




**Micronutrients:
Magnesium**

Dr. Ritamarie Loscalzo

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Magnesium General Info

- ✓ Essential macro mineral
- ✓ Very frequently deficient in modern diet
- ✓ Vital for over 325 enzymes in human body

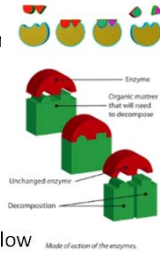


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INE: Micronutrients - Minerals: Magnesium

Magnesium and Enzyme Regulation

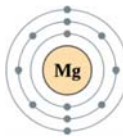
- ✓ Energy production, transport, storage and utilization
- ✓ Nerve conduction
- ✓ Heart and skeletal muscle contraction
- ✓ Skeletal strength
- ✓ DNA and RNA synthesis
- ✓ Cell reproduction and growth
- ✓ Heart activity
- ✓ Neuromuscular transmission
- ✓ Blood pressure and peripheral blood flow
- ✓ Entry and release of calcium from the cells



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Magnesium Functions

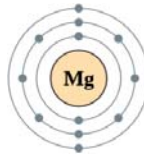
- ✓ Catalyst in enzyme activity, especially in energy production
- ✓ Assists in calcium and potassium uptake
- ✓ Necessary to prevent the calcification of soft tissue
- ✓ Protects the arterial linings from stress caused by sudden blood pressure changes
- ✓ Plays a role in the formation of bone
- ✓ Important in carbohydrate metabolism and insulin sensitivity
- ✓ Helps reduce and dissolve calcium phosphate kidney stones, and may prevent calcium-oxalate kidney stones (Along with vitamin B6)



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Magnesium Functions – Part 2

- ✓ May reduce cholesterol levels
- ✓ Effective in preventing premature labor and convulsions in pregnant women
- ✓ Activating muscles and nerves
- ✓ Creating energy in your body by activating adenosine triphosphate (ATP)
- ✓ Helping digest proteins, carbohydrates, and fats
- ✓ Serving as a building block for RNA and DNA synthesis
- ✓ It's also a precursor for neurotransmitters like serotonin

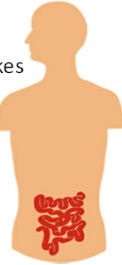


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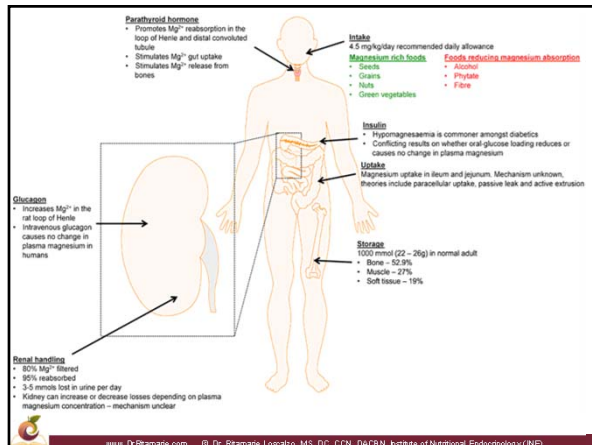
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Magnesium Absorption

- ✓ Mainly in distal jejunum and ileum
- ✓ Absorbed via active transport at low intakes
- ✓ Absorbed via diffusion at higher levels
- ✓ Some absorption may occur in large intestine
- ✓ 40-60% of ingested magnesium is absorbed with regular intake.
- ✓ 11-35% is absorbed at higher intakes of 550 to 850 mg
- ✓ Up to 75% absorbed when deficiency occurs



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Intake
4.5 mg/kg/day recommended daily allowance
Magnesium rich foods:
• Grains
• Nuts
• Green vegetables
Foods reducing magnesium absorption:
• Alcohol
• Phytate
• Fibre

Intestinal
• Hypomagnesaemia is common amongst diabetics
• Conflicting results on whether oral glucose loading reduces or causes no change in plasma magnesium

Uptake
Magnesium uptake in ileum and jejunum. Mechanism unknown, theories include paracellular uptake, passive leak and active extrusion

Storage
1000 mmol (22 - 26g) in normal adult
• Bone - 52.9%
• Muscle - 27%
• Soft tissue - 19%

Excretion
• Increases Mg^{2+} in the rat loop of Henle
• Intravenous glucagon causes no change in plasma magnesium in humans

Renal handling
• 80% Mg^{2+} filtered
• 95% reabsorbed
• 3-5 mmol lost in urine per day
• Kidney can increase or decrease losses depending on plasma magnesium concentration - mechanism unclear

