Magnesium — A Key Nutrient for Health and Disease Prevention

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Story at-a-glance

Magnesium plays an important role in a wide variety of biochemical processes including optimizing mitochondrial function and the creation of ATP, regulation of blood sugar, and the activation of muscles and nerves

Eating processed food is a primary risk factor for magnesium deficiency. Magnesium is also lost through stress and lack of sleep. If you have elevated insulin levels, you're quite likely to have low magnesium levels

Foods high in magnesium are listed and recommendations for magnesium supplementation are included; as well as guidance for other nutrients that work in tandem with magnesium (calcium, vitamin D, and K2)

By Dr. Mercola

Magnesium is the fourth most abundant mineral in your body. More than 3,750 magnesium-binding sites have been detected on human proteins,[1] and it's required for more than 300 different enzymes in your body.

In short, magnesium plays an important role in a wide variety of biochemical processes, including the following:

Creation of ATP[2,3] (adenosine triphospate), the energy molecules of your body	Action of your heart muscle	Proper formation of bones and teeth
Relaxation of blood vessels	Regulation of blood sugar levels	Activating muscles and nerves
Helping digest proteins, carbohydrates, and fats	Serving as a cofactor for RNA and DNA	It's also a catalyst for neurotransmitters like serotonin

As is the case with vitamin D, if you don't have enough magnesium, your body simply cannot function optimally, and insufficient cellular magnesium levels set the stage for deterioration of metabolic function that can snowball into more serious health problems.

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For starters, magnesium is critical for the optimization of your mitochondria, which have enormous potential to influence your health, especially the prevention of cancer.

In fact, optimizing mitochondrial metabolism may be at the core of effective cancer treatment. But your mitochondrial function is also crucial for overall good health, energy, and athletic performance.

Optimizing Mitochondrial Function with Magnesium

Mitochondria are tiny organelles, originally thought to be derived from bacteria. Most cells have anywhere from 1 to 2,000 of them. Your organs need energy to function properly, and that energy is produced by the mitochondria in each cell.

Since mitochondrial function is at the very heart of everything that occurs in your body, optimizing mitochondrial function (and preventing mitochondrial dysfunction) by making sure you get all the right nutrients and precursors your mitochondria need is extremely important for health and disease prevention.

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As explained by Rhonda Patrick, Ph.D., in the video above, magnesium plays an important role. Patrick has done extensive research on the link between mitochondrial metabolism, apoptosis and cancer, and on the effects of hyperthermic conditioning on muscle growth.

High-intensity interval training helps optimize athletic performance by increasing your oxidative capacity, meaning the ability of your muscle cells to consume oxygen. Your oxidative capacity relies on your mitochondria's ability to produce ATP by consuming that oxygen inside the cell.

As noted by Patrick, "You want your ATP production to exceed your ATP consumption, in order to enhance or maximize your performance and avoid muscle fatigue."

You can increase your oxidative capacity in two ways:

- **Increasing the total number of mitochondria in your cells** by engaging in high intensity interval exercises. However, in order for new mitochondria to be created, *you must have sufficient amounts of magnesium*.
- **Increasing the efficiency of your mitochondria** to repair damage and produce ATP. This process also requires magnesium as a co-factor.

Common Causes for Magnesium Deficiency

A century ago, we were getting an estimated 500 milligrams (mg) of magnesium from the food we ate, courtesy of the nutrient-rich soil in which it was grown. Today, estimates suggest we're only getting 150 to 300 mg a day from our food supply.

As noted by Patrick, eating a diet rich in calories and poor in micronutrients (read processed foods) is a primary risk factor for magnesium deficiency, for the simple reason that magnesium resides at the center of the chlorophyll molecule.

Chlorophyll, as you may know, is what gives plants their green color. Most Americans eat far too few fruits and vegetables, which may explain why more than half of the American public is deficient in magnesium.

In addition to not getting sufficient amounts from your diet, magnesium is also lost through stress, lack of sleep, alcohol consumption, and prescription drug use (especially diuretics, statins, fluoride and fluoride-containing drugs such as fluoroquinolone antibiotics).

Magnesium levels can also decline in the presence of certain hormones, such as estrogen. If you have elevated insulin levels — which an estimated 80 percent of Americans do — you're quite likely to have low magnesium levels.[4]

Increasing your magnesium intake may actually go a long way toward improving your condition, or warding off insulin resistance and diabetes in the first place. In one study,[5] prediabetics with the highest magnesium intake reduced their risk for blood sugar and metabolic problems by 71 percent.

A second study[6] also found that higher magnesium intake reduces the risk of impaired glucose and insulin metabolism and slows progression from pre-diabetes to diabetes.

