INE | INSTITUTE OF NUTRITIONAL ENDOCRINOLOGY

Micronutrients: Magnesium

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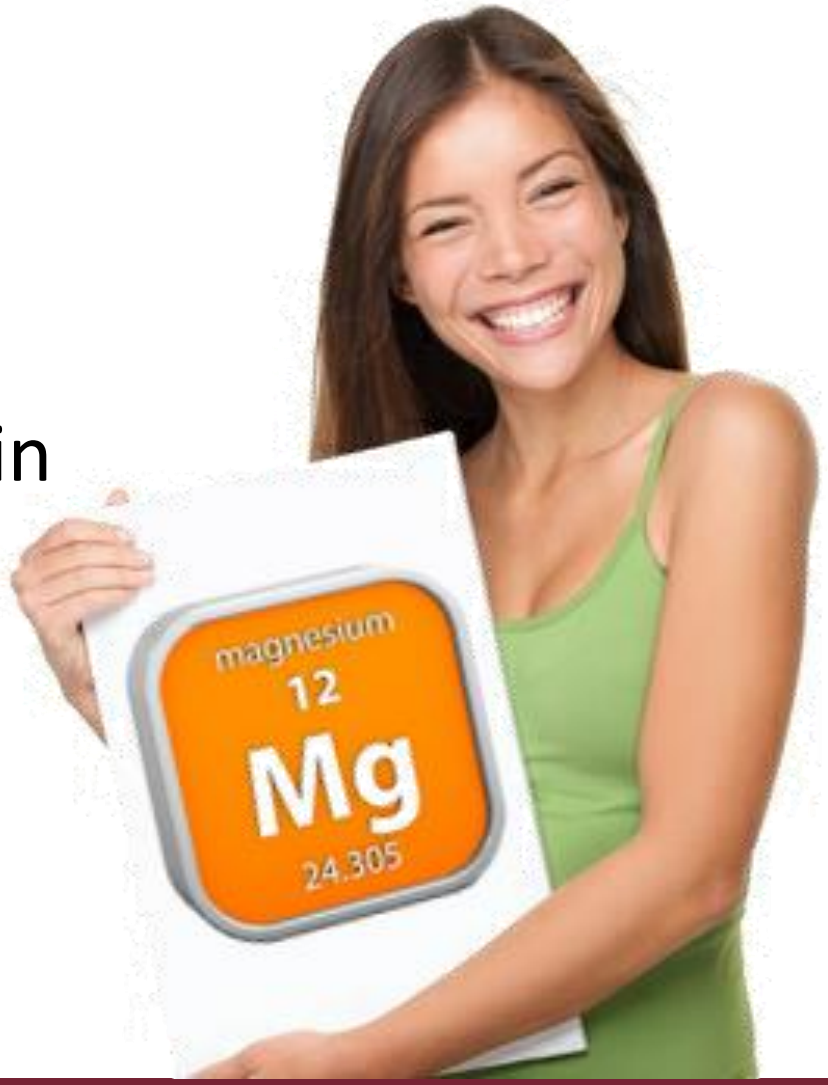
Medical Disclaimer: The information in this presentation is not intended to replace a one-on-one relationship with a qualified health care professional and is not intended as medical advice. It is intended as a sharing of knowledge and information from the research and experience of Dr. Ritamarie Loscalzo, drritamarie.com, and the experts who have contributed. We encourage you to make your own health care decisions based upon your research and in partnership with a qualified health care professional.

