter picks up an ionized form [of the mineral], binds it and immediately pulls it in and then it goes into the bloodstream and goes where it is needed.

The Importance of Balance in Nutrition

Why Balance is Crucial to Health and Well-Being

Balance is an important concept that many of us relate to; for many, it's a personal objective we strive to maintain within the multi-faceted aspects of daily life. We talk about balancing work, family, personal demands, and stress, etc. Within the field of nutrition, we also hear a lot about balance, namely the importance of eating a "balanced" diet (*i.e*., fruits and vegetables). However, as outlined in the previous sections, there is sufficient data to indicate this is not always possible.

Just as important as ensuring an optimal intake of minerals in the right form is ensuring an optimal *balance*. Balance is an important concept within the field of nutrition. In fact, all living creatures on this planet—from the simplest organisms to humans—owe their very existence to balance.

The Link Between Our Bodies and the Seas

There is significant evidence that life began in the seas, according to Forrest H. Nielsen of the U.S. Department of Agriculture's Agricultural Research Service. One clue is that certain elements such as magnesium, iron, and sulphur are minerals whose presence is critical for life today, and this is probably due to the fact the first living organisms used these elements while they were evolving in the seas. In fact, states Nielsen, the biological importance of minerals tends to parallel oceanic abundance.

According to Forrest H. Nielsen of the Grand Forks Human Nutrition Center of the USDA (United States Department of Agriculture)[15] :

The first organic materials, and, ultimately, life forms most likely were formed in the presence of water containing minerals that provide structural integrity and catalytic ability to the first complex organic substances…The mineral elements incorporated in the first primitive organisms, therefore, most likely reflected the mineral element concentrations in the sea water where they evolved. This is supported by the finding that most primitive modern invertebrates that live in the present oceans have tissue fluid composition that is very similar to the composition of the sea water around them.

Note that Nielsen refers to minerals in the plural form; not one mineral or a mineral. Human development was formed and became dependent on a balance of elements that are as crucial to our health today as they were millions of years ago. Nielsen continues[15]*:*

> *Sulfur, iron, manganese, and magnesium are mineral elements crucial to life today; this probably occurred because the first living organisms utilized these elements which are characteristic of hydrothermal environments…The wide variety of other mineral elements that assumed essential functions for various forms of life could also have been introduced to simple early organisms sited on a hydrothermal-associated environmental substrates which made them more highly concentrated and reactive.*

Nutritional balance or equilibrium performs three important functions. First, all nutrients work synergistically with other minerals and vitamins. Vitamins need minerals (*e.g.*, vitamin C and iron, calcium and vitamin D, vitamin E and selenium, etc.) in order to perform crucial biochemical functions in the body, and minerals function in the same manner. Minerals work together with other minerals to perform their respective roles in human health.

> *The minerals iron and copper, for example, are closely related, and are needed by the body in the right proportions for production of red blood cells. Without enough copper, iron could not be incorporated into hemoglobin. Magnesium may be required to correct potassium deficiency symptoms, since magnesium enhances the cellular retention of potassium. Calcium, magnesium, and phosphorous work together to maintain the skeletal structures.*[16]

For those who take a daily multivitamin/mineral supplement, it's imperative they check the label closely to ensure it contains a proper and complete balance of minerals and trace minerals. Individuals should also closely monitor the use of single-nutrient supplements for the reasons that are outlined below.

The second reason why nutritional balance is important is that a disruption in mineral equilibrium can, in turn, result in widespread imbalance within the body. Single-nutrient supplements are extremely common and popular, however, an excessive intake of one mineral can cause imbalanced levels of another mineral or, worse, it may lead to a deficiency.

Perhaps the most common modern-day case in point of this misunderstanding concerns calcium. Many individuals—particularly young and older females—take calcium supplements to reduce the risk of osteoporosis. However, individuals consuming megadoses of calcium may be causing a deficiency of phosphorous and magnesium—two other important minerals crucial to bone health—and may actually be worsening the very condition they are trying to prevent.

High intakes of calcium reduce levels of magnesium in the body because in some instances—such as absorption—both elements compete within the body. According to the *Physicians' Desk Reference:*[17]

> *Magnesium is intimately interlocked, biologically with calcium. In some reactions, such as the synthesis of nucleic acids and protein, calcium and magnesium are antagonistic. Magnesium is necessary for these processes, while calcium can inhibit them…*

According to the *PDR*, women with postmenopausal osteoporosis have significant reductions in bone mineral content and serum magnesium. Other studies have echoed these findings similarly correlating dietary magnesium intake with bone mineral content and bone mineral density.

According to Carolyn Dean, author of the *Miracle of Magnesium*, besides assisting in the absorption of calcium, magnesium stimulates calcitonin, which preserves bone structure by drawing calcium out of the blood and back into the bones; suppresses parathyroid, a hormone that breaks down bone, converts vitamin D to its active form to facilitate calcium absorption, and activates an enzyme necessary to forming new bone.[18]

But, again, it's not just a story of one mineral or two; there are additional studies reporting that trace minerals (*e.g*., copper, manganese, boron) have exhibited anti-osteoporotic activity. The human body is a complex organism, and maintaining optimal health is not the result of supplementing with just one or two nutrients, but a balance of elements.

Again, balance is fundamental, and taking the time to understand nutrient interrelationships is just as important for our health and well-being as eating a healthy diet, consuming essential minerals and vitamins, and exercising, etc.

A third reason underscoring the importance of consuming a balance of nutrients is that it may protect you from certain problems with toxicity. For instance, cadmium is considered a toxic element that is linked with certain forms of cancer. According to Philip G. Reeves of the USDA, diets containing adequate amounts of other essential elements (*e.g*., calcium, zinc, iron) may keep cadmium levels in check.[19]

Reeves conducted studies with human volunteers consuming a specific food with a natural amount of cadmium for one year. Volunteers, however, also consumed foods containing adequate amounts of zinc and iron. After one year, the volunteers showed no signs of cadmium overload. So, an optimal balance of minerals may reduce one's chances of absorbing certain toxic minerals found in our environment.

Why Some Elements are Toxic and Others Are Not

"Toxicity," according to Forrest Nielsen, "of both essential and non-essential elements occurs when an organism is exposed to amounts that overwhelm homeostatic mechanisms." The ability and efficiency of attempts by homeostatic mechanisms to deal with toxicity depends on the exposure of the organism to the element during its evolution. "Exposure to elements in concentrations found in sea water is not likely to be toxic to living things," adds Nielsen[15].

Nielsen explains that during evolution organisms have developed homeostatic mechanisms to maintain steady, optimal concentrations of an element in the body through absorption, storage, and secretion based on its exposure to a particular element:

> *The efficiency of homeostatic mechanisms to deal with a specific element most likely depends upon the exposure of an organism to the element during its evolution. Thus, exposure to elements in concentrations found in sea water is not likely to be toxic to living things. The corollary to this is that exposure to elements at concentrations well above that to which living organisms were exposed while living in the sea or on the pre-human earth crust often will be found toxic to life.*[15]

Natural Balance; Perfect Solution: The Health Solu+ions ™ Difference

About ConcenSea ™ and MRI's Harvesting Methods

Utah's Great Salt Lake, the source of ConcenSea (CMD), is the largest body of ultra-concentrated sea water rich in naturally balanced essential minerals and potentially essential minerals including magnesium, chloride, boron, lithium and selenium in ionic form—the form most easily assimilated by the body. ConcenSea ™ (CMD) serves as the foundation for MRI's entire product line, including MRI's tableted supplements.

In addition to being (by their very nature) naturally occurring ionic elements, the minerals from ConcenSea ™ are naturally balanced as a result of natural processes as well as delicate harvesting processes MRI follows to ensure a pure, optimally balanced mineral and trace mineral product.

We, at Health Solu+Ions ™ and MRI, firmly believe the secret to producing the most effective and powerful mineral and trace mineral supplements hinges on certain key strategies: beginning with a unique and pure source (Northshore), following natural methods for harvesting the minerals that do not upset the delicate balance of the lake and environment; and adhering to stringent manufacturing standards and procedures that ensure quality.

Northshore

MRI's products begin and end with our annual mineral harvest. Northshore Limited Partnership, situated on the very northern tip of the Northwest arm of Utah's Great Salt Lake near historic Promontory Point, is MRI's exclusive supplier for food-grade minerals from the Great Salt Lake.

Our remote location affords us numerous advantages. Because Northshore is located far from civilization, there are no industrial processes or operations nearby that interfere with the quality of the raw material. In addition, the northwest arm is more concentrated so there are higher concentrations of magnesium, boron, lithium, etc.

Yet another benefit of our location is the climate, which helps cultivate an ultra-rich, concentrated mineral product base. During the summer, temperatures can climb into the triple digits, and the air is extremely dry. The winters can be especially cold, thereby causing the lake's temperature to plummet. This extreme contrast in climate conditions helps craft a superior raw ingredient rich in essential minerals, yet free from undesirable elements.

Nature and Nurture: The Role of MRI's Natural Harvesting Methods

MRI strives to produce the highest quality raw ingredient that eventually becomes ConcenSea ™. The concentration process is time-consuming, work-intensive, and requires delicate cooperation with nature. On average, it takes two years before the minerals reach the right level of concentration and balance before it can eventually become ConcenSea ™ CMD, our core product. MRI never uses harmful chemicals or synthetic ingredients in its all-natural process and conducts consistent testing to ensure product is contaminant free.

MRI maintains a full-time harvesting staff that monitors the ponds 365 days a year, 24 hours a day. Staff members work closely with nature to create an optimal product by running scientific tests, sometimes multiple times per day. Samples are regularly taken and sent in to our laboratory as well as independent labs to ensure that product has reached specifications for the highest levels of standardization and purity possible. The decision as to when to harvest our raw ingredient is paramount; key analytical factors include the optimal concentration level of the minerals, balance, other key laboratory analytical factors as described above plus other important proprietary internal company assessments and considerations.

At MRI, we firmly believe that we have been entrusted with a stewardship to not only to support the health of consumers who purchase our products, but to care for the delicate ecosystem of the Great Salt Lake. Therefore, we strongly feel it is our duty to carefully, yet gently concentrate and collect the minerals while protecting the natural, delicate habitat of the Great Salt Lake. To this end, MRI has undergone a rigorous multiple-year approval process with the State of Utah and The Army Corps of Engineers for authorization to harvest minerals from the Great Salt Lake.

MRI abides by the highest safety and environmental regulations and conditions, raising temporary structures rather than permanent buildings so as not to disturb the landscape. Further, MRI utilizes natural harvesting methods that emphasize and ensure quality rather than quantity, returning unused minerals back to the lake. And we transport all refuse away to proper disposal facilities.

Manufacturing and Quality Assurance Standards

During our manufacturing process, whether we are producing liquid or tableted products, quality is of utmost importance during each stage.

Once analysis and testing have verified that the raw material can be harvested, it is collected and transferred to MRI's manufacturing facility located in Ogden, Utah. Upon its arrival at MRI's facilities, the lot is quarantined where it then undergoes extensive testing, processing, filtration, and proprietary procedures to ensure potency, purity, and balance.

MRI is inspected and certified by the State of Utah as complying with all applicable food processing and handling good manufacturing practices (GMPs). These include proper hygienic requirements, documentation, and finished product purity.

Once the lot of liquid minerals has been approved, it is stored in a separate building at MRI's facility where it awaits further testing and processing whereupon it is either bottled as liquid product, used as a main ingredient in MRI's tableted products, or used as one of our numerous bulk mineral products. We view every instance or point of contact with in-process product as an essential opportunity to ensure and improve quality.

Liquid Products

Prior to bottling, MRI's quality assurance department conducts a range of tests to validate potency, balance, and purity. Finished product is filtered and bottled in our clean rooms and

sealed with careful attention. Once this procedure is complete, MRI conducts final-stage quality tests and inspects the product prior to releasing it for shipment.

Tableted Products

Our goal is to provide nutrition, which provides the conditions for optimal health in a way that actually makes people feel better, and we go to great lengths during our tablet production process to ensure we fulfill this goal. We produce approximately 50 tableted dietary supplement formulations using ionic minerals as the basis for each product.

We begin with the finest, high-quality ingredients that we either produce ourselves or purchase from only reputable, quality suppliers who provide a Certificate of Analysis for every ingredient.

Once the potency and purity of each ingredient has been ascertained, we combine each of the ingredients in measured stages. MRI is one of the few manufacturers in the world who uses the cumbersome yet highly effective process of combining herbs and other nutrients in a wet mix with ionic minerals to achieve the highest synergy possible. Other ingredients are added at the very end in a dry mix to ensure that nutrients maintain their unique and individual benefits for health. Work-in-progress is prepared in a series of clean-room environments.