According to the authors, "Magnesium intake may be particularly beneficial in offsetting your risk of developing diabetes, if you are high risk." The mechanism by which magnesium controls glucose and insulin homeostasis appears to involve two genes responsible for magnesium homeostasis.[7]

Magnesium is also required to activate tyrosine kinase, an enzyme that functions as an "on" or "off" switch in many cellular functions and is required for the proper function of your insulin receptors. Last but not least, digestive problems such as Crohn's disease and leaky gut impair your body's ability to absorb magnesium, which is yet another cause of inadequate magnesium levels.

As noted by Dr. Dean, it's quite possible that magnesium insufficiency is part of why health problems such as heart disease, diabetes, and high blood pressure are so prevalent these days. It may also play a role in fibromyalgia,[8] magnesium deficiency is a well-recognized factor in migraines.[9]

How to Identify Magnesium Deficiency

Unfortunately, there's no lab test that will give you a truly accurate reading of your magnesium status. The reason for this is that only 1 percent of the magnesium in your body is found in your blood; 50 to 60 percent resides in your bones, and the remaining is in your soft tissues.

Since most of your magnesium is stored *inside your cells and bone* rather than in blood plasma, there are no satisfactory blood tests for assessing it. That said, some specialty labs do provide an RBC magnesium test which is reasonably accurate.

Other tests your doctor may use to evaluate your magnesium status include a 24-hour urine test or a sublingual epithelial test. Still, these can only give you an estimate of your levels, and doctors typically need to evaluate them in light of the symptoms you exhibit.

Early signs of magnesium deficiency may include headaches, loss of appetite, nausea and vomiting, fatigue, or weakness. More chronic magnesium deficiency can lead to far more serious symptoms such as:

- Abnormal heart rhythms and coronary spasms
- Muscle cramps and contractions
- Seizures
- Numbness and tingling
- Personality changes

These signs and symptoms are by no means an exhaustive list. In her book, "The Magnesium Miracle," Dr. Carolyn Dean lists no less than 100 factors that will help you decide whether or not you might be deficient.

You can also follow the instructions in her blog post, "Gauging Magnesium Deficiency Symptoms,"[10] which will give you a check list to go through every few weeks. This will help you gauge how much magnesium you need to resolve your deficiency symptoms.

Your Best Source of Magnesium: REAL Food

You could theoretically keep your magnesium levels in the therapeutic range without resorting to supplements simply by eating a varied diet, including plenty of dark-green leafy vegetables. One way to really increase your magnesium, as well as many other important plant-based nutrients, is by juicing your greens.

That said, it's important to remember that the magnesium content of your foods depends on the richness of magnesium in the soil in which the plant was grown.

Most soils have become severely depleted of nutrients, and for this reason, some magnesium experts, including Dr. Dean, believe that virtually everyone needs to take supplemental magnesium. Organic foods may have more magnesium if grown in nutrient-rich soils, but it is very difficult to make that determination. If you eat organic whole foods and have no signs of deficiency, you're probably doing quite alright.

But regardless of how seemingly healthy your diet is, if you have symptoms of magnesium deficiency, you'd be wise to add a supplement, which I'll cover in the next section. Based on data collected by GreenMedInfo[11] and The World's Healthiest Foods,[12] the following are among the richest food sources of magnesium:

Dried seaweed, agar	Rice bran	Herbs and spices: basil, coriander, chives, cumin seed, parsley, mustard seeds, and fennel
Nuts: Brazil nuts, cashews, and almond butter	Seeds: pumpkin seeds, flaxseed, sesame seeds, and sunflower seeds	Unsweetened cocoa powder
Whey, sweet or dried	Leafy greens: spinach, Swiss chard, turnip greens, beet greens, collard greens, broccoli, Brussel sprouts, and romaine lettuce	Quinoa, buckwheat, brown rice, millet, oats, rye, and wheat
Beans: black beans, navy beans, pinto beans, lima beans, and kidney beans	Squash: summer and winter squash	Fruits and berries: papaya, raspberries, tomato, cantaloupe, strawberries, and watermelon

Suggested Dosages and Other Recommendations When Taking Magnesium Supplements

The recommended dietary allowance (RDA) for magnesium[13] ranges from 310 to 420 mg per day, depending on your age and sex. However, as noted by Dr. Dean, some researchers believe we may need anywhere from 600 to 900 mg/day for optimal health.

There's certainly many reasons for making sure you're above the RDA, and fortunately, magnesium is quite safe so you don't have to worry about taking too much. Dr. Dean suggests using your intestinal reaction as a marker for your ideal dose. She recommends starting out at 200 mg of oral magnesium citrate per

day, and gradually increase your dose until you develop slightly loose stools.

This is your personal cutoff point, as when your body has too much magnesium it simply flushes it out the other end. Magnesium citrate is known for having a laxative effect, which is why it's recommended in this case.

You may reach 600 mg/day before you notice a change in your bowel movements, or it may occur at a much lower dose — it depends on how much magnesium you're getting from your diet. Keep in mind that it's better to divide your dose and take it two or three times a day rather than taking one large dose.