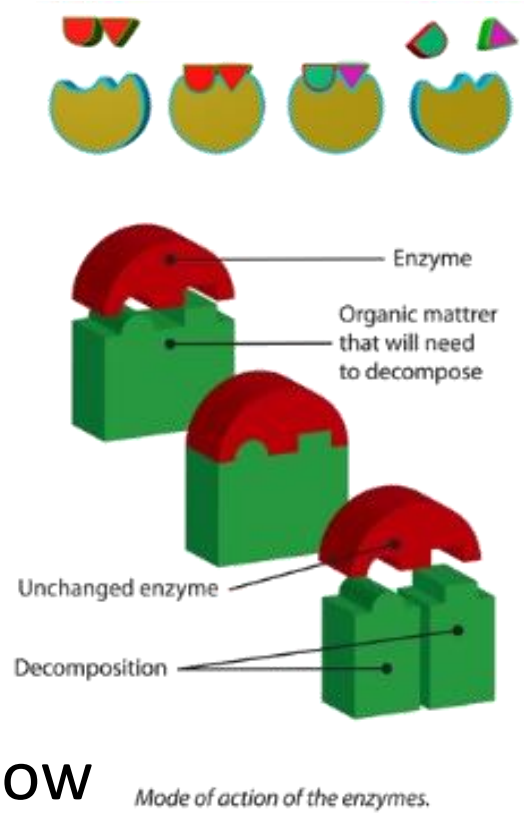
Magnesium General Info

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



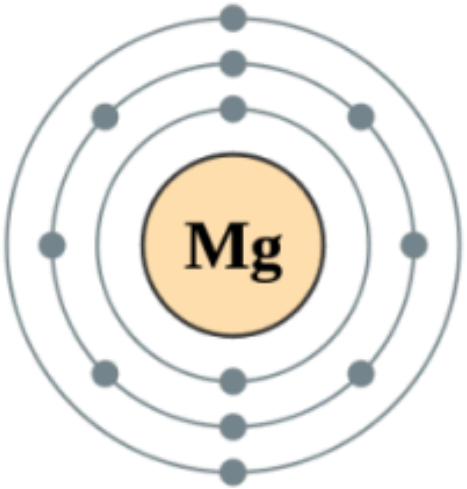
Magnesium and Enzyme Regulation

- ✓ 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



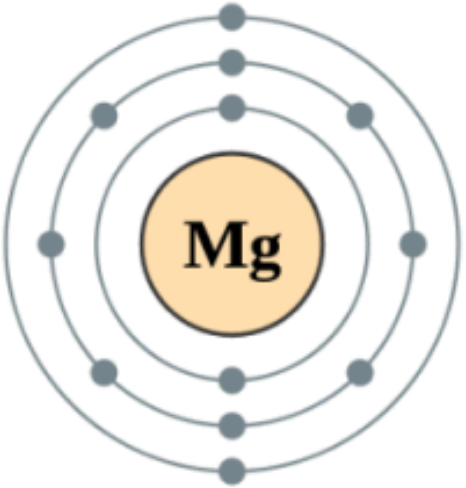
Mode of action of the enzymes.

Magnesium Functions – Part 1



- ✓ 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)

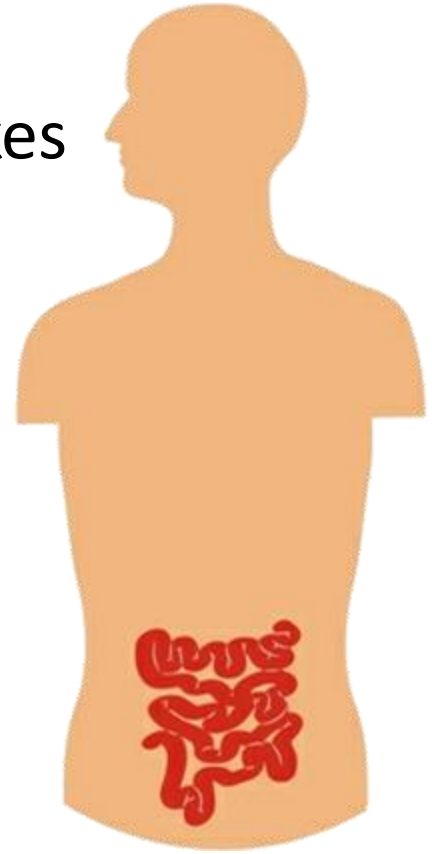
Magnesium Functions – Part 2



- ✓ 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

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



Parathyroid hormone

- Promotes Mg^{2+} reabsorption in the loop of Henle and distal convoluted tubule
- Stimulates Mg^{2+} gut uptake
- Stimulates Mg^{2+} release from bones

Intake

4.5 mg/kg/day recommended daily allowance

Magnesium rich foods

- Seeds
- Grains
- Nuts
- Green vegetables

Foods reducing magnesium absorption

- Alcohol
- Phytate
- Fibre

Insulin

- Hypomagnesaemia is commoner 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

Glucagon

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

Storage

1000 mmol (22 – 26g) in normal adult

- Bone – 52.9%
- Muscle – 27%
- Soft tissue – 19%

Renal handling

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

Influences on Magnesium Absorption

Decreases Mg Absorption

- ✓ Phytates
- ✓ Oxalates
- ✓ Non-fermentable fiber
- ✓ Steatorrhea (fatty acids bind to form soap)
- ✓ High calcium intake
- ✓ High phosphorus intake

(forms $Mg(PO_4)_2$ and renders both not absorbable)

Increases Mg Absorption

- ✓ Protein in a moderate amount; too much can inhibit
- ✓ Vitamin D3
- ✓ Vitamin B1 (thiamine)
- ✓ Selenium
- ✓ Vitamin E
- ✓ Vitamin B6

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

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)]

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.