Once work-in-progress has been mixed, we use a low temperature, slow-drying process. The temperature in our drying rooms is kept below 120° degrees Fahrenheit to preserve the enzymes, vitamins, and volatile oils and other phytonutrients in the herbs.

Throughout each work-in-progress stage, samples are taken and numerous laboratory tests are conducted by MRI's quality assurance team. Prior to product bottling and labeling, tablets again undergo a final round of testing to ensure safety, efficacy and quality. Once this step is complete, product is inspected and approved before it is released for shipment.

Summary

In Section One, we've explained what minerals are and the important functions minerals and trace minerals perform in human health. We hear a lot these days about the importance of eating a "balanced" diet—one that emphasizes fresh fruits and vegetables. Unfortunately, as we have learned through the research of Dr. David Thomas and Paul Bergner, though these foods may look like they always have, modern farming practices and food processing techniques combined with other factors such as a global shift in eating patterns have further contributed to our declining intake of essential elements and subsequent increase in many chronic, degenerative conditions.

Supplementing with essential minerals and trace minerals is critical to protecting one's health in this day and age; however, equally critical is understanding the concepts of form and balance. This chapter has discussed the four main forms of minerals and the importance of consuming a balance of elements—rather than just one or two minerals.
Utah's Great Salt Lake, where MRI harvests the raw ingredient that eventually becomes CMD is the largest inland body of concentrated sea water rich is essential minerals such as magnesium, selenium, boron, and lithium that are vitally important for health. MRI uses the naturally

balanced, naturally occurring ionic minerals as the basis not just for CMD, but for all of its products.

But the quality and effectiveness of MRI's mineral supplements is not just attributable to its source. We, at MRI, also believe that following natural harvesting methods and adhering to strict quality control procedures are also strong factors as to why we are able to offer the most powerful mineral and trace mineral supplements.

In Section Two, you will learn more about 34 individual elements and their effect on human health. The mineral monographs contain valuable information on the following items:

- The function of that particular element in the body
- The Recommended Daily Allowance as established by the National Academies of Science Institute of Medicine.
- The signs and symptoms of particular mineral deficiencies.
- Safety considerations including contraindications and the signs of mineral toxicity
- A brief review of current research findings and their role in human health

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Boron

Facts:

- Boron (B) is a trace mineral essential for plants. Boron has only recently been established as an mineral of nutritional significance to humans and animals.[1] Although this mineral has not been officially recognized as essential by the National Academies of Science, there is growing consensus within the scientific and medical community that it plays a valuable role in a number of physiological functions—primarily calcium and bone metabolism. [2]
- Boron is found in most tissues but is primarily concentrated in the bone, spleen, and thyroid.
- Excesses of boron are excreted in the urine.

Functions:

- Several studies have demonstrated that this trace mineral is required in calcium and bone metabolism to help prevent bone loss associated with osteoporosis.
- Several studies have also shown an association between sufficient boron intake and a reduction in the incidence of tooth decay.[1]
- Studies have linked optimal intakes of boron with enhanced memory, alertness, and cognitive function.[3]
- Some studies have shown that boron supplementation of 3 milligrams per day results in both calcium and magnesium retention and elevations in serum concentrations of testosterone and estrogen.[4]
- Men who consume optimal intakes of boron also have decreased risk of developing prostate cancers.
- Elderly individuals benefit from supplementing their diet with 2 to 3 milligrams per day of boron due to a reduced ability to absorb calcium.[4]
- Some research findings have indicated that boron is a “dynamic” trace element that can affect the metabolism of other substances involved in many processes including hormones such as estrogen and thyroid hormone.[5]

Requirements:

No recommendations or Daily Values have been established. Typical daily intakes in the United States vary between 0.5-7.0 milligrams. Those consuming Westernized diets consume between 0.1-0.5 milligrams of boron per day. [1]

Signs of Deficiency:

In animals (with a vitamin D deficiency) fed low amounts of boron, there were increases in total calcium loss, interruption with the use of insulin, fat and glucose as well as diminished bone development. In closely monitored studies, humans fed a diet low in boron exhibited similar changes as witnessed in the boron-deficient animals. Low intakes of boron may also aggravate the symptoms of arthritis. It reduces

blood ionized calcium and calcitonin levels and elevates urinary calcium loss in humans, while adequate supplementation inhibits these conditions.

Interactions:

Low levels of boron can cause increased urinary excretion of calcium and magnesium.

Signs of Toxicity:

The majority of boron that enters the body is excreted through the urine. Boron is considered non-toxic unless consumed in highly excessive amounts. Doses up to 18 mg daily appear safe even when taken for prolonged periods of time. In animals, large doses of boron have caused loss of appetite, nausea, vomiting, skin rashes, lethargy, and diarrhea.

Current Research:

Heart Disease: Researchers at the University of Sydney in Australia have found that boron might reduce cardiovascular disease by inducing small increases in plasma estrogen concentrations.[6]

Arthritis: Researchers at the International Symposium on Health Effects of Boron and its Compounds held at the University of California at Irvine report that boron levels in arthritic patients are low and that the arthritis rates are typically higher in regions where boron intakes are the lowest. However, in patients that supplemented their diet with boron, bone density is much greater. Osteoarthritis: Supplemental boron may relieve some of the symptoms of osteoarthritis. Some epidemiological studies suggest that in areas of the world where boron intakes are 1 mg or less, the incidence of arthritis ranges from 20 to 27 percent.[10] A double-blind, placebo-controlled study of 20 patients in which half of the patients were given 6 mg of boron daily and the other half received placebo reported that 50 percent of those taking boron reported improvement while only 10 percent of those on placebo showed similar improvement.[10]

Cognitive Function: According to the United States Department of Agriculture (USDA) Agricultural Research Center, boron is essential for mental function, hand-eye coordination, attention span, perception, and short and long-term memory.[5] Comparing spectral analysis of electroencephalographic data of low boron intake compared to high boron intake, there was a significant increase in the proportion of low-frequency activity and a decrease in the proportion of higher frequency activity (an effect often observed in general malnutrition or heavy metal toxicity). In addition, low boron intake resulted in "significantly poorer" performance on tasks emphasizing manual dexterity, eye-hand coordination, attention, perception, encoding, and short-term memory and long-term memory.[5]

Prostate Cancer: Researchers at the University of California at Los Angeles conclude that men whose diets had the most boron, at least 1.8 milligrams of boron per day, had less than one-third as many prostate cancers as men who consumed less than 0.9 milligrams per day.[8]

Boron

Immune Function: There is emerging evidence that dietary boron aids the immune system by reducing the incidence and severity of inflammatory disease. Researchers believe boron facilitates the normal inflammatory process by reducing the activity of serine proteases, enzymes that are typically elevated during the normal inflammatory process.[9]

Osteoporosis: Boron may help prevent against postmenopausal osteoporosis. Researchers at the USDA Agricultural Research Service found that women who supplemented their diet with 3 milligrams of boron excreted approximately 40 percent less calcium, 30 percent less magnesium and slightly less phosphorous through their urine than they had prior to supplementation.[4]

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Calcium

Facts:

- Calcium is the most abundant mineral in the body. It is also the fifth most common substance in the body after carbon, hydrogen, oxygen, and nitrogen. Until about age 30, calcium accretion outpaces calcium loss, which results in increased bone density and growth. After age 30, however, the body gradually loses calcium, resulting in a gradual depletion of bone minerals.
- Heavy exercising hinders calcium's assimilation while moderate amounts of exercise improve its assimilation. Female athletes and menopausal women require increased amounts of calcium due to lower estrogen levels.[1] Estrogen aids the skeletal system by promoting the deposition of calcium in the bone.
- Taking too much calcium can interfere with the absorption of zinc, magnesium, and iron. Likewise high doses of magnesium, zinc, and iron can interfere with the absorption of calcium. [1]
- Because the body slowly absorbs calcium, calcium supplements are more effective if they are taken in small doses throughout the day and at bedtime. Another reason to take calcium at bedtime: calcium is useful in promoting a sound, restful sleep. [1]

Functions:

- Calcium is essential for the formation of strong bones and teeth and for the maintenance of healthy gums. It increases the rate of bone growth and prevents against bone loss associated with osteoporosis.[1]
- Calcium is important in the maintenance of a regular heartbeat and transmission of nerve impulses. Calcium helps lower cholesterol levels and helps prevent against cardiovascular disease and certain forms of cancer including colorectal cancer.[2]
- Calcium is an important of normal blood clotting processes that aid in the early stages of wound healing. In addition, calcium also wards off the accumulation of an excess of acid or alkali in the blood.[3]
- It is involved in the activation of several enzymes including lipase, which breaks down fats for utilization by the body. [1] In addition, calcium maintains proper cell membrane permeability, aids in neuromuscular activity, and protects against pre-eclampsia in pregnancy, the number one cause of maternal death, according to *Prescription for Nutritional Healing* by James and Phyllis Balch.[1]

Requirements:

The current Recommended Dietary Allowance (RDA) as established by the Food and Nutrition Board of the Institute of Medicine for children, adolescents, and adults is as follows:[4]

Calcium

Category and Age:	RDA (milligrams):
Infants 0 to 0.5 year	210 mg
0.5 to 1 year	270 mg
Children 1-3 years	500 mg
4-8 years	800 mg
9 -18 years	1,300 mg
Adults 19 to 50 years	1,000 mg
Adults 50+,	1,200 mg

Signs of Deficiency:

A deficiency in calcium is associated with aching joints, eczema, brittle nails, elevated blood cholesterol, hypertension, heart palpitations, insomnia, muscle cramps, nervousness, rickets, tooth decay, rheumatoid arthritis, cognitive impairment, depression and, in severe cases, convulsions and delusions.[1,2]

Safety:

Individuals who suffer from recurrent kidney stones, have kidney disease, cancer, hyperparathyroidism or who take calcium channel-blocking medication should consult a physician or health care professional before taking a calcium product. [2]

Signs of Toxicity:

Calcium intakes of several grams per day combined with vitamin D may result in calcium deposition in soft tissue. High doses of calcium can impair absorption of other minerals including iron, magnesium and zinc.

Current Research:

Arthritis: According to the *Nutrition Almanac*, "Arthritis, structural rigidity often caused by depletion of bone calcium, can be helped with regular supplements of calcium. Early consumption of calcium may help prevent arthritis. Rheumatism can also be helped with calcium therapy."[3]

Blood Pressure: Calcium supplementation can lower hypertension. Researchers at Cornell University Medical School studied 26 hypertensive adults and administered 2,000 mg of calcium. After six months, researchers found a "modest but consistent" drop in blood pressure—from an average of 164/91 at the beginning of the study to 154/89 at the study's conclusion.[4]

Calcium

Cancer: Researchers at Memorial Sloan-Kettering Cancer Center and Cornell University Medical College in New York found that when they gave 1,250 mg of calcium to individuals with a high familial history of colon cancer, calcium reduced excessive cell duplication, which is often found in people susceptible to developing colon cancer. Before calcium supplementation, researchers found that cell proliferation was what they would expect in people prone to colon cancer. However, after two to three months on the calcium regimen, cell duplication, or proliferation, was lower, nearly comparable to that of people with a lower risk of colon cancer. The researchers theorized that calcium binds the bile and fatty acids, thereby reducing the irritation it can cause to the lining of the colon, which would decrease cell proliferation and, thus, colon cancer.[4]

Osteoporosis: Research shows that increasing calcium for children, adolescents, young adults, middle-aged women can increase bone density. In fact, two studies show that other micronutrients such as trace elements are needed for proper bone metabolism and resorption. In one study, a group of post-menopausal women were given a combined trace element and calcium supplement, a calcium supplement or placebo. In the group receiving the combined trace element and calcium supplement, bone density *increased* 1.48 percent. In the group receiving only the calcium supplement, bone density decreased with an average of 1.25 percent. For the placebo group, bone density decreased 3.53 percent.[5,6] In the second study, post-menopausal women on HRT were given a multi-vitamin, multi-mineral supplement containing 500 mg. of calcium, 600 mg. of magnesium, 2 mg. of copper and 10 mg. of manganese. Control subjects receiving the supplement experienced an increase in bone density from 0.303 g/cm² to 0.337g/cm².[7,8]

