Magnesium:

The Underappreciated Mineral of Life Part I

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Almost everyone in the United States is at least marginally deficient in magnesium--adults and children alike. In order to understand the importance of magnesium it is necessary to know: (1) why this mineral is so essential to life and justly called the mineral of life; (2) what it does; and (3) how it affects the brain. It is equally important to know why diets and people tend to be deficient in magnesium, and what can be done about Americas magnesium-deficiency crisis.

Magnesium is the activator mineral for over 300 different enzymes--more than any other mineral. (1) Enzymes are catalysts that facilitate biochemical reactions and are at the core of virtually all metabolic processes that occur in the bodys 60 trillion cells. All of our cells, including our brain cells, run on a form of biochemical energy that depends on the production of Adenosine Triphosphate (ATP). Three interlocking cycles produce 90-95% of the body and brains ATP. These cycles which primarily burn sugar and fat for fuel are; (1) the glycolytic cycle; (2) the Krebs (citric acid) cycle; and (3) the electron transport side chain (ETSC).

Magnesium serves as the necessary activator mineral for almost all of the enzymes that allow the glycolytic and Krebs cycles to turn the sugar and fat we eat into ATP. (2) The ATP produced by the ETSC is derived from electron sparks released by the magnesium-powered Krebs cycle. Once cells (including brain cells) produce ATP--which they must do every second of our lives--the ATP must be combined with magnesium for stable storage. (2) Otherwise, ATP breaks down at random, releasing its energy as heat instead of as energy doing useful cellular work. Thus, magnesium is literally the key to producing, storing, and using the ATP energy which is at the very root of life. Twenty percent of the total body ATP is used by the brain for its myriad of functions. When brain energy diminishes, so does the minds ability to sustain focus and pay attention. Anyone who has ever tried to follow a prolonged, difficult or boring intellectual book or discussion while tired and hungry can attest to this phenomenon from personal experience. Now imagine what a chronic brain magnesium-deficiency (and thus brain energy deficiency) might due to a childs ability to sustain attention. Consequently, I believe that what often is diagnosed as ADD in children (and adults) is a manifestation of a chronic magnesium deficiency.

Magnesium also helps regulate nerve cell function. It must be present in adequate amounts in the synaptic gap between nerve cells to control the rate of neuron firing. (3) When synaptic magnesium levels are too low, nerves fire too easily from even minor stimuli. For example, noises will sound excessively loud, lights will seem too bright, emotional reactions will be exaggerated, and the brain will be too stimulated to sleep. In extreme magnesium-synaptic deficiency, epilepsy--a sort of whole-brain shotgun-blast excessive neuronal firing--may result.

Calcium and acetylcholine help muscles to contract, but adequate magnesium is required at the neuromuscular junction to allow muscles to relax. Chronic magnesium deficiency promotes chronic excessive muscle tension, and may lead to muscle spasms, tics, restlessness, and twitches, especially of the hands and feet and facial muscles. Interestingly, the first criterion for hyperactivity listed in the Diagnostic Statistical Manual - IV (the text which gives physicians approved criteria for diagnoses) is often fidgets with hands or feet or squirms in seat. Of course, squirming in the seat is often the only way a child can prevent magnesium-deficient muscles from cramping or spasming.

Magnesium activates glutamine synthetase, a key enzyme that helps cells dispose of ammonia. (4) Ammonia, an extremely toxic byproduct of normal protein metabolism, is always produced in our cells, thus requiring constant disposal. Even modest increases in brain ammonia may diminish the ability to focus attention, while extreme increases may result in unconsciousness.

Cellular DNA/RNA and protein synthesis are magnesium-dependent processes. (4) It is generally agreed that memory formation requires new protein synthesis in the neurons that help store the memory. Although the number of brain cells we have is fixed by two years of age, these cells gradually extend dendrite-connections to other brain cells. Eventually a neuron may connect to hundreds or thousands of others. This gradually-woven, and continually rewoven (hence the maxim use it or lose it) three-dimensional neuronal web is the neurological basis of learning and memory, and is formed most intensively in the first 10 to 20 years of life. This neural web-weaving activity is based on adequate magnesium-dependent/activated DNA/RNA and protein synthesis in our multi-billion brain nurons.

Causes of Widespread Magnesium Deficiencies
Given the obvious importance of magnesium to optimal biological function, is there any reason to believe that cellular deficiencies may be widespread? The bodys magnesium status is a function of three main variables: (1) dietary magnesium level, (2) efficiency of intestinal magnesium absorption, and (3) urinary and fecal magnesium losses.