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Influences on Magnesium Absorption

<u>Decreases Mg Absorption</u>	<u>Increases Mg Absorption</u>
✓ Phytates	✓ Protein in a moderate amount. Too much can inhibit.
✓ Oxalates	✓ Vitamin D3
✓ Non-fermentable fiber	✓ Vitamin B1 (thiamine)
✓ Steatorrhea (fatty acids bind to form soap)	✓ Selenium
✓ High Calcium intake	✓ Vitamin E
✓ High Phosphorus intake (forms $Mg(PO_4)_2$ and renders both not absorbable)	✓ Vitamin B6

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INE: Micronutrients - Minerals: Magnesium

Things That Deplete Magnesium

- ✓ Gluten
- ✓ Processed and overly cooked foods – they strip minerals from the body.
- ✓ Alcohol
- ✓ Herbicides and pesticides
- ✓ Refined sugar, corn syrup and artificial sweeteners.
- ✓ Prolonged stress
- ✓ table salt
- ✓ Tap water - sodium fluoride
- ✓ Unfermented soy products.
- ✓ Regular and decaffeinated coffee or black tea
- ✓ Excess zinc and Vitamin D



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Magnesium Nutrient Interactions: Zinc

- ✓ High doses of zinc in supplemental form interfere with the absorption of magnesium.
- ✓ One study reported that zinc supplements of 142 mg/day in healthy adult males significantly decreased magnesium absorption and disrupted magnesium balance



Spencer H, Norris C, Williams D. Inhibitory effects of zinc on magnesium balance and magnesium absorption in man. *J Am Coll Nutr.* 1994;13(5):479-484. [\[PubMed\]](#)



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Magnesium Nutrient Interactions: Protein

- ✓ Magnesium absorption was lower when protein intake was less than 30 grams/day in adolescent boys.
- ✓ Higher protein intakes (93 grams/day vs. 43 grams/day) were associated with improved magnesium absorption in adolescents




Schwartz R, Walker G, Linz MD, MacKellar I. Metabolic responses of adolescent boys to two levels of dietary magnesium and protein. I. Magnesium and nitrogen retention. *Am J Clin Nutr.* 1973;26(5):510-518.



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Cause of Magnesium Deficiency


- ✓ Deficient soil
- ✓ Processed foods
- ✓ Fluoride in water
- ✓ Food antagonists – high protein, tannins, oxalates, phytate
- ✓ Excess mineral antagonists – calcium, phosphorus
- ✓ Drugs
- ✓ Deficient vitamin D



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Impact of Magnesium Deficiency


- ✓ Anxiety and panic attacks – adrenals
- ✓ Asthma – bronchial spasms and histamine
- ✓ Blood clots – blood becomes thicker
- ✓ Bowel disease – slower bowel function
- ✓ Cystitis (bladder infection) – bladder spasms
- ✓ Diabetes and blood sugar imbalances – glucose transport into cells
- ✓ Fatigue – important in Krebs cycle – glycolysis
- ✓ Irritability and nervousness
- ✓ Diabetes/insulin resistance



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Impact of Magnesium Deficiency

- ✓ Heart disease – heart contraction, even fatal arrhythmias
- ✓ Hypertension – blood vessel spasm
- ✓ Insomnia – melatonin deficiency
- ✓ Kidney disease and kidney stones
- ✓ Migraine – serotonin related, muscle spasms
- ✓ Fibromyalgia
- ✓ Muscle cramping and spasms
- ✓ Vertigo
- ✓ Interferes with the transmission of nerve and muscle impulses



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Impact of Magnesium Deficiency

- ✓ Osteoporosis
- ✓ Raynaud's
- ✓ Tooth decay
- ✓ Complications of pregnancy
 - preeclampsia
- ✓ PMS and menstrual cramps
- ✓ Mental confusion
- ✓ Depression – serotonin is magnesium dependent
- ✓ Slow detoxification



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Magnesium Deficiency Signs from Nutrient Assessment Chart