Premenstrual Syndrome: Calcium may reduce symptoms of PMS. A multi-center, placebo-controlled study reported that those taking calcium reported a 54 percent reduction in aches and pains versus a 15 percent *increase* in pains in the placebo group. Researchers have speculated that women with PMS may have hypocalcemia (low calcium despite normal blood and urine levels of calcium) due to high levels of parathyroid hormone that leech calcium from the bones.[8]

Weight Loss: Increasing dietary intake of calcium may aid weight loss. One group of researchers recently reported that obese patients who increased calcium intake for one year had a 4.9 kilogram loss of body fat. These researchers concluded, "Increasing dietary calcium suppresses adipocyte intracellular calcium and thereby modulates energy metabolism and attenuates obesity risk." Similar studies have shown that calcium inhibits lipogenesis (the production or deposition of fat).[8]

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Chloride

Facts:

- One of three powerful electrolytes required by the body (the other two being sodium and potassium), chloride performs a number of important functions within the body. It makes up about 0.15 percent of our body weight. Chloride is a major component of stomach acid (hydrochloric acid), and it stimulates the production of hydrochloric acid.[1] As individuals age, they secrete less hydrochloric acid, which diminishes one's ability to properly digest goods and assimilate important nutrients.[1,2]
- Chloride is an anion that is usually consumed as sodium chloride (NaCl) or as common table salt.[2]
- The highest concentrations of chloride can be found in cerebrospinal fluid and gastric and pancreatic juices.
- Chloride is readily absorbed through the intestinal tract and excesses are excreted in the urine, feces and perspiration.[2]

Functions:

- Chloride is an enzyme activator and is also involved in maintaining acid-base and water balance. It allows fluids to pass in and out of cell membranes until the concentration of dissolved particles is equal on both sides.[2]
- Chloride adjusts metabolic alkalosis resulting from disease or chronic use of diuretic agents.
- It stimulates the liver to act as a filter to separate waste and then eliminate it from the body.[2]
- Chloride and the other electrolytes work with calcium and magnesium in maintaining nerve transmission and normal muscle contraction and relaxation.
- Chloride, as a member in the chloride-bicarbonate shift, moves in and out of red blood cells and blood plasma. This allows the plasma transport of tissue carbon dioxide as bicarbonate to the lungs for excretion.[2]

Requirements:

No Recommended Dietary Allowance (RDA) has been established for chloride. The Food and Nutrition Board of the National Academies of Science has estimated daily minimum chloride requirements as follows[3]:

Category and Age:	RDA (milligrams):
Infants 0-5 months	180 mg
6-11 months	300 mg
Children 1 year	350 mg
2-5 years	500 mg
6 -9 years	600 mg
Children 10+ years and Adults	750 mg

Chloride

Signs of Deficiency:

- Because chloride is an electrolyte, a deficiency would result in an imbalance in the normal acid-base balance, which in extreme cases could be characterized by nausea, vomiting, diarrhea, and perspiration. It is important to note that deficiencies of chloride are very rare except in certain instances where an individual is experiencing chronic vomiting, diarrhea, or excessive perspiration. Other symptoms include hair and tooth loss and impaired digestion.[2]

- Infants deficient in chloride can develop loss of appetite, lethargy, failure to thrive, muscle weakness.[3]

Signs of Toxicity:

- Only known cause of chloride toxicity is water-deficiency dehydration. Excessive intake, however, of sodium chloride (processed salt) can elevate blood pressure in individuals sensitive to salt.[2,3] Increased blood levels of chloride can occur when there is improper waste elimination, which is common in kidney diseases. People who suffer from kidney diseases should avoid chloride.

Research Findings:

Hypertension: Researchers at Washington State University at Spokane found evidence linking salt with hypertension and concluded a high intake of sodium chloride (common table salt) increases urinary loss of magnesium, thereby creating a negative calcium balance and a possible increased risk for developing hypertension.[4]

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Chromium

Facts:

- Chromium is an essential element required for proper sugar and fat metabolism. It acts as a potentiator of insulin and is involved in normal carbohydrate metabolism.
- According to *Prescription for Nutritional Healing*, two out of three Americans are hypoglycemic, pre-hypoglycemic, or diabetic. The ability to maintain normal blood sugar levels is further jeopardized by the lack of chromium in the soil and water supply and by a diet high in refined white sugar, white flour and junk foods.[1] Dietary surveys have shown a significant number of Americans receive less than 20 micrograms (mcg.) per day, which is considered generally inadequate to meets the established nutritional requirement.[2]
- The biologically active form of chromium is called glucose tolerance factor or GTF chromium.

Functions:

- Chromium potentiates insulin action and, therefore, is involved in the metabolism of glucose and is vital in the synthesis of cholesterol, fats, and protein.
- Studies have indicated that chromium picolinate (chromium chelated with picolinate, a naturally occurring amino acid metabolite) promotes weight loss and increases lean muscle tissue.[1]
- Some studies have indicated that individuals with low plasma chromium levels can be and indication of coronary heart disease.[1]

Requirements:

There is currently no Recommended Daily Allowance or Daily Value for chromium. Because chromium is of benefit for carbohydrate and lipid metabolism, an Estimated Safe and Adequate Daily Dietary Intake (ESADDI) has been established.[3] These intakes are as follows[4]:

Age:	ESADDI (micrograms):
Infants: 0 -6 mos	10 to 40 mcg
6 mos.-1 year	20 to 60 mcg
1-3 yr.	20- 80 mcg
4-6 yr.	30 -120 mcg
7 and older	50 to 200 mcg

Signs of Deficiency:

Symptoms of a chromium deficiency include: fatigue, anxiety and glucose intolerance (particularly individuals with diabetes), inadequate metabolism of amino acids, elevated plasma free fatty acids, neuropathy, and increased risk of arteriosclerosis.[1]

Chromium

Safety:

Individuals with diabetes should first consult with a physician or health care professional before taking supplemental chromium, especially chromium picolinate as chromium can affect insulin requirements. Individuals with low blood sugar may experience symptoms of hypoglycemia if an excess of chromium is taken.[5] Pregnant women and nursing mothers should avoid doses greater than the ESADDI.

Signs of Toxicity:

According to *Prescription for Nutritional Healing*, excessive intake of chromium (which is not defined) can produce gastric irritation, ulcers, kidney and liver impairment.[1]

Current Research:

Gestational diabetes: According to researchers at Sansum Medical Research Foundation in Santa Barbara, Calif., insufficient intakes of chromium, magnesium, potassium, and vitamin B-6 might lead to a tendency towards hypoglycemia in gestational diabetic women.[6]

Heart Disease: Recent findings indicate that chromium supplementation can reduce one's risk factors for developing cardiovascular disease. Researchers at Shaare Zedek Medical Center in Israel found that supplementation of 250 mcg. of chromium lowered serum triglyceride levels and raised high density lipoprotein (HDL) levels in 76 patients diagnosed with atherosclerosis. In animals, the same researchers discovered that chromium supplementation reduced "…aortic intimal surface covered by plaque, aortic weight and cholesterol concentrations in rabbits."[6,7]

Diabetes: Chromium has been shown to improve glucose tolerance, insulin and hemoglobin of persons in China with Type 2 diabetes. In a study performed in China, the use of 1,000 micrograms of chromium per day (five times above the upper limit of the ESADDI and is not recommended) was highly effective in relieving many of the symptomatic manifestations of type 2 diabetes mellitus.[8] In a separate study, 200 mcg of chromium was administered to persons with slightly elevated blood sugar levels and persons with moderately low blood sugar levels (hypoglycemia). In the subjects with slightly elevated blood sugar levels, there was a considerable drop of roughly 20 points in blood sugar levels. In persons with hypoglycemia, chromium supplementation was affiliated with a 10-point increase in blood sugar levels.[9]

Weight Loss: In a recent review of the literature on chromium, two researchers conclude, "In addition to type-2 diabetes mellitus, chromium supplementation may be useful to direct overall weight decrements specifically towards fat loss with the retention of lean body mass and to ameliorate many manifestations of aging."[8]

Chromium

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Cobalt

Facts:

- Cobalt is a trace mineral that is an integral part of vitamin B-12. As such, the functions of cobalt are essentially the same as B-12.[1]
- Cobalt is primarily stored in the liver with decreasing amounts found in the spleen, kidneys and pancreas.
- Blood cobalt concentrations typically range from 80 micrograms per milliliter (mcg/ml) to 300 mcg/ml.

Functions:

- Cobalt activates a number of enzymes within the body. It plays a key role in the proper functioning and promotes the formation and maintenance of red blood cells in addition to all other cells. [1]
- Cobalt can replace zinc and manganese in the activation of several enzymes.

Requirements:

There is no recommended dietary allowance (RDA). The average daily intake is approximately 5 to 8 mcg.

Signs of Deficiency:

Cobalt deficiency is rare.

Signs of Toxicity:

Symptoms include: paleness, fatigue, diarrhea, heart palpitations and numbness in the fingers and toes.[1]

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Copper

Facts:

- Copper is involved in the absorption, storage, and metabolism of iron. It may also have antioxidant activity.[1]
- The human body contains approximately 50 milligrams (mg) to 120 mg of copper. Copper concentrates in the brain, heart, kidney, but is highest in the liver where it contributes to energy and detoxification processes.[1] Blood values typically average 120 mg/dl for women and 109 mg/dl for men.
- Copper is absorbed primarily in the small intestine and, to a certain extent, the stomach.
- Increased consumption of fructose can significantly worsen a copper deficiency, according to researchers with the U.S. Department of Agriculture. Individuals who consumed 20 percent of their daily calories from fructose showed decreased levels of red blood cell superoxide dismutase (SOD), a copper-dependent enzyme essential for antioxidant protection within the red blood cell.[2]

Functions:

- Aids in the formation of bone, hemoglobin, red blood cells.[2] Copper aids in the conversion and transport of iron from the intestinal lumen into red blood cells.
- Works in balance with zinc and vitamin C to form elastin.[2]
- Involved in the healing process, energy production, hair and skin coloring, and taste sensitivity.[2]
- Involved in the development and maintenance of the cardiovascular system.
- Helps maintain the myelin, which sheaths nerves and aids in the transmission signals from the brain to the body and vice versa.
- Involved in producing and regulating neurotransmitters in the brain, including norepinephrine.
- Plays a role in the activation of superoxide dismutase, an antioxidant enzyme that is a free radical scavenger. Copper also protects against oxidative damage especially in the thyroid, uterus, lungs, liver, brain, red blood cells, kidneys and pituitary.

Requirements:

The Food and Nutrition Board of the U.S. National Academy of Sciences has recommended the following Estimated Safe and Adequate Daily Dietary Intakes (ESADDI)[3]:

Age:	ESADDI (milligrams):
Infants 0-6 mos.	0.4 to 0.6 mg
6 mos.-1 year	0.6 -0.7 mg
1 to 3 yr	0.7-1.0 mg
4-6 years	1.0 -1.5 mg
7-10 years	1.0-2.0 mg
11 + years	1.5 to 2.5
Adults	1.5-3.0

Copper

Signs of Deficiency:

Signs of copper deficiency include: general weakness, osteoporosis, anemia, baldness, diarrhea, general weakness, skin sores, poor respiratory function. [2,4]

Safety:

Too much copper can cause an upset stomach and nausea. Copper absorption can be decreased by an excess of intake of dietary iron or zinc. Vitamin C supplementation results in decreased copper.[3] Those with Wilson's disease, chronic liver and kidney failure should avoid taking copper. Pregnant women and nursing mothers should avoid doses greater than the ESADDI.

Toxicity:

If consumed by a child, copper (3 grams) can be fatal. Occasional copper toxicity has been reported in individuals consuming drinking water that passes through copper water pipes where the mineral has leached into the drinking water. Symptoms of copper toxicity include: nausea, anemia, weakness, diarrhea, headache, a metallic taste in the mouth,[2] depigmentation, dermatitis and neurologic impairments. [1] Wilson's disease is a genetic disorder where there is an excessive accumulation of copper in the soft tissues that can result in damage to the kidneys, brain and liver.

Current Research:

Heart Disease: Copper deficiency may play a role in the development of heart disease. According to the *Physicians' Desk Reference*, "There is no doubt that copper deficiency can contribute to heart disease. It seems likely that supplemental copper might be helpful in preventing and treating cardiovascular disease even in those with marginal copper deficiency." Animal studies have shown that copper deficiency increases the susceptibility of lipoprotein and tissues to peroxidation.[4]

Osteoporosis: Copper is involved in cross linking of collagen in bone and, therefore, has implications for osteoporosis. In postmenopausal women, supplementation of copper and zinc has been associated with conservation of bone density and prevention of spinal bone loss.[4] In one study, researchers at the University of Ulster in Ireland reported that copper plays an important role in the prevention of osteoporosis. Seventy-three postmenopausal women supplemented their diets with either 3 milligrams of copper or a placebo. Two years later, when the study ended, the supplemented group maintained bone mineral density while the placebo group lost significant amounts of bone [6].

