Manganese
little known and underrated by both doctors and the general public, is an essential mineral important to many enzyme systems in carrying out such functions as energy production, protein metabolism, bone formation, and the synthesis of L-dopamine, cholesterol, and mucopolysaccharides.

The human body contains a total of about 15–20 mg. of manganese. About half of that is in the bones, and the remainder is found in the liver, pancreas, pituitary gland, adrenal glands, and kidneys—the active metabolic organs. Manganese is present in many enzymes in body cells, particularly in the mitochondria (or energy factories) as manganese—containing superoxide dismutase, an antioxidant enzyme.

In the food chain, most manganese is present in plant tissues, mainly in nuts, seeds, and whole grains, but in most vegetables as well, particularly the dark leafy greens. Like that of iron, our absorption of manganese is low; utilization of manganese from the diet has been estimated in the range of 15—30 percent efficiency. Absorption may be influenced by body manganese levels. Alcohol and lecithin cause slight increases in manganese absorption.

Large amounts of calcium and/or phosphorus will interfere with manganese absorption. Heavy milk drinkers, meat eaters, or consumers of soda beverages may therefore need additional manganese. Magnesium, as is found in antacids, may interfere somewhat with manganese absorption. Iron definitely has a seesaw interaction with manganese; too much of either mineral will interfere with absorption of the other. In other words, taking extra manganese can interfere with iron absorption and lead to deficiency, which must then be corrected by taking extra iron. Zinc, cobalt, and soy protein may also interfere with manganese absorption into the blood from the intestines. Manganese can interfere with copper absorption and can decrease copper levels. Optimal absorption of manganese occurs when it is taken in the absence of other minerals or food and in its protein–chelated form.

After absorption, manganese is transported to the liver and then to other organs, such as the kidneys, for storage. A globulin protein called transmangamin carries the manganese molecules in the blood. Manganese is eliminated mainly through the feces after being excreted in the bile. The kidneys clear only a small amount. A manganese blood level (whole blood) can be measured; this level is often low in a person who eats the average American diet.

Sources: Nuts and whole grains are the best sources of manganese. Most animal foods have low levels, though egg yolks are a decent source. Seeds, legumes (peas and beans), and leafy greens, especially spinach, are all good sources of manganese if there is manganese in the soil in which these plants are grown. Alfalfa is high, and black teas and coffee beans have some manganese.

A number of factors, however, can affect dietary manganese levels. As I just implied, food manganese levels may vary greatly because of soil deficiencies; the leafy greens are particularly sensitive to this. Soil mineral losses related to runoff and high-tech farming have created manganese and other mineral depletion problems. Lime added to the soil binds manganese, and, though it may make nice greens, it will result in most foods having a lower manganese content.

Also, though the whole grains, such as barley, whole wheat, millet, and oats, all have good levels of manganese, most of it is in the bran and germ, and these outer parts are often stripped away through milling and refining. Nearly 90 percent of manganese is lost in the refinement of wheat to white flour. Ideally, we should eat whole and unprocessed foods from healthy, balanced soil to get sufficient amounts of manganese and many other minerals.

Functions: Manganese is involved in many enzyme systems-that is, it helps to catalyze many biochemical reactions. These and its other functions, shown to be essential in animals, are still under investigation for humans, but we are finding out that manganese also has some very important roles in the human body. There are some biochemical suggestions that manganese is closer to magnesium in more than just name. It is possible that magnesium can substitute for manganese in certain conditions when manganese is deficient.

Manganese activates the enzymes necessary for the body to use biotin, thiamine (B1), vitamin C, and choline. It is important for the digestion and utilization of food, especially proteins, through peptidase activity, and it is needed for the synthesis of cholesterol and fatty acids and in glucose metabolism. As a cofactor in glycolysis, manganese aids glucose metabolism. By activating the arginase enzyme, manganese helps form urea, the end product of protein and ammonia breakdown cleared by the kidneys. Manganese may also be important in the growth and development of normal bone structure and in the formation of mucopolysaccharides, which are needed for healthy joint membranes.

Manganese may function as a protective antioxidant, especially in its +2 valence state. Divalent manganese, commonly found in the brain and other tissues as part of the enzyme superoxide dismutase (SOD), can bind oxygen free radicals, thus protecting the cell membranes and tissues from degeneration and disruption. Those areas in danger of oxidative damage are the cell membranes, nerve coverings (myelin), and tissue linings, and these are mainly protected by the antioxidant nutrients and enzymes. The manganese present in SOD is found in the "energy factories," the mitochondria, within the cells, and this enzyme protects the mitochondrial membrane from destruction, especially from superoxide free radicals. Trivalent (+3) manganese may be a prooxidant, meaning that it may generate oxidation and unstable molecules. This role as well as manganese's antioxidant functions are still being researched.

Also still under study is manganese's role in the production of thyroxine, essential for thyroid function; its role in normal lactation, in bone health, and in glucose metabolism; and its importance in reproduction. Since manganese seems to be needed in cholesterol synthesis, which is important to sex hormone formation, it may be essential in normal sexuality and reproduction. The idea that manganese is important to some enzymes that seem to stimulate maternal instincts is vague and difficult to research, and there is currently no proof to support this contention.