- | | | |
|-----------------------------------------|------------------------------------------------------------------------------------|---------------------------------------------------|
| <input type="checkbox"/> Anxiety |  | <input type="checkbox"/> Irregular heartbeats |
| <input type="checkbox"/> Breast cysts | | <input type="checkbox"/> Irritability |
| <input type="checkbox"/> Confusion | | <input type="checkbox"/> Irritable Bowel Syndrome |
| <input type="checkbox"/> Constipation | | <input type="checkbox"/> Muscle weakness |
| <input type="checkbox"/> Chronic stress | | <input type="checkbox"/> Nausea |
| <input type="checkbox"/> Cramps | | <input type="checkbox"/> Nervousness |
| <input type="checkbox"/> Dandruff | | <input type="checkbox"/> Noise sensitivity |
| <input type="checkbox"/> Depression | | <input type="checkbox"/> PMS |
| <input type="checkbox"/> Excess ear wax | | <input type="checkbox"/> Restlessness |
| <input type="checkbox"/> Heart attack | | <input type="checkbox"/> Spasms |
| <input type="checkbox"/> Hyperactivity | | <input type="checkbox"/> Twitching |
| <input type="checkbox"/> Insomnia | | <input type="checkbox"/> Sores around mouth |
| | | <input type="checkbox"/> Breaking nails |



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Assessing Magnesium Status

- ✓ Serum is not accurate: only 1% of magnesium is in blood
- ✓ Red and white blood cell magnesium
- ✓ Buccal Smear – EXATest – Intracellular Diagnostics
- ✓ Magnesium Challenge- IV plus 24 hour urine
- ✓ Blood Ionized magnesium
- ✓ Oral Challenge
- ✓ Spectracell
- ✓ NutrEval by Genova / Metamatrix
- ✓ Questionnaires and good history taking for signs and symptoms



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Magnesium RDA

Table 1: Recommended Dietary Allowances (RDAs) for Magnesium [1]

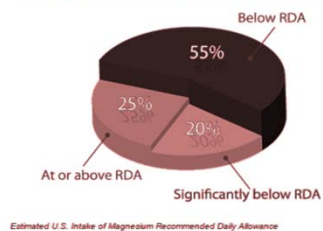
Age	Male	Female	Pregnancy	Lactation
Birth to 6 months	30 mg*	30 mg*		
7-12 months	75 mg*	75 mg*		
1-3 years	80 mg	80 mg		
4-8 years	130 mg	130 mg		
9-13 years	240 mg	240 mg		
14-18 years	410 mg	360 mg	400 mg	360 mg
19-30 years	400 mg	310 mg	350 mg	310 mg
31-50 years	420 mg	320 mg	360 mg	320 mg
51+ years	420 mg	320 mg		



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Magnesium Intake in US

U.S. Intake of Magnesium
Percent of U.S. population meeting Recommended Daily Allowance (RDA)



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Methods of Magnesium Administration

- ✓ Food and herbs
- ✓ Oral supplements – to bowel tolerance
- ✓ Topical – magnesium oil
- ✓ Intravenous
- ✓ Intramuscular




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Good Sources of Magnesium

- ✓ greens
- ✓ apples
- ✓ apricots
- ✓ avocados
- ✓ bananas
- ✓ brewer's yeast
- ✓ brown rice
- ✓ cantaloupe
- ✓ dulse
- ✓ figs
- ✓ watercress
- ✓ garlic
- ✓ grapefruit
- ✓ kelp
- ✓ lemons
- ✓ lima beans
- ✓ millet
- ✓ nuts
- ✓ peaches
- ✓ black-eyed peas
- ✓ sesame seeds



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Herbs High In Magnesium


- ✓ Alfalfa
- ✓ Bladderwrack
- ✓ Catnip
- ✓ Cayenne
- ✓ Chamomile
- ✓ Chickweed
- ✓ Dandelion
- ✓ Eyebright
- ✓ Fennel seed
- ✓ Fenugreek
- ✓ Hops
- ✓ Horsetail
- ✓ Lemongrass
- ✓ Licorice
- ✓ Mullein
- ✓ Nettle
- ✓ Oat straw
- ✓ Paprika
- ✓ Parsley
- ✓ Peppermint
- ✓ Raspberry leaf
- ✓ Red Clover
- ✓ Sage
- ✓ Shepherd's purse
- ✓ Yarrow
- ✓ Yellow dock