Immune Function: A copper-deficient diet can result in impaired immune function long after increased intakes return blood copper levels to normal.[7] The study, conducted at the U.S. Department of Agriculture's Western Human Nutrition Research Center in San Francisco found that healthy men fed a copper-poor diet for two months followed by a diet replenished with 2-3 mg of copper (within the

Copper

recommended range) showed that indices of immune function declined during the copper-deficient period and remained compromised even after the increased dietary intakes of copper had returned blood copper levels to normal.

Growth: Copper "...reduces growth rate through effects on both food intake and efficiency of food utilization for growth," conclude researchers at the University of California at Davis.[9] The study, using rats, found that a copper-deficient diet stunted growth.

Pregnancy: According to W. Thomas Johnson of the USDA's Grand Forks Human Nutrition Research Center, preliminary research indicates that long-lasting heart defects occur in the offspring of rats fed a low-copper diet during pregnancy and lactation.[9] Copper is one of several minerals whose requirements are increased during pregnancy and lactation. During pregnancy, the RDA for copper increases to 1 mg per day, and increases to 1.3 mg daily during lactation. Although these seem like small amounts of copper, results from food-intake surveys show the average copper intake in 14-30 year-old women range from 0.44-0.76 mg per day. These surveys also indicate that up to 75 percent of pregnant women and 90 percent of women who are nursing may have dietary copper intakes below the RDA. [9] Further studies are needed, but this particular finding suggests that low copper intakes by pregnant or nursing female rats may have irreversible consequences on mitochondrial function and oxygen radical production in the hearts of their offspring. [9]

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Fluoride

Facts:

- In 1972, fluoride was recognized as an essential mineral, most notably because of its role in reducing the incidence of dental caries.
- Fluoride is best known for its role as a catalyst for the mineralization of developing tooth enamel prior to emergence and for its remineralization of surface enamel.
- The average human male's bones contain 2.6 grams of fluoride.
- According to *Prescription for Nutritional Healing*, more than half of the cities in the U.S. fluoridate their water supply.[1]

Functions:

- The primary function of fluoride is that it strengthens tooth enamel. Ingestion of fluoride decreases the incidence of dental caries or tooth decay.[1]
- Fluorine also increases the deposition of calcium, which strengthens bones.[2]

Requirements:

No RDA or Daily Value has been established for fluoride. Fluoridated water supplies approximately 1 ppm, which provide an adult with 1.5-4.0 mg daily. The average intake of fluoride is between 0.2 - 4.4 mg. The Adequate Intake ranges for fluoride, though, are as follows: [3]

Age:	AI (milligrams):
Infants: birth-6 mos.	0.1-0.5 mg
6 mos.-1 yr.	0.2-1 mg
1-3 yrs.	0.5-1.5 mg
4-6 yr.	1-2.5 mg
7 +	1.5- 2.5 mg
Adults	1.5-4 mg

Signs of Deficiency:

A high incidence of dental caries is present in areas of the U.S. where the water is not fluoridated and /or fluoride consumption is low.[3]

Signs of Toxicity:

An excess of fluoride (2 to 8 ppm) can result in dental fluorosis, which is characterized by dull, mottled, or pitted teeth.[2] Fluorosis of the bones occurs in 8 ppm can cause arthritic-like symptoms.[2] Chronic toxicity occurs at intakes between 20 mg to 80 mg or for extended periods of time. Groups at risk for fluorosis include: formula-fed infants, heavy exercisers, individuals who consume high quantities of water-based beverages, people with malfunctioning kidneys and the elderly. Persons with cardiovascular problems are

Fluoride

also at risk for fluoride toxicity. In addition, "People with renal insufficiency would have impaired renal clearance of fluoride. People with diabetes mellitus and heart insufficiency have also been found to have impaired renal clearance of fluoride."[4]

Note: The issue of fluoridation of community water supplies is controversial. Supporters of fluoridation assert that fluoride reduces the incidence of dental caries and osteoporosis in the population; opponents counter that harmful levels of fluoride can accumulate in the body leading to fluoride toxicity. A report issued by the U.S. Department of Health, Agency for Toxic Substances and Disease Registry, Division of Toxicology reported in 1991 that certain population groups including the elderly, people who have a magnesium deficiency, and persons with cardiovascular and kidney problems "may be unusually susceptible to the toxic effects of fluoride and its compounds."[4] Fluoride is contained in ConcenSea™ (CMD), however, it is a naturally-occurring form of fluoride. In addition, both in-house and independent lab test results show the amount of fluoride in CMD to be in very minute, trace amounts. However, it is important to point out that magnesium plays a significant role in its interaction with fluoride in the body. Magnesium is the activator of more than 300 enzymes while fluorine is known as their inhibitor, although some enzymes' activity is increased by the presence of fluorine.[5] In plants, supplementation of magnesium protects against the toxic effects of fluoride.[5] One researcher concludes that "In intoxication with fluorine compounds, magnesium plays a protective role by countering and reduce the toxic effects of F-."[5]

Current Research:

Bones: The research of fluoride in preventing osteoporosis is mixed. Some studies show a protective effect while other studies report that high intakes of fluoride increase the risk of hairline bone fractures.[6,7] In addition, according to the American Society for Nutrition's web site, "Under controlled experimental conditions, slow release administration of fluoride (23 mg/day) plus calcium has been shown to stimulate new bone formation in some individuals."[3]

Tooth decay: In an animal study, the administration of both fluoride and magnesium jointly influenced enamel hardening and significantly reduced the incidence of dental caries.[5]

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Iodine

Facts:

- Iodine is converted to iodide in the gut, absorbed in the digestive tract, and circulated throughout the body. Most iodide is trapped by the thyroid gland where it then forms an essential component of thyroid hormones.[1]
- Estimates are that the body contains 25 mg of iodine.[2]

Function:

- Required in only trace amounts, iodine helps metabolize excess fat and is key for physical and mental development.
- Iodine is important for proper functioning of the thyroid gland and for the prevention of goiter, an enlargement of the thyroid gland. [1-3]
- The condition of the hair, skin, nails, and teeth are all dependent on the proper functioning of the thyroid as is the conversion of carotene to vitamin A.[2]

Requirements:

The Recommended Dietary Allowance for iodine is as follows:

Age:	ESADDI (micrograms):
Infants: 0 -6 mos	40 to 50 mcg
1-3 yrs.	70 mcg
4-6 yrs..	90 mcg
7-10 yrs.	120 mcg
11 +	150 mcg
Adults	150-200 mcg

Signs of Deficiency:

In adults, an iodine deficiency can result in hypothyroidism, a reduced rate of thyroid hormone secretion characterized by lethargy, weight gain, and, sometimes, goiter. A deficiency can result in impaired growth and neurological development and has been linked with thyroid cancer in a number of studies.[4] In adult women, iodine deficiency has been linked with breast cancer.[3,5] In children, a iodine deficiency can result in mental retardation, stunted growth, cretinism, and impaired movement, speech, or hearing.

Interactions:

Certain foods consumed raw and/or in large quantities can inhibit the uptake of iodine by the thyroid gland. These foods include: Brussels sprouts, cabbage, cauliflower, kale, peaches, pears, spinach and turnips.[3] Concomitant use of anti-thyroid drugs and iodide may potentiate hypothyroid effects. Use of potassium iodide with warfarin can decrease the anti-coagulant effect of warfarin.

Iodine

Safety:

Pregnant women and nursing mothers should avoid iodine intakes greater than RDA amounts. Children with cystic fibrosis are susceptible to goitrogenic effects of high iodide doses.

Signs of Toxicity:

Large doses of iodine can produce a metallic taste in the mouth and sores in the mouth, swollen salivary glands, diarrhea, and vomiting.[3,5]

Current Research:

Brain function: Researchers have linked low iodine consumption with impaired cognition. In Indonesia, supplementing infants with iodized oil reduced infant mortality less than 4 months of age.[1]

Fibrocystic Breasts: According to the *Physicians' Desk Reference*, there is one case report showing that elemental iodine taken for four months produced significant relief from symptoms of fibrocystic breast disease. Subsequent studies have also reported significant benefit from supplementation with other iodine-containing compounds.[5]

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Iron

Facts:

- Iron is an essential mineral that carries oxygen and forms part of the hemoglobin in the red blood cells and myoglobin in muscle.
- Iron is primarily stored in the liver, spleen, and bone marrow in the form of ferritin.
- There are two forms of iron: heme and non-heme.[1] Heme iron (found in meat, poultry, fish) is 15 to 45 percent absorbed. Non-heme iron is absorbed more poorly than heme iron (about 1 to 15 percent) depending on iron stores and other factors (*e.g.*, ascorbic acid, phytic acid in whole grains and legumes, polyphenols in tea, coffee, or red wine, calcium, etc.)

Functions:

- Iron is involved the production of hemoglobin and myoglobin. Hemoglobin carries oxygen from the lungs to the body.
- Iron is essential for many enzymes and is important for growth, proper cognitive function.
- Iron is vital in energy production and in maintaining an optimal immune system.

Requirements:

The RDA for iron in women is higher than it is for males due to menstruation, pregnancy, poor iron intake. The RDAs for iron are as follows[2]:

Category and Age:	RDA (milligrams):
Infants: birth-6 mos.	6 mg
6 mos.-10 yrs	10 mg
Adolescent Males:11-18 yr.	12 mg
Adolescent Females and Women: 11-50 yr. old	15 mg
Men (18+) and women over 50	12 mg
Pregnant	30 mg
Lactating	15 mg

Signs of Deficiency:

Iron deficiency is one of the most common mineral deficiencies in the world.[1] It can result from intestinal bleeding, excessive menstruation, etc. A diet high in phosphorous, poor digestion, long-term illness, ulcers, strenuous exercise, excessive perspiration, insufficient amounts of hydrochloric acid in the stomach and prolonged use of antacids all contribute to iron deficiency.[3] Symptoms include: anemia, brittle hair and nails, cognitive impairment, digestive disturbances, dizziness, fatigue, fragile bones, hair loss, inability to concentrate, inflammation of tissues of the mouth, intolerance to cold, paleness and a general lack of well-being.[1-3] It is estimated that in women 20-49 years of age, iron deficiency anemia affects 5 percent of this group. In children, iron deficiency is associated with behavioral abnormalities and reduced cognitive performance (see below).[4]

Iron

Interactions:

Moderate to large amounts of calcium, zinc, and vitamin E can interfere with the absorption of iron.[1,3] Copper, manganese, molybdenum, vitamin A and B-complex vitamins also play an essential role for complete iron absorption.[3] Vitamin C also enhances the absorption of iron.

Safety:

Iron supplements are not safe for people with iron storage disorders including hemosiderosis, idiopathic hemochromatosis, or thalossemias.[4] Treatment of iron deficiency should only be done under medical supervision. Iron supplements should not be used for self-treatment of iron-deficient anemias.

Pregnant women and nursing mothers should not take supplemental doses of iron higher than RDA amounts, unless recommended by a physician.

Iron can be fatal to children if taken in an overdose.

Signs of Toxicity:

High levels of iron can lead to increased production of free radicals within the body. Excessive amounts of iron have been linked with heart disease and cancer.

Current Research:

Cellular Function: In an iron-deficient state, iron-starved cells can shut down the activity of more than 80 genes in order to conserve what little iron there is in the body and still maintain essential physiological functions. Some of the genes damaged by iron deficiency are necessary for energy, protecting cells from free radicals, and copying cell's genetic code.[4]

Cognition: An iron deficiency in infancy can adversely affect one's sight and hearing years later even if the deficiency was corrected, according to researchers at the University of Michigan and the University of Chile. Researchers studied 84 Chilean children; 41 of whom had been diagnosed with iron-deficiency anemia in infancy while 43 had not. Researchers measured the children's' response times to visual and auditory stimuli and found the children who had been iron-deficient as infants had a slower response time.[5]

Energy, Exercise, and Endurance: Iron supplementation can improve exercise performance. Animal studies have discovered that endurance capacity increased more than three-fold after iron supplementation.[5] In women on low-calorie diets, supplemental iron has been reported to be of benefit.[5]

Immunity: Iron helps to ward off infections, according to researchers at Boston University. It enables phagocytes, or white blood cells, to defend the body against bacterial infections. Phagocytes depend on the oxygen iron brings in order to produce substances to kill bacteria. In addition, lymphocytes and the production of antibodies also depend on iron.[7] Iron is also important in the case of viral infections.