Uses: Manganese has been used as a therapeutic nutrient, but other than preventing problems of manganese deficiency, its influence on certain disease states seems only anecdotal to date; further research will provide us with more evidence. The superoxide dismutase enzymes, only one of which contains manganese (others utilize zinc or copper), have an anti-inflammatory effect in the body, and this function may be relevant to many of the possible uses suggested here.

Manganese has been helpful in some cases of fatigue (possibly by enhancing certain enzymes), poor memory (by protecting brain tissue and helping oxygenation), and nervousness, irritability, or dizziness. In his book Mental and Elemental Nutrients, Carl Pfeiffer, M.D., suggests that manganese along with zinc will help decrease copper levels by both decreasing absorption and increasing urinary losses. He feels that copper in higher than normal amounts can cause psychological problems and even some forms of schizophrenia (see the earlier section on Copper). Also, by some unknown mechanism, manganese may help reduce some of the parkinsonian symptoms, such as muscle rigidity and twitching, secondary to phenothiazine drug use. Manganese supplementation may also help in some cases of epilepsy.

Whether manganese is useful in the treatment of diabetes by helping glucose metabolism or in people with osteoarthritis by stimulating mucopolysaccharide production to heal joints is still undemonstrated and questionable. It is more likely that a manganese deficiency reduces our ability to handle glucose and may thus worsen a diabetic condition. Manganese has also been tried in treatment for multiple sclerosis and myasthenia gravis. When given with B vitamins, manganese may alleviate fatigue or weakness by enhancing nerve impulses. Research has found most tumors and cancer cells to be very low in this mineral, which suggests a possibility that manganese may have a role in preventing cancer cell production and protecting against cancer growth.

Deficiency and toxicity: From a nutritional point of view, manganese may be one of the least toxic minerals. There is no known natural toxicity from manganese in food or from taking reasonable amounts in supplements. Lung problems can be caused, however, by breathing in the dust when mining the inorganic mineral.

In Chile, where much manganese is mined, workers sometimes develop a strange syndrome they call locura manganica, or "manganese madness." The first symptoms may be anorexia, weakness, and apathy. However, there may be an initial manic phase, characterized by inappropriate laughter, increased sexuality, insomnia, and even delusions or hallucinations. Violence and other mental change may occur. The earlier mania may shift to depression, impotence, and excessive sleeping. Parkinsonian symptoms such as tremors and muscle rigidity may also appear in the later stages. These symptoms may appear, as in Parkinson's disease, from a loss of dopamine in the brain cells. L-dopa, which converts to dopamine in the brain, is used in the treatment of manganese toxicity to reduce symptoms. Avoiding further manganese inhalation is obviously also suggested.

Manganese deficiency in animals has been studied extensively. In rats, manganese deficiency can lead to sterility or, if occurring during pregnancy, to poor growth in the offspring and decreased lactation in the mother. There is decreased bone growth, especially in length. Poor brain function may occur from decreases in several manganese activities. A decreased threshold for seizures has also been measured. Poor bone and cartilage health and spinal disc degeneration are possible with low manganese. The relevancy of these findings to humans is currently only theoretical and needs further documentation.

In children, severe manganese deficiency may lead to convulsions, paralysis, or blindness. In adults, dizziness, weakness, and problems with the hearing, such as strange ear noises, are associated with manganese deficiency. Decreased strength

and ataxia (unstable gait) have also been related; in addition, weight loss, irregular heartbeat, and skin problems have been described by some authors.

Manganese deficiency may cause decreased glucose tolerance, or ability to remove excess sugar from the blood, as occurs also with chromium or zinc deficiency. Low manganese levels may even cause decreased function of the pancreatic cells, and this problem might be helped by manganese supplementation. Research on this relationship between manganese and glucose tolerance and other suggested effects of manganese deficiency is at a preliminary stage, and, to my knowledge, none of these effects has yet been proved. Whether the decreased manganese levels found in cancer are indicative of a causal relationship (which implicates a role of SOD in cancer) or a result of increased nutrient use is of great interest as well.

Requirements: There is no specific RDA for manganese; however, we probably need somewhere from 2.5-5 mg. per day. The average diet contains about 4 mg., depending on manganese soil levels, and intakes from food may range from 3-9 mg. per day. To be safe, I believe that we should get at least 4-5 mg. per day. When we take extra calcium and/or phosphorus, we probably also need extra manganese. However, taking supplemental manganese may decrease iron utilization and storage, so we need to make sure we get enough iron as well.

Since dietary manganese is relatively nontoxic, even 10-20 mg. per day is safe. Multivitamin/mineral supplements usually contain from 2-4 mg., but the amount may range from 1-9 mg. Separate manganese supplements are available in the chelated form or as manganese sulfate or gluconate. These are best absorbed when taken between meals and without other minerals, as these may interact with manganese and reduce its absorption. We should probably limit our intake of additional manganese to 10-15 mg. per day on a regular basis. Up to 50 mg. daily has been used in some research studies without negative effects.