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Food Sources of Magnesium

Food	Serving Size	Magnesium (mg)	Food	Serving Size	Magnesium (mg)	Food	Serving Size	Magnesium (mg)
Spinach	1 cup	156.60	Oats	0.25 cup	69.03	Strawberries	1 cup	18.72
Swiss Chard	1 cup	150.50	Tofu	4 oz	65.77	Bok Choy	1 cup	18.70
Beet Greens	1 cup	97.92	Almonds	0.25 cup	61.64	Mustard Greens	1 cup	18.20
Pumpkin Seeds	0.25 cup	190.92	Papaya	1	57.96	Cumin	2 tsp	15.37
Summer Squash	1 cup	43.20	Flaxseeds	2 TBS	54.88	Parsley	0.50 cup	15.20
Turnip Greens	1 cup	31.68	Green Peas	1 cup	53.72	Watermelon	1 cup	15.20
Soybeans	1 cup	147.92	Tuna	4 oz	47.63	Mustard Seeds	2 tsp	14.80
Sesame Seeds	0.25 cup	126.36	Scallops	4 oz	41.96	Fennel	1 cup	14.79
Black Beans	1 cup	120.40	Collard Greens	1 cup	39.90	Leeks	1 cup	14.56
Quinoa	0.75 cup	118.40	Beets	1 cup	39.10	Basil	0.50 cup	13.57
Cashews	0.25 cup	116.80	Broccoli	1 cup	32.76	Cucumber	1 cup	13.52
Sunflower Seeds	0.25 cup	113.75	Brussels	1 cup	31.20	Romaine	2 cups	13.16
Navy Beans	1 cup	96.46	Raspberries	1 cup	27.06	Cauliflower	1 cup	11.16
Tempeh	4 oz	87.32	Winter Squash	1 cup	26.65	Celery	1 cup	11.11
Buckwheat	1 cup	85.68	Cabbage	1 cup	25.50	Bell Peppers	1 cup	11.04
Pinto Beans	1 cup	85.50	Asparagus	1 cup	25.20	Cloves	2 tsp	10.88
Brown Rice	1 cup	83.85	Kale	1 cup	23.40			
Lima Beans	1 cup	80.84	Green Beans	1 cup	22.50			
Millet	1 cup	76.56	Tomatoes	1 cup	19.80			
Kidney Beans	1 cup	74.34	Cantaloupe	1 cup	19.20			



<http://www.whfoods.com/genpage.php?name=nutrient&did=75>
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Forms of Magnesium Supplementation

Absorption of oral magnesium supplements vary from 4% absorbed to about 50%.

Mineral salt forms

- ✓ Bicarbonate
- ✓ Carbonate
- ✓ Chloride
- ✓ Hydroxide
- ✓ Oxide – low bioavailability – 4%
- ✓ Phosphate
- ✓ Sulfate

Acid Complexes – “Organic Salts”

- ✓ Ascorbate
- ✓ Aspartate*
- ✓ Citrate
- ✓ Fumarate
- ✓ Gluconate
- ✓ Glutamate*
- ✓ Lactate
- ✓ Malate
- ✓ Pidolate

Amino Acid Complexes – Chelates (most expensive)

- ✓ Glycinate
- ✓ Lysinate
- ✓ Orotate
- ✓ Taurate



*Magnesium aspartate and glutamate break down into neurotransmitters that, when not bound with other amino acids, are neurotoxic.

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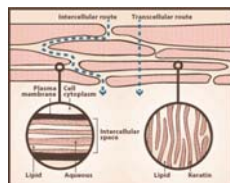
Ionic Magnesium Liquid



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Topical Magnesium

- ✓ Magnesium chloride Oil - 1 teaspoon ≈ 560 mg of elemental magnesium.
- ✓ Magnesium chloride bath flakes - 1 cup ≈ 15 g of elemental magnesium.
- ✓ Epsom salts – Magnesium sulfate – 2 cups dissolved in 15 gallons of water



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Nebulized Magnesium

- ✓ 7.5 g Magnesium per 100 ml distilled water for pulmonary infections and lung problems
- ✓ Nebulized magnesium sulfate for acute asthma attack similar in studies to effectiveness of albuterol

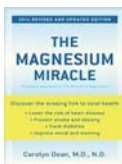
<http://medind.nic.in/iac/t05/t1/iact05i1p29g.pdf>
<http://www.ncbi.nlm.nih.gov/pubmed/9727782>



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Resources

- ✓ *Advanced Nutrition and Human Metabolism* – Gropper, Smith and Groff
- ✓ *The Magnesium Miracle*
 - Carolyn Dean, MD
- ✓ *Magnesium Factor*
 - Mildred Seelig, MD
- ✓ *Transdermal Magnesium Therapy*
 - Mark Sircus
- ✓ Linus Pauling Institute:
<http://lpi.oregonstate.edu/mic/minerals/magnesium>
- ✓ Ancient Minerals Website:
<http://www.ancient-minerals.com/magnesium-supplements/>
- ✓ Detailed article on Magnesium Function:
<http://www.uwm.edu.pl/jold/poj1532010/jurnal-16.pdf>



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