Iron

Cold Tolerance: In animal studies, anemic rats exposed to 39 degree Fahrenheit temperatures for 24 hours became ill compared to non-anemic rats who were more tolerant to exposure. In addition, the anemic rats displayed lower body temperatures, reduced oxygen consumption, reduced thyroid activity and less metabolic activity.[7] This finding is backed by research conducted at the USDA Grand Forks Human Nutrition Research Center that the body's requirements for water, energy, minerals, and trace minerals increase during cold weather. The reason is that the body has to expend additional resources in order to maintain its core temperature in the cold. According to James Penland, deficiencies in iron, zinc, and copper impair thermoregulation. Studies conducted at Pennsylvania State University and the Grand Forks Human Nutrition Research Center have shown iron-deficient adults are unable to maintain their core body temperature when exposed to cold water and air versus people with normal iron status and equivalent body weight. In study subjects, iron supplementation improved one's ability to maintain core body temperature in the cold. The study demonstrates the importance of iron in thermoregulation. Incidentally, deficiencies in pyridoxine and thiamine may also impair the muscle activity involved in shivering.[9]

Spina Bifida: Women who do not consume enough iron, magnesium, and niacin may be five times more likely to give birth to a baby with spina bifida. Scientists comparing the nutrient intake of 106 mothers with spina bifida babies versus women who gave birth to healthy babies found that the mother of spina bifida babies had lower intakes of iron (6 percent), magnesium (6 percent), and niacin (10 percent).[10] Further research, however, is needed.

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Lithium

Facts:

- The lightest of all minerals, lithium (Li) has a density half that of water. It is distributed throughout the Earth's crust. It can vary between 1.2 parts per million (ppm) in light organic soils to 98 ppm in alluvial soils.[1]
- Although not proven essential yet, there is growing evidence that lithium plays a number of roles within the human body.
- The average daily intake of Li has been estimated to vary between 10 mcg to 2 mg per day. The average output in humans per day is estimated in the range of 200 to 800 mcg.

Functions:

- Involved in the respiration of nuclear membranes at the intracellular level, uptake of glucose into cells, may improve fertility, aids in treating sodium imbalances in atherosclerosis, hypertension, mental disorders and aggression.
- Lithium is primarily known for its role as a pharmacological mood-regulating agent.
- According to Alexander Schauss, Ph.D., "Other evidence finds that Li is incorporated into bone at a rate directly proportional to the rate of bone growth, probably owing to the physicochemical similarities between Li, calcium and magnesium."[1]

Requirements:

No RDAs have been established; the average daily intake is estimated to be between 10 mcg to 2 mg.

Signs of Deficiency:

In animals studies, specifically female goats, inducing a lithium deficiency led to diminished fertility and increased postpartum mortalities.[1]

Signs of Toxicity:

Not available.

Current Research:

Sodium Imbalances: In the mid-1970's, researchers discovered that Li may confer a protective effect in treating sodium imbalance that contributes to atherosclerotic heart disease in humans. Other trials have shown that supplementing lithium chloride for sodium chloride reduced hypertension in persons with high blood pressure. Notes author A. Schauss, "Recently researchers have found that Li's beneficial effect on salt imbalances may be due to the way in which Li is metabolized differently in the body than Na [sodium] and K [potassium]."[1]

Lithium

Mental Disorders: Since the 1970's, researchers in Texas have noted that lithium found naturally in drinking water was inversely associated with the incidence of admissions and readmission of patients for psychoses, neuroses, and personality disorders in 27 Texas state mental hospitals.[1] Two years later the same study was repeated, with the results confirming the original's study's conclusion and that homicide rates were inversely related to lithium levels in water.

Mood Stabilizer:
Lithium is primarily known as a pharmaceutical drug therapy useful for the treatment of manic depression. But it is also a naturally occurring trace element found in certain bottled mineral waters, mineral-rich hot springs, and the Great Salt Lake. One will find trace amounts of it in MRI's products. Lithium has been shown to act as a mood stabilizer; it acts on the neurotransmitter *glutamate* keeping levels consistent and balanced between cells. Too little glutamate can cause depression while too much may cause agitation. A study published in *Trace Elements and Electrolytes* reveals another facet of lithium's effect on brain function—increased levels of nitric oxide, a molecule that occurs naturally in the body. Nitric oxide has been shown to be involved in numerous biological functions such as regulating the activity of the brain and other organs and controlling blood circulation.[2]

Immune Benefits: New studies have shown that lithium affects blood cell production and that its regulatory effects may boost the body's natural defense system against viral infections, specifically DNA viruses. In addition, in both *in-vitro* and human studies, lithium ions have been found to increase the synthesis of neuroprotective proteins in the human brain.[3]

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Magnesium

Facts:

- Magnesium is the fourth most abundant cation in the body. Approximately 60 percent found in the body is contained within the bone with the remaining 40 percent distributed between muscle and non-muscular soft tissue.[1]
- Dietary surveys consistently show that the average individual receives approximately 200 to 250 mg of magnesium per day. The RDA for adults is 300-400 mg/day. The occurrence of sudden cardiac death is lower among persons living in hard water regions than among those persons living in soft water areas. Many researchers have proposed that higher magnesium levels found in hard water are a protective factor against cardiac deaths.[2]

Functions:

- Magnesium is an essential nutrient required for many biologic functions in the body, including more than 300 enzyme reactions. It also functions in the activation of amino acids, the syntheses of DNA, and is involved in neurotransmission and immune function.[1]
- Numerous studies show that a magnesium deficiency may be an underlying cause of cardiovascular disease, hypertension, asthma, chronic fatigue and pain syndromes, depression, insomnia, irritable bowel syndrome, and many pulmonary disorders.[3]
- Magnesium is necessary to prevent the calcification of soft tissue. It confers a protective effect on the arterial lining, and protects it from stress caused by changes in blood pressure.
- Studies show that magnesium can positively affect the occurrence of migraine headaches.
- Accompanied by vitamin B-6 (pyridoxine), magnesium can help reduce and dissolve calcium phosphate kidney stones.[3]
- Supplementing the diet with magnesium may also prevent depression, dizziness, muscle weakness, twitching, and premenstrual syndrome (PMS).
- It promotes the absorption and assimilation of other minerals including calcium, phosphorous, sodium, and potassium while enabling the utilization of vitamin B complex and vitamins C and E.[4]

Magnesium

Requirements:

The Food and Nutrition Board of the Institute of Medicine of the U.S. National Academy of Sciences recommends the following RDA values for magnesium[1]:

Category and Age:	RDA (milligrams):
Infants 0-6 mos.	30 mg
7-12 mos.	75 mg
Children 1-3 yrs.	80 mg
4-8 yrs.	130 mg
9-13	240 mg
Males 14-18 yrs.	410 mg
Males 19-30 yrs.	400 mg
Males 30 yrs. +	420 mg
Females 14-18 yrs.,	360 mg
Females 19-30 yrs.	310 mg
Females 30 yrs. +	320 mg

Note: Stress increases the need for magnesium. According to Mildred Seelig, M.D., M.P.H., M.A.C.N., physical stress including exercise, working in high temperatures, surgery, trauma and psychological stress increase the body's need for magnesium. "Stress causes secretion of epinephrine (adrenaline) and corticosteroids and results in Mg loss in animals and humans."[2]

Other factors such as dietary fat, protein sugar and alcohol intake affect magnesium status in the body. Pregnant women and elderly persons need to ensure they are receiving enough magnesium in their diet.

Signs of Deficiency:

Symptoms of a magnesium-deficiency include: confusion, insomnia, irritability, nervousness, poor digestion, rapid heartbeat, seizures, diabetes, cardiac arrhythmia, cardiovascular disease, hypertension, asthma, chronic fatigue, chronic pain syndrome, depression, irritable bowel syndrome, premature labor, pre-eclampsia, and diabetes.[3,5]

Safety:

People with kidney diseases or renal failure should not take magnesium supplements. Magnesium is also contraindicated in people who have high-grade atrioventricular blocks and those sensitive to magnesium supplements. Magnesium also interacts with bisphophosphates and some antiobiotics. Please review supplements with your physician.

Signs of Toxicity:

Hypermagnesia or magnesium toxicity is very rare yet can occur if urinary excretion is very low or there is a considerable increase in magnesium's absorption within the body.

Magnesium

Current Research:

Arrhythmia: Supplementation of magnesium and potassium treats arrhythmias. In a randomized, double blind study, 232 patients with frequent ventricular arrhythmias were treated over 3 weeks with either 6 mmol of magnesium/12 mmol of potassium-DL-hydrogenaspartate daily or placebo. The researchers concluded that oral administration of magnesium and potassium salts when directed to patients with frequent and stable ventricular tachyarrhythmias had an anti-arrhythmic effect. A 50 percent increase in the recommended minimum daily dietary intake of the two minerals for three weeks results in a moderate but significant anti-arrhythmic effect.[6] Researchers at the University of California at Irvine have used magnesium to treat arrhythmia patients who did not respond to standard therapies.[7]

Asthma: Researchers have discovered low magnesium levels in persons suffering from asthma compared to non-asthmatics. "Dominguez et al. [2] report that intracellular (erythrocyte) magnesium levels are lower in asthmatic subjects and correlate with airway reactivity to methacholine in a group of asthmatic and non-asthmatic, atopic subjects with and without bronchial hyperreactivity. This is not the first study to report that intracellular magnesium levels are lower in asthmatic subjects. Lower levels of magnesium in skeletal muscle [3] and in polymorphonuclear cells [4] from asthmatic subjects have been demonstrated previously."[8]

Attention Deficit Disorder (ADD): According to one study in Poland, mineral concentrations of magnesium, zinc, copper, iron, and calcium in the children diagnosed with ADD was lower compared to healthy, ADD-free children. Study's authors show that it is critical to supplement trace elements in children diagnosed with ADD.[9]

Diabetes: "Magnesium plays the role of a second messenger for insulin action; on the other hand, insulin itself has been demonstrated to be an important regulatory factor of intracellular magnesium," according to the findings of one study in Germany. The study authors state that chronic magnesium supplementation can improve the insulin action in diabetic patients.[10]

Energy: According to Carolyn Dean N.D., M.D., author of *The Miracle of Magnesium*, magnesium participates in the production of ATP (adenosine triphosphate), which are the "energy packets" the body uses to produce and store energy. If one is not getting enough magnesium, states Dean, then energy levels will be low because one is not generating enough energy to run the body. When magnesium intake is increased, however, many notice increased energy. In addition to producing ATP, magnesium also helps the body make the most of energy consumed from foods. Magnesium is involved in the production, function, and transport of insulin It makes it possible for the body's cells to allow glucose to enter so that it can be used for energy.[11]

Magnesium

Epilepsy: According to researchers at the International Center for the Disabled in New York City, a deficiency of magnesium exists in the red blood cells of a number of epileptics suffering from seizures not responding to conventional drug therapy.[7]

Heart-Related Conditions: Several studies have demonstrated a relationship between intake of magnesium and the occurrence of cardiovascular problems. According to Seelig, magnesium "... is accepted treatment in conditions in which arrhythmias are a risk (in congestive heart failure and after cardiac surgery) and even in forms of arrhythmia resistant to drug therapy."[2] In fact, continues Seelig, "When the first analysis of magnesium intakes and balances in normal young adults was published in 1964, magnesium deficiency was suggested as a neglected factor in vulnerability to heart disease."[2] Magnesium has been clinically shown to confer a cardioprotective effect. Several animal studies have shown that inducing a magnesium deficiency caused the formation of arterial and cardiac lesions resembling that witnessed in diseases that afflict mankind.[2,12]

Myocardial Infarction: According to Seelig, "There is growing evidence that magnesium deficiency may be a predisposing factor for myocardial infarction and subsequent complications...addition of magnesium to the postmyocardial infarction parenterally...and orally subsequently—needs serious consideration."[11]

Congestive Heart Failure: Again, according to Seelig, in cases of congestive heart failure, "...the only antiarrhythmic intervention needed to prevent recurrence of cardiac arrest may be repletion of K (potassium) and Mg (magnesium)."[12]

Hypertension: There is a significant body of research demonstrating magnesium deficiency increases high blood pressure and that increasing magnesium intake decreases blood pressure. Supplementation of magnesium both intravenously and orally has been used to lower blood pressure.[7,12] In hypertensive diabetic patients, one study concluded that, "magnesium administration may be useful in decreasing arterial blood pressure and improving insulin-mediated glucose uptake."[13]