Besides magnesium citrate, there are a variety of other magnesium supplements on the market. I personally prefer magnesium threonate, as it seems to penetrate cell membranes, including your mitochondria, which results in higher energy levels.

It also penetrates your blood-brain barrier and may help improve memory. The following table summarizes some of the differences between the various forms. Whichever supplement you choose, avoid those containing magnesium stearate, a common but potentially hazardous additive.

Magnesium glycinate is a chelated form of magnesium that tends to provide the highest levels of absorption and bioavailability and is typically considered ideal for those who are trying to correct a deficiency	**Magnesium oxide** is a non-chelated type of magnesium, bound to an organic acid or a fatty acid. Contains 60 percent magnesium, and has stool softening properties
Magnesium chloride / Magnesium lactatecontains only 12 percent magnesium, but has better absorption than others, such as magnesium oxide, which contains five times more magnesium	**Magnesium sulfate / Magnesium hydroxide** (milk of magnesia) are typically used as a laxative. Be aware that it's easy to overdose on these, so ONLY take as directed
Magnesium carbonate, which has antacid properties, contains 45 percent magnesium	**Magnesium taurate** contains a combination of magnesium and taurine, an amino acid. Together, they tend to provide a calming effect on your body and mind
Magnesium citrate is magnesium with citric acid, which has laxative properties	**Magnesium threonate** is a newer, emerging type of magnesium supplement that appears promising, primarily due to its superior ability to penetrate the mitochondrial membrane, and may be the best magnesium supplement on the market

Other Important Nutrients That Work in Tandem with Magnesium

One of the major benefits of getting your nutrients from a varied whole food diet is that you're less likely to end up with unbalanced nutrient ratios. When it comes to magnesium, calcium, vitamin D, and K2 also come into play. These four nutrients work together synergistically, with one supporting the other. All of them are needed in order for each individual nutrient to perform properly.

- An appropriate magnesium to calcium ratio is thought to be 1:1. Excessive amounts of calcium without the counterbalance of magnesium can lead to heart attacks, strokes, and sudden death. If you're calcium deficient, your best bet is to increase consumption of foods high in calcium before opting for a supplement. This is because many high calcium foods also contain naturally high amounts of vitamin K2.

Nature cleverly gives us these two nutrients in combination, so they work optimally. Good sources of calcium include nuts, seeds, and dairy, especially cheeses and vegetables, although veggies aren't high in K2. One exception is fermented vegetables where a starter culture specifically designed to produce ample amounts of K2 was used.

Homemade bone broth is another excellent source. Simply simmer leftover bones over low heat for an entire day to extract the calcium from the bones. You can use this broth for soups, stews, or drink it straight.

- For vitamin D, you want to be in the optimal range of 50 to 70 ng/ml. Sensible sun exposure is the ideal way to optimize your levels, but a tanning bed and/or vitamin D3 supplement (and to a lesser degree certain foods) can also be used during winter months when you're unlikely to produce enough vitamin D from sun exposure.
- The optimal amounts of vitamin K2 are still under investigation, but it seems likely that 180 to 200 micrograms (mcg) of vitamin K2 might be enough to activate your body's K2-dependent proteins to shuttle calcium to the proper areas.

Boost Magnesium to Optimize Your Health and Energy Levels

The evidence is clear: if you want to optimize your mitochondrial function, metabolism, and reduce your risk for type 2 diabetes and cardiovascular disease, one of the things you need to do is consume adequate magnesium. Magnesium also plays a role in your body's detoxification processes and therefore is important for helping to prevent damage from environmental chemicals, heavy metals, and other toxins.

Even glutathione, your body's most powerful antioxidant that has even been called "the master antioxidant," requires magnesium for its synthesis. Your need for magnesium can be magnified by factors such as age, stress, lack of sleep, alcohol consumption, insulin resistance and diabetes, prescription drug use, an unbalanced gut microbiome, poor kidney function, and more.

Among the most common symptoms that your body is lacking in magnesium are "Charlie horses" (the muscle spasm that occurs when you stretch your legs), muscle or coronary spasms, fatigue, nausea, and headaches or migraines.

These are all warning signs indicating you probably need to boost your magnesium intake, either through your diet or through a magnesium supplement. For more details, please see Dr. Dean's blog post, "Gauging Magnesium Deficiency Symptoms."[14]

While it's best to get your magnesium from your diet, most foods are deficient in magnesium and other minerals due to being grown in mineral-depleted soils. Fertilizers like glyphosate also act as chelators, effectively blocking the uptake and utilization of minerals.

As a result, I believe it would be prudent for most people to consider a magnesium supplement. This is my personal strategy even though I have access to organic foods.

Another way to improve your magnesium status is to take regular Epsom salt baths or foot baths. Epsom salt is a magnesium sulfate that can absorb into your body through your skin. Magnesium oil can also be used for topical application and absorption.

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