Dietary Magnesium Levels
While the adult RDA for magnesium is about 300 - 400 mg per day, magnesium intake by Americans has been dropping throughout this century. Dietary surveys have shown the average daily intake for women to be 175 - 225 mg per day; for men 220 - 260 mg per day.(1) In contrast, those Asian and vegetarian diets which are whole-food based and calorie-adequate typically provide 500 - 700 mg per day of magnesium. (1)

Why is the American diet so low in magnesium? Magnesium is virtually never added back to our soils in synthetic fertilizers, despite the fact that crops continually lower soil magnesium. This is because magnesium is the center of the chlorophyll molecule. It is never added back to our foods after processing as well. For example, 99% of the magnesium in sugar cane is lost when it is refined into white sugar, while 80 - 96% of the magnesium content of wheat is removed when it is refined into white flour. But magnesium is not added back into so-called enriched flour. (1) Fats (e.g. butter, margarine, oils, shortenings) contain no magnesium, and meat and dairy products are generally poor sources of magnesium. (1) When vegetables are cooked, 50% of their magnesium may be lost in the cooking water. Thus, the typical American diet is literally a prescription for magnesium deficiency!

Efficiency of Intestinal Absorption
Various factors serve to inhibit the intestinal absorption of the magnesium that is present in the diet. Phosphoric acid in soft drinks and phosphates used in baking powders and as preservatives combine with magnesium in the intestine to form magnesium phosphate, an insoluble compound which then precipitates out of the intestinal juices and is lost in the feces. Oxalates in foods such as rhubarb, spinach and chocolate also form insoluble magnesium compounds that cannot be absorbed. A high-fat diet (the average American diet is 40-45% fat calories) will tend to suppress magnesium absorption by forming insoluble soap-like magnesium compounds. Phytic acid, a phosphated form of inositol found in wheat bran, unleavened bread/cracker products, and many grains, seeds and legumes also prevents magnesium absorption.(4) High levels of dietary or supplementary calcium may also suppress magnesium absorption due to competition for the same intestinal absorption sites. (1) The typical American high-dairy diet contains 2.5 to 4 times as much calcium as magnesium! Many physicians ill-advisedly recommend that children (because of their growing bones) and adults (because of osteoporosis fears) take 500 to 2000 mg of calcium supplements daily! Excessive or prolonged diarrhea (e.g. due to intestinal parasites, laxative abuse or food allergies) may also cause significant intestinal magnesium loss.

Efficiency of Kidney Magnesium Recycling
The primary mechanism for preventing excessive loss of body magnesium stores is the kidneys ability to remove magnesium from urine before the urine is excreted, recycling the magnesium back into the body. In people with healthy kidneys, magnesium recycling efficiency may reach 95%,(5) yet a large number of factors can seriously impair this recycling effectiveness. Alcohol --even social drinking--may promote magnesium loss. In modern America, alcohol consumption is not uncommon, even among 10-12 year olds. So-called coffee nerves are often in part coffee-induced magnesium deficiency. A high animal protein diet can cause magnesium deficiency; some of the high sulfur ash from the protein will combine with magnesium and be excreted in the urine. A high sugar (glucose/fructose/sucrose) diet is a powerful urinary magnesium spiller. High blood levels of the stress hormones adrenaline, noradrenaline and cortisol cause serious magnesium urinary losses. Human and animal studies have demonstrated that high stress-hormone levels produce urinary magnesium losses significant enough to seriously sensitize the organism to further stressors, which elicits further urinary magnesium losses, in a vicious cycle. Interestingly, the number one drug used to treat ADD, Ritalin(r), is known to increase blood adrenaline levels. Excessive noise and heat stress promote urinary magnesium loss. Noise stress has been shown to be one of the most effective promoters of urinary magnesium loss. High sodium, high calcium diets (the norm in America) are powerful promoters of urinary magnesium loss.(1) Intestinal candida yeast overgrowth provides constant acetaldehyde production, which in turn causes magnesium urinary loss. This is often caused by antibiotic abuse combined with a high sugar diet. What American child hasnt suffered from this combination? Some antibiotics, including gentamicin, tricarcillin and carbenicillin, are efficient promoters of urinary magnesium loss. This list should make it evident that many factors common to the American way of life conspire to promote potentially serious magnesium urinary losses.

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