Migraine Headaches: Several studies support the theory that an underlying magnesium deficiency is intricately involved in the occurrence of migraine headaches. Researchers have found that nearly 50 percent of patients have low levels of ionized magnesium during an acute migraine headache attack.[14] According to one study, "Two double-blind studies suggest that chronic oral magnesium supplementation may also reduce the frequency of migraine headaches...we feel that a trial of oral magnesium supplementation can be recommended to a majority of migraine sufferers."[14] A large-scale study comprised of 500 women (300 of whom were pregnant) who suffered from migraine headaches were administered 200 mg of magnesium per day. Eighty percent of women reported cessation of their migraines.[7]

Magnesium

Pre-Eclampsia and Pre-Term Labor: Pregnant women that supplement their diet with magnesium supplements do not have premature uterine contractions and have fewer complications during pregnancy.[1] Pregnant women that consumed a magnesium supplement did not have premature uterine contractions and also had a reduced occurrence of calf cramps, numbness and fewer complications.[1] In addition, supplementation with magnesium during pregnancy also resulted in fewer pre-term deliveries and fewer cases of intrauterine growth retardation. In Hungary, where the rate of pre-term deliveries is high, 255 pregnant women were given 300 mg/day magnesium from diagnostic confirmation of pregnancy to delivery. The pre-term birth rate for this group was 8.5 percent. For the 280 pregnant women who received placebo, the pre-term birth rate was 10.9 percent.[15]

Muscle Cramps: Researchers at Brigham Young University in Provo, Utah found that when pregnant women in their last trimester were given 266 mg of magnesium, it reduced the occurrence of leg cramps approximately 57 percent.[7]

Pre-Menstrual Syndrome: Magnesium deficiency has been affiliated with premenstrual syndrome.[15-16] According to Seelig, "The condition [PMS] has been reported to respond to Mg supplements alone or in combination with trace minerals and vitamins."[15]

Prostate Health: Magnesium plays an important role in male reproduction. Researchers have identified high levels of magnesium and zinc in the prostate. One study that analyzed the differences in magnesium and zinc levels in men with chronic inflammation of the prostate revealed that magnesium levels—not zinc—were significantly lower in men with chronic prostatitis. They proposed that low magnesium in seminal fluid be classified as a diagnostic marker for prostatitis.[16]

Thromboses: Magnesium helps prevent the occurrence of thromboses and emboli. When individuals supplemented their diet with magnesium, thromboses and embolisms were prevented. However, these conditions often recurred once the supplements were discontinued. [4,15]

Osteoporosis: Women suffering from osteoporosis have reduced serum magnesium levels compared to osteoporosis-free, similarly aged women.[15] "Mg is needed for maintenance of normal bone structure, both directly for matrix formation and indirectly for mineralization through its requirement for normal parathyroid and vitamin D metabolism," according to Seelig.[15] In one study, a group of menopausal women were administered magnesium to gauge the effects of magnesium on bone density. At the conclusion of the study, researchers found that magnesium prevented fractures and resulted in a significant increase in bone density."[18]

Magnesium

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Manganese

Facts:

- Manganese is a trace mineral that is believed to be an essential mineral. It is concentrated mainly in the bone, liver, pancreas, and brain.
- On average, most people excrete about 4 mg. of manganese each day.[1]
- Dietary sources of manganese include whole grain cereals, eggs, nuts, seeds, and green vegetables. The majority of manganese is lost in the processing and milling process of foods and, in the case of vegetables, manganese content varies depending on the amount contained in the soil.

Functions:

- Manganese is a component of several enzymes and, therefore, acts as a catalyst in the synthesis of cholesterol and fatty acids, and plays a role in protein, fat, and carbohydrate production.[1]
- It also activates a number of other enzymes including formation of cartilage in the bone and skin.[2]
- Manganese is important for the production of milk, formation of urea, or part of the urine. It also maintains sex-hormone production, nourishes the nerves and brain, and is essential for the formation of thyroxin, an important component of the thyroid gland.

Requirements:

The estimated intake (ESADDI) ranges established by the Food and Nutrition Board of the U.S. National Academy of Sciences are as follows[2]:

Age:	ESADDI (milligrams):
Children ages 1-3 yrs.	1.0-1.5 mg
4-6	1.5-2.0 mg
7-10	2-3 mg
11-18	2-5 mg
Adults	2-5 mg

Signs of Deficiency:

Symptoms include: dizziness, ear noises, loss of hearing, impaired glucose tolerance and cholesterol metabolism, atherosclerosis, ataxia (failure of muscle coordination).[1]

Safety:

People with liver failure should not take manganese supplements. Some patients with end-stage liver disease have been found to have high manganese levels. Manganese supplements are also contraindicated in those who are hypersensitive to manganese-containing supplements. Pregnant women and nursing mother should avoid intakes above the ESADDI, which is 2.0 to 5.0 mg/daily.

Manganese

Signs of Toxicity:

According to the American Society for Nutrition, "There is no evidence of toxicity occurring from ingestion of typical diets."[2] Toxicity has occurred from industrial exposure, *i.e.* miners inhaling manganese dust and drinking contaminated well water. Symptoms include: weakness and psychological and motor difficulties.[1]

Current Research:

General: Lower manganese levels have been noted in patients with osteoporosis, non-trauma epilepsy and Perthes' disease. In addition, low levels of manganese lower the levels of Mn-superoxide dismutase, which prevents tissue damage caused by the oxidation of fat. This, in turn, may increase one's risk for colon cancer. Manganese has been shown to be helpful in treating diabetes.

Osteoarthritis: In a recent randomized, placebo-controlled, double-blind study, manganese ascorbate, taken with glucosamine hydrochloride and chondroitin sulfate, reduced knee pain in individuals suffering from osteoarthritis of the knee.[2]

Schizophrenia: Many schizophrenics have been documented as having high levels of copper in the body. Manganese, as well as zinc, has been shown to be effective in excreting copper from the body.[1]

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Molybdenum

Facts:

- Molybdenum is an essential trace mineral for both humans and animals. The highest concentrations of molybdenum are found in the liver, kidney, adrenal gland, and bone.
- Molybdenum is absorbed from the gastrointestinal tract and is excreted in the urine.

Functions:

- Molybdenum is a component of a number of enzymes including: sulfite oxidase, which is involved in the metabolism of sulfur amino acids; xanthine oxidase, which is involved in the production of uric acid and in mobilizing iron from the liver reserves; and aldehyde oxidase, which is necessary for the oxidation of fats.[1,2]
- Molybdenum is a factor in copper metabolism.[1]

Requirements:

The estimated safe and adequate intakes daily dietary intake (ESADDI) of molybdenum are as follows[3]:

Category and Age:	ESADDI (micrograms):
Infants:0-6 mos.	15-30 mcg
6 - 12 mos.	20 -40 mcg
1-3 yrs.	25-50 mcg
4-6	30-75 mcg
7-10	50-150 mcg
Adults 19+	75-250

Signs of Deficiency:

Molybdenum deficiency can occur in cases of prolonged parenteral nutrition.[3] According to *Nutrition Almanac*, a molybdenum deficiency may also occur due to the numerous refining and processing techniques employed in virtually every area of food production today.[1]

Safety:

Molybdenum is contraindicated in those who are sensitive to molybdenum-containing products. Pregnant women and nursing mothers should not take supplemental doses of molybdenum greater than the RDA (75 mcg.).

Signs of Toxicity:

Symptoms include: diarrhea, anemia, reduced growth rate, gout (reported with intakes at 10 to 15 mg/day).[1,2] There is one report of toxicity from molybdenum supplementation from a male who consumed a cumulative dose of 13.5 mg of molybdenum over 18 days (an intake of 300-800 mcg daily).

Molybdenum

Current Research:

General: Molybdenum may play a role in the prevention of anemia. Tooth enamel also contains this element and, as such, some studies have found it to play an important role in the prevention of tooth decay. Some research has also borne out that intakes of this element are associated with decreased rates of esophageal cancer.[1]

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Potassium

Facts:

- Potassium in the form of K+ is the most essential cation of the cells, according to the American Society for Nutrition Its concentration is regulated by the cell membrane through the sodium-potassium pump.[1]
- Potassium accounts for approximately five percent of the total mineral content of the body.[2]
- Mounting evidence suggests that diets high in potassium may be protective against high blood pressure, stroke, cardiovascular disease, and possibly other degenerative diseases.[3]

Functions:

- Besides maintaining water balance, pH and distribution within the body, potassium is also key for a healthy nervous system, regular heart rhythm, and proper muscle function.[1]
- Potassium is necessary for chemical reactions within the cells and helps in maintaining normal blood pressure and in generating electrochemical impulses.[1]
- In persons with hypertension, potassium can dramatically lower both systolic and diastolic pressure.
- It functions in cell metabolism, enzyme reactions and the synthesis of muscle protein from amino acids in the blood.[2] It works with phosphorous to send oxygen to the brain and functions with calcium in regulating neuromuscular activity.[2] It is also necessary for healthy skin.[1]
- Potassium will also stimulate the kidneys to eliminate poisonous wastes.[2]

Requirements:

There is no RDA for potassium.

Signs of Deficiency:

Excessive urinary losses caused by a high intake of salt have caused potassium deficiency to become rather common.[2] Symptoms include: abnormally dry skin, acne, chills, cognitive impairment, constipation, depression, diarrhea, diminished reflexes, edema, glucose intolerance, insatiable thirst, insomnia, slow and irregular heartbeat, nervousness, high cholesterol levels, muscle weakness, periodic headaches, and vomiting.

Note: Persons who are diabetic or have diseases of the digestive tract are often deficient in potassium. High sodium intake, use of diuretics, kidney disorders, high stress levels and diarrhea can disrupt potassium levels. Caffeine intake and smoking also reduce the absorption of potassium.[1]

Safety:

Potassium supplements are contraindicated in those sensitive to potassium-containing supplements. People who are taking ACE inhibitors should be closely monitored by their physician before taking supplemental potassium.

Potassium

Pregnant women and nursing mothers should not take potassium supplements unless indicated by a physician.

Signs of Toxicity:

According to the American Society for Nutrition, urinary excretion usually protects against the accumulation of high amounts of potassium. Acute hyperkalemia can cause cardiac arrest, however, no dosage level was mentioned.

Current Research:

Hypertension: Researchers in Israel examined the eating habits of vegetarians whose average age was 60 versus similarly aged meat-eaters. Both groups consumed the same intake of salt and had the same genetic predisposition for hypertension. Researchers found a very low prevalence of hypertension in the vegetarians, which the researchers attributed to a potassium-rich diet of vegetables, fruits, and nuts that protected the vegetarians from developing hypertension.[3] Researchers speculate that potassium is effective for hypertension because it appears to be able to "slough off" sodium.[4] A meta-analysis of 33 randomized studies involving 2,609 subjects concluded that low potassium can be an important contributing factor to hypertension and that increased potassium intake can prevent and treat hypertension.[3]

Headache-Related Allergies: According to *Nutrition Almanac*, "Since potassium is essential for the transmission of nerve impulses to the brain, it has been effective in the treatment of headache-causing allergies."[2]

Muscle Cramps: According to James Knochel, M.D., chief of medical services with the Veterans Administration in Dallas, Texas, potassium may help with cramps. "A potassium deficiency also impairs the ability of the muscles to use glycogen, a sugar that is their main source of energy," Knochel states. "Potassium and other mineral deficiencies may also affect the 'excitability' of nerves—their tendency to fire off a series of muscle-cramping messages. And they may affect the muscles' 'fatigue threshold'—their ability to do more work without becoming tired or spasm-prone."[4]

Stroke: Studies have found an inverse association between potassium intake and stroke. One study found that men who had the highest potassium intakes had a 38 percent lower risk of any type of stroke versus those men with the lowest intakes of potassium.[3]

Potassium

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Selenium

Facts:

- Selenium is an essential mineral found in minute quantities in the body.[1]
- The liver and kidneys contain four to five times as much selenium than tissues and muscle.
- Selenium is normally excreted via the urine.

Functions:

- Selenium's primary function is that it inhibits the oxidation of fats. Combined with vitamin E, selenium is a powerful antioxidant. Selenium and vitamin E have been shown to act synergistically in producing antibodies and in helping to maintain a healthy heart and liver.[2]
- As an antioxidant, it protects the immune system by inhibiting the formation of free radicals, which can damage the cells and tissues of the body. It also has been shown to confer a protective effect against certain forms of cancer.[2]
- It appears to help preserve tissue elasticity by delaying the oxidation of polyunsaturated fatty acids.
- It aids in the production of prostaglandins, substances that affect blood pressure. Low prostaglandin levels can result in a deficiency in other substances, which help keep the arteries free from platelet aggregation.[1]
- Combined with vitamin E and zinc, selenium can help reduce an enlarged prostate.
- In addition, selenium supplementation has been shown to be helpful in treating people with alcoholic cirrhosis of the liver, cancer and heart disease, sterility, aging and high cholesterol levels.[2]

Requirements:

The Food and Nutrition Board of the Institute of Medicine has established the following RDAs for selenium[4]:

Category and Age:	RDA (micrograms):
Infants 0-0.5 yrs.	10 micrograms (mcg)
0.5-1 year	15 mcg
1-6 years	20 mcg
7-10 years	30 mcg
Males 11-14 years	40 mcg
Females 11-14 years	45 mcg
Males and females 15-18 years	50 mcg
Adult males	70 mcg
Adult females	55 mcg
Pregnancy	65 mcg
Lactation	75 mcg

Selenium

Signs of Deficiency:

A deficiency reduces the activities of selenium-dependent enzymes resulting in damage to the muscle tissue, including heart muscle, premature aging, diminished vision, nerve disorders. [2,3] It has been associated with cancer and heart disease, exhaustion, impaired growth, high cholesterol levels, infections, liver and pancreatic impairment and sterility.[2]

Signs of Toxicity:

Symptoms include: skin lesions, brittle hair and nails, irritability, lethargy, a metallic taste in the mouth, pallor.[1,2]

Current Research:

Aging: In Finland, 15 elderly nursing-home residents (average age 76) were given 400 mg of vitamin E, 8 mg sodium selenate, and 50 mcg of organic selenium. At the study's conclusion, the experimental group showed "…significant improvement in mental alertness, emotional stability, depression, anxiety, fatigue and other measures of overall health."[5]

Cancer: Studies bear out an inverse relationship with the increased risk of certain cancers corresponding with low levels of selenium in the body. Researchers at the University of North Carolina at Chapel Hill found that 240 people with skin cancer, compared to cancer-free individuals, had low selenium levels.[4] In China, researchers found a high incidence of lung cancer corresponding with low levels of selenium in the soil. In areas where the selenium in the soil was plentiful, researchers found a low rate of lung cancer.[4] In a review published in *The Lancet*, one researcher calls on health professionals to take notice of selenium. Margaret Rayman, professor of nutritional medicine at the University of Surrey, found that selenium levels were significantly lower in Europeans than those in North Americans due to selenium depleted European soil. The review links selenium deficiency to early pregnancy loss, male infertility, mood problems, increased risk of cardiovascular disease and arthritis. "Probably the strongest evidence in terms of selenium and health would be the effect on cancer risk," states Rayman.

Breast Tumors: In mice, researchers at Baylor College of Medicine in Houston, Texas found that selenium supplementation reduced the incidence of breast tumors from 80 percent to 18 percent.[4]

Colon Cancer: At the University of Nebraska's Eppley Institute for Research in Cancer, rats fed both a low and high doses of selenium exhibited reduced rates of colon cancer. In the group receiving very high amounts of selenium, 16 out of the 30 rats male rats had developed colon cancer. In the group receiving low amounts of selenium, cancer was found in 28 out of the 29 rats.

Cancer Prevention: In Germany, a study involving mice fed selenium measured selenium's ability to prevent cancer. Out of 50 mice not given selenium, 31 developed tumors. Of 50 mice treated with

Selenium

selenium, only 14 developed tumors and the tumors were significantly smaller than those in the selenium-deficient mice.[5]

Prostate Cancer: A Harvard-based study involving 34,000 men found that men with the lowest levels of selenium had three times the likelihood of developing advanced prostate cancer compared to those with the highest selenium levels. According to Gerhard N. Schrauzer, a pioneer in selenium research, states that selenium "...alters the metabolism of carcinogenic substances thus preventing an accumulation of free radicals."[4]

Diabetes: Selenium is an insulin-like trace mineral that transports glucose into tissue for conversion into energy, according to new research published in the journal *Cellular and Molecular Life Sciences*. Although researchers do not fully understand the mechanisms by which selenium imitates insulin, the research indicates that the body has multiple systems to regulate metabolic processes.[5] Some researchers believe that persons with diabetes benefit from supplemental and dietary forms of selenium.

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Sodium

Facts:

- Sodium is an essential mineral found mainly in extracellular fluids, vascular fluids within the blood vessels, arteries, veins, and capillaries; and intestinal fluids surrounding the cells.[1-3] Approximately 50 percent of the body's sodium is found in these fluids while the remaining amount is contained in the bones.[3]
- Sodium is absorbed in the small intestine where it is carried via the bloodstream to the kidney. The kidneys then filter out the necessary sodium the body needs to maintain blood sodium levels and then releases this amount into the bloodstream. The excess is then excreted in the urine.[3]
- Disorders involving the regulation of sodium are a culprit in many human diseases.

Functions:

- Sodium is essential for maintaining blood pH and proper water balance.[1] Together with potassium, sodium helps regulate the distribution of fluids on either side of the cell walls. Sodium and potassium are also intricately involved in muscle contraction and expansion as well as nerve stimulation.
- During intense exercise or extreme heat, sodium activates the thirst response.
- Sodium also keeps the other blood minerals soluble so that a build up of other minerals will not accumulate in the blood stream.
- Sodium also acts with chlorine to improve blood and lymph health and aids in eliminating carbon dioxide from the body.

Requirements:

There are no RDAs for sodium. The Estimated Minimum Requirement from the National Academies' of Science for healthy persons ranges from 120 mg/day for infants to 500 mg/d for adults and children >10 years. The maximum amount of sodium that can be added into a healthy diet range from 2,400 to 3,000 mg/d or 6 to 7.5 grams of table salt/day.[5] Of course, persons with hypertension should consult a physician regarding his or her sodium intake.

Signs of Deficiency:

Deficiencies are uncommon as most foods contain high levels of sodium. However, persons that experience pronounced losses of sodium through heavy perspiration, diarrhea, or an impairment of the kidney to reabsorb sodium, may experience decreased blood volume and a decrease in blood pressure.[5] Symptoms of sodium loss (and dehydration) include: abdominal cramps, confusion, dehydration, dizziness, fatigue, muscular weakness, vomiting, weight loss.[3,5]

Sodium

Signs of Toxicity:

Sodium is generally non-toxic for healthy adults as it is readily excreted in the urine. Excessive sodium intake, however, has been associated with edema, high blood pressure, potassium deficiency, liver and kidney disease.[1]

Current Research:

Sports Performance and Heat: Electrolytes, including sodium, potassium, and chloride, are lost in sweat during endurance exercise in hot temperatures or for those individuals that work in very high temperatures. For persons either exercising or working in extreme conditions, he or she should take care to ensure they are replacing the losses of sodium, potassium, chloride, magnesium, and other electrolytes. People who work or exercise intensely in hot temperatures should closely monitor fluid losses. A good rule of thumb is to drink at least two cups of water for every pound of weight loss during exercise or exertion.

Excess Sodium and Hypertension: There are no known benefits to consuming large amounts of sodium. In fact, maintaining a low-sodium diet throughout one's life may decrease the risk for developing hypertension. Several studies have reported that a reduction in sodium intake lowers both systolic and diastolic blood pressure. One study, the *Trials of Hypertension Prevention*, demonstrated that a moderate reduction in sodium (from 155 to 100 mmol/day) over a period of a year and a half lowered the mean systolic and diastolic blood pressure of 30-54 year old adults who had a high normal diastolic blood pressure prior to the study's commencement.[5]

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Zinc

Facts:

- Zinc (Zinc) is an essential trace mineral occurring between 1.5-2 grams—making it almost as abundant as iron.
- Zinc has only been recognized as essential since 1974 by the National Academies' of Science.
- The typical intake of Zinc in Western diets hovers around 10 mg, one-third less than the recommended dietary intake.[1]
- Approximately 90 percent of total body zinc is found in skeletal muscle and bone. Over 95 percent of total body zinc is bound to proteins within cells and cell membranes.[2]

Functions:

- Zinc has a variety of functions in the body. It is a component of at least 25 enzymes involved in digestion and metabolism, including carbohydrate digestion, and phosphorous metabolism[1,2].
- Zinc is essential for general growth and proper development of the reproductive organs and prostate gland function.[2,3]
- It also may help prevent acne and control the activity of oil glands[3]. It also aids in the synthesis of protein and collagen formation, promotes a healthy immune system, aids in wound healing and allows for enhanced vision, taste and smell.[3-4]
- Zinc is also a component of insulin and many vital enzymes.[2-3] It also will fight and prevent against the formation of free radicals. Zinc also increases the absorption of vitamin A.[3]

Requirements:

The RDA for zinc is as follows[4]:

Category and Age:	RDA (milligrams):
Infants	5 mg
Children<10 years,	10 mg
Males >10 years	15 mg
Females>10 years	12 mg
Pregnancy	15 mg/day
Lactation: First 6 mos. Second 6 mos.	 19 mg 16 mg

Zinc

Signs of Deficiency:

Symptoms include: retarded growth, delayed sexual maturity, prolonged healing of wounds, diminished taste or smell, brittle and thin nails, acne, fatigue, hair loss, high cholesterol levels, poor nigh vision, impotence, increased susceptibility to infection, infertility, poor memory, propensity for diabetes, prostate problems, poor appetite, recurrent colds and flu, skin lesions.[1-4]

Note: Several factors increase the need for zinc including alcohol consumption, smoking, physical and mental stress, fatigue, susceptibility to infection, and injury.[1]

Safety:

People who are sensitive to zinc-containing supplements should avoid zinc. Pregnant women and nursing mothers should not exceed the RDA.

Signs of Toxicity:

Excessive intakes of zinc can interfere with copper and iron metabolism and can be immunosuppressive. Symptoms of toxicity include: gastrointestinal upset, dizziness, nausea, impaired immunity, adverse changes in HDL/LDL cholesterol levels.[2] According to *Prescription for Nutritional Healing*, an individual should not consume more than 100 mg of zinc per day. Doses under 100 mg enhance immune function while dosages of 100 mg or more have the opposite effect.[3]

Current Research:

Arthritis: Preliminary evidence reveals that zinc deficiency may play a role in rheumatoid arthritis. Diminished plasma zinc has been reported in some with this disease.

Blood Sugar: A zinc deficiency directly affects the way the body handles glucose, according to the results of an animal study published in *Pediatrics Annals*. Examinations of rat livers show that when a zinc deficiency exists, a zinc-dependent enzyme (a branch-point enzyme), which acts as a railroad-type switch determining the reaction between energy burning and fat storage, becomes inactive. “The result is that glucose is shunted toward making triglycerides [blood fats] that can be stored in the fatty tissues rather than being burned for energy.”[4]

Colorectal Cancer: One of the functions of zinc is that it’s involved in cell growth, including colorectal epithelial cells. Several epidemiological studies have demonstrated a link between blood zinc concentration and the development of certain cancers. A new study published in *Trace Elements and Electrolytes* adds further supporting evidence of this link reporting that patients with cancer and polyps of the colon had significantly lower zinc levels compared to healthy, cancer-free individuals.[5]

Endurance: Active adults who don’t get enough zinc in their diet may suffer diminished cardiovascular fitness and physical endurance, according to a study published in the *American Journal of Clinical*

Zinc

Nutrition. Researchers reported that fourteen active young men fed a nine-week diet low in zinc (3.5 mg of zinc in food) experienced increases in heart rate and a decline in breathing efficiency. During a 45-minute endurance ride, four of the nine men had to stop. Zinc appears to affect fitness and endurance through an enzyme called carbonic anhydrase, which helps the body rid itself of carbon dioxide that naturally increases during exercise. During the low-zinc diet phase, the men's enzymes were less active and the result was that during exercise, they were not as efficient in removing carbon dioxide. The study appears to corroborate prior studies showing an association between zinc intake, exercise capacity, and muscle strength.[6]

Immune Function: The thymus, a gland located in the chest, distributes and nourishes T-lymphocytes, or white blood cells, that are the body's first defense against invading bacteria, virus or cancer cells.[6] The thymus is full of zinc, which is necessary for cell division and protein synthesis. The thymus also secretes FTS, a zinc-dependent hormone important for immunity. Researchers have found that even marginal deficiencies of zinc impair FTS activity. Elderly individuals and persons with Down's Syndrome lack both FTS and zinc. When Down 's syndrome children were administered 1 mg of zinc per kg of body weight, the children suffered less infections and missed fewer days of school.[5] "Though zinc gets little attention, it is critical for to a healthy body," writes Micahel Janson, M.D. First, it helps the body fight germs that can cause a host of unpleasant illnesses from strep to influenza. Recently, researchers discovered that the thymus gland, which is responsible for controlling the body's immune system functions, is affected by the amount of zinc in the body. At birth, this gland weighs almost one-half ounce, but shrinks as we age. Scientists and doctors long believed this was a normal process, but a recent animal study in which zinc supplements were administered to mice showed zinc was associated with restored thymus gland functions and, most surprising, its regrowth. Based on this study, researchers concluded that age-related shrinkage of the thymus gland could be reversed with zinc supplements.[7]

Fertility: Sperm contains significant amounts of zinc. One researcher found that 10 to 15 percent of patients tested at an infertility clinic had very low levels of zinc. [6]

Pregnancy and Nursing: Zinc performs numerous functions during pregnancy. A zinc deficiency during pregnancy can have serious effects on the growth of the fetus and newborn. For instance, it can be teratogenic, producing neural tube defects, according to the *Physicians' Desk Reference*. For nursing mothers, some studies show that giving nursing moms 15 mg of zinc daily resulted in more weight gain in their babies compared to the babies of non-supplemented mothers. Zinc supplementation in non-breast fed infants has also shown benefits.

Zinc

Obesity: Platon Collip, M.D., former professor of pediatrics at State University of New York, Stony Brook has found that children deficient in zinc might not be able to discern the difference between feeling hungry versus feeling full. Zinc-deficient children do not appear to rely on internal cues to stop eating. "I think a zinc deficiency may also affect some part of the brain involved in the self-monitoring of the body, a kind of satiation center that lets you know when you've had enough to eat or drink."[8]

Osteoporosis: Zinc-dependent hormones are also involved in bone metabolism. Currently researchers postulate that zinc may help weak bones attract calcium . Researchers in Turkey demonstrated that persons with osteoporosis had 25 percent lower levels of zinc than those without osteoporosis.[8]

Taste: Some individuals suffer from an inability to detect flavors and odors, which can cause an individual to no longer derive pleasure from eating their favorite foods. Illnesses such as the flu or even physical and mental stress can decrease the body's ability to detect certain flavors. However, according to researchers at the USDA's Grand Forks Human Nutrition Research Center, zinc, copper, magnesium, and nickel have been found to improve taste and smell in individuals with impaired senses. According to Forrest Nielsen, taking supplements of these elements for a short time may be one way to restore taste and smell.[9]

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Other Trace Elements

There are 92 elements that are found in nature with 22 other documented or theoretical elements. In sea water, there are approximately 66 elements that have been identified to date. Each year, as more research is conducted and released to the media and consumers, minerals and trace minerals are garnering more recognition and consideration for the beneficial role they play in human health. During the next few years, experts predict there will continue to be an expansion or "golden-age" of knowledge concerning the essential role of a number of minerals and trace minerals in health and nutrition.

Microelements, or trace minerals, are minerals the body requires in very small, or trace, amounts. Without a steady, minute intake of these trace elements, your body cannot function, and health problems may occur. "Trace minerals, such as chromium, manganese, selenium, vanadium, and copper, have far-reaching health effects as evidenced by current research," states Chris D. Meletis, dean of naturopathic medicine and chief medical officer at the National College of Naturopathic Medicine in Portland, OR.[1]

Listed below, in alphabetical order, are identified elements that have been studied for their role in health and nutrition.

Aluminum:

The average daily intake varies between 3 to 100 mg. Sources of aluminum (Al) include baked goods prepared with leavening agents, *i.e.* baking powder, processed cheese, grains, vegetables, certain antacids, white flour, etc.[2-3] There is no established function of aluminum in human health.[2] Aluminum, if consumed in high amounts, can be fatal.[3] However according to *Nutrition Almanac*, Adelle Davis, author, speaker and pioneer of America's "Health Food" movement, reported that magnesium can displace aluminum in the body. A patient of Davis' suffering from irritability, poor concentration, and memory due to aluminum toxicity was able to end the symptoms after taking magnesium supplements.[3] Further research is needed.

Arsenic:

Although arsenic (As) is primarily known for its toxic properties, there is some evidence from animal studies only to suggest that it plays a unique role in health. Numerous animal studies involving rats, hamsters, goats, and chicks have provided circumstantial evidence that arsenic is essential—in very small amounts. In goats, arsenic deficiency resulted in decreased growth rates, impaired fertility, and increased infant mortality.[4] Despite its fearsome reputation, arsenic is found in the earth's crust and water. Based on animal studies that were extrapolated to humans, it has been estimated the dietary intake of arsenic is equal to 12.5-25 mcg/day.[2] Human diets normally contain 12-50 mcg arsenic daily. Nutritionists advise a safe upper intake of arsenic could well be 140-250 mcg/day.[5]

Other Trace Elements

Beryllium:

This mineral is a component of many industrial processes including electronic devices and some alloys such as steel, bicycle wheels, and other household products. Estimated intakes of this element approximately 100 mcg/day.[6] In industrial toxicology, inhalation of beryllium (Be) dust has led to lung injury, scarring, or fibrosis.[3] However, the literature does not report a case of beryllium toxicity associated with a dietary supplement that contains trace amounts of Be.[6] Some studies have shown that 1 ppm of beryllium chloride prevents calcification of the precursor associated with increased risk of dental caries.[6]

Bismuth:

Bismuth (Bi) has no known function with in the body, but it has been used historically to treat syphilis and, today, is an ingredient in certain anti-diarrhea medications (Pepto-Bismol™) and rectal suppositories. Bismuth toxicity can cause staggering gait, poor memory, tremors, visual and hearing disturbances.[3]

Bromine:

The typical daily intake of bromine (Br) is 2 to 8 mg. Bromide is normally ingested as the bromide ion, which has a low degree of toxicity, and, as such, does not pose a toxicological threat in terms of nutrition. Some studies suggest Br may be nutritionally beneficial (*i.e.*, low Br levels associated with hemodialysis patients with insomnia).[2]

Cadmium:

The typical dietary intake of this element daily is 10-20 mcg.[1] Cadmium (Cd), found in cigarette smoke, industrialization, and population growth, has a long half life (10-30 yrs.), and high intakes can cause organ damage—especially kidney damage. If there is a deficiency of zinc in the diet, the body will compensate, storing cadmium.[2] Cadmium is known to experimentally cause hypertension, cancer, and immune disorders. In prostate cancer, there is a correlation between the grade of malignancy and cadmium content.[6] However, little cadmium is absorbed orally unless there are nutrient deficiencies. Other elements and nutrients that confer a protective effect against cadmium include: zinc, calcium, vitamin C, and sulfur amino acids.[6]

Germanium:

Average daily intakes hover between 0.4-1.5 mg. The maximum safe intake level of germanium (Ge) has been estimated to be >30 mg per day or 0.43 mg/kg/d for a healthy adult and >7.5 mg per day in a healthy child.[6] Inorganic germanium toxicity can result in damage to the kidneys. There have been reports of kidney failure associated with the use of organic germanium supplements, however, the intake ranged from 16-328 grams over a 4 to 36-month period.[3,6] Still, there is little information available about germanium, and germanium supplements should be avoided.

Other Trace Elements

Lead:

Typical daily intakes are 15-100 mcg per day. In animal studies, lead (Pb) deficiency had adverse effects on growth and disturbed iron metabolism. Toxicity is a nutritional concern.[1] Humans can only tolerate 1-2 mg of lead without suffering toxic effects including anemia, kidney damage, and central nervous system abnormalities.[2-3]

Mercury:

The average daily intake of mercury is estimated to be 0.5 mg.[3] Mercury (Hg) has no known essential function in the body and is a toxic element presenting numerous hazards if it is ingested or inhaled. Individuals can be exposed to mercury through industrial processes or by consuming contaminated fish or wild game. Currently, there is controversy whether individuals can be exposed to the harmful effects of mercury from mercury-containing fillings. Two forms of mercury, methyl and phenyl mercury, deplete brain tissues of zinc.[3]

Nickel:

An essential element for higher animals, a deficiency disease has not been identified for humans.[7] Average intakes of Western-based diet ranges from 60-260 mcg/day. Nickel, demonstrated through animal and human tests, plays a role in hormone, lipid, and membrane metabolism.[3] It can act as an activator of certain enzymes and may be involved in glucose metabolism.[3] The oral toxic dose is about 1,000 times the amount consumed in food. Nickel can be toxic to humans if intake levels are high. Excessive amounts of nickel in tissue can lead to altered hormone and enzyme activities and can impact glucose tolerance, blood pressure, and immune function.[7]

Phosphorous:

Needed for proper bone and tooth formation, cell growth and contraction of the heart muscle, phosphorous (P) also assists in the assimilation of vitamins and the conversion of food into energy.[2] It also works with calcium to maintain the calcium-phosphorous balance in the bones of 2.5 parts calcium to 1 part phosphorous.[3] The recommended amount is 800 mg/day for men and women. Deficiency can cause lack of appetite and weight loss. There is no known toxicity of phosphorous. There are some studies that have reported supplemental phosphorous enhances athletic performance, but some studies have not replicated the same results. The majority of studies provide some support. Phosphate loading in ten trained distance runners attenuated increases in blood lactate after exercise. Another study reported that 1,000 mg of tribasic sodium phosphate administered four times daily for six days significantly increased maximal oxygen uptake and ventilatory anaerobic thresholding. It did not, however, improve five-mile run times compared with placebo.[8]

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Rubidium:

Typical daily intake of rubidium (Rb) is 1-5 mg. There is little information about rubidium. Rubidium is relatively non-toxic and does not pose toxicological concern. In animals, specifically goats, rubidium deficiency depresses growth and life expectancy.[2] There is no information available about the nutritional effects of rubidium in humans.

Silicon:

Found in the connective tissue of the body including the aorta, trachea, tendons, bone, and skin, silicon (Si) also works with calcium to form strong bones, which has implications for osteoporosis.[2,3] It also stimulates the immune system and inhibits the aging process in tissues.[2] Aging increases the need for silicon. Recommended intakes range from 5-10 mg/day.[4]

Strontium:

There is minor, circumstantial evidence suggesting strontium (Sr) may be an essential trace mineral; however, further research is needed.[3] Strontium is similar to calcium in chemical composition and is necessary for proper bone growth and prevention of dental caries.[3] Researchers at St. Mary's Hospital in Montreal, Canada, have found that strontium may confer a protective effect of certain energy-producing structures with in the cell. Not to be confused with radioactive Strontium-90, strontium is stable and is not considered a toxic trace elements.[3]

Sulfur:

Sulfur (S) accounts for 0.25 percent of human body weight.[3] Referred to as nature's "beauty mineral," it works with other nutrients, including protein, to support hair glossiness, lustre, and smoothness and help maintain a clear, youthful appearance.[3] Sulfur also plays a role in bacteria resistance, bile secretion, and the aging process.[8] Sulfur is stored in each cell of the body with the highest amounts found in the joints, hair, skin and nails.[3] There is no RDA for sulfur.

Tin:

Tin is a heavy metal that is not considered an essential nutrient for humans. Tin deficiency in animals has resulted in poor growth and hemoglobin synthesis.[3] Widely used in many industrial processes, a tin salt, stannous fluoride, is used in commercial toothpastes.[3] Estimated daily intakes range from 2-17 mg/day; estimated requirements hover between 3-4 mg/day.[3] The typical daily dietary intake ranges from 1-40 mg.[8]

Vanadium:

There is circumstantial evidence for the essentiality of vanadium (V), however, essentiality has not been established. It is present in most body tissues. Cartilage, bones and teeth require vanadium for proper development. It also plays a role in growth and reproduction and cholesterol synthesis.[8] Animal studies show that vanadium deficiency in increased rates of spontaneous abortion, infant mortality, skeletal

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deformities.[2-3,5] Vanadium is a component of many sports performance enhancers and is advertised for its beneficial effects on glucose metabolism.[5] Both experimental and clinical trials demonstrate that vanadium
has insulin-mimetic properties, but claims that it promotes increased muscle mass have been refuted by science.[8] High doses of vanadium may be toxic to humans.[4] In animal studies, vanadium toxicity has adverse effects reduced blood glucose levels, diarrhea, red blood cells and caused immunosuppression.[6] Therefore, the use of supplemental vanadium is not indicated for any purpose at this time.[8]

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