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

Impact of Magnesium Deficiency - 1

- ✓ 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, insulin resistance, and blood sugar imbalances – glucose transport into cells
- ✓ Fatigue – important in Krebs cycle – glycolysis
- ✓ Irritability and nervousness

Impact of Magnesium Deficiency - 2

- ✓ Heart disease – heart contraction, even fatal arrythmias
- ✓ 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

Impact of Magnesium Deficiency - 3

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

Magnesium Deficiency Signs from Nutrient Assessment Chart

- ❑ Anxiety
- ❑ Breast cysts
- ❑ Confusion
- ❑ Constipation
- ❑ Chronic stress
- ❑ Cramps
- ❑ Dandruff
- ❑ Depression
- ❑ Excess ear wax
- ❑ Heart attack
- ❑ Hyperactivity
- ❑ Insomnia

- ❑ Irregular heartbeats
- ❑ Irritability
- ❑ Irritable Bowel Syndrome
- ❑ Muscle weakness
- ❑ Nausea
- ❑ Nervousness
- ❑ Noise sensitivity
- ❑ PMS
- ❑ Restlessness
- ❑ Spasms
- ❑ Twitching
- ❑ Sores around mouth
- ❑ Breaking nails

Assessing Magnesium Status

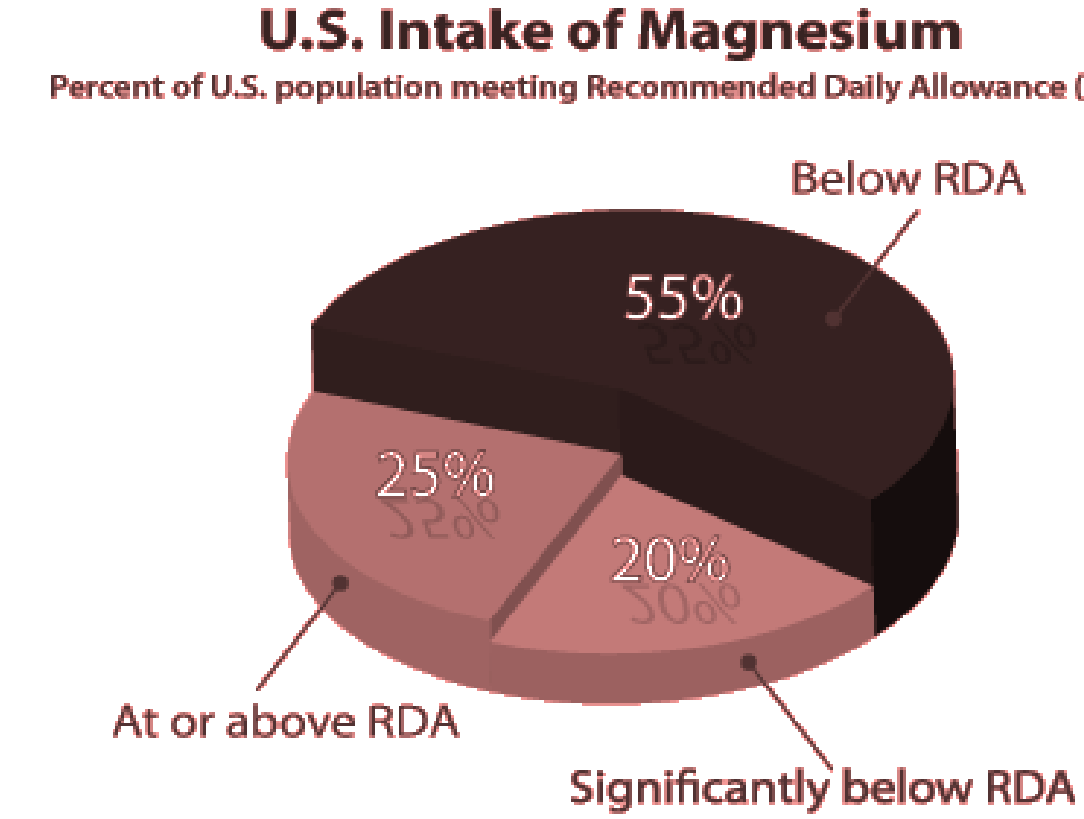
- ✓ Serum is not accurate: only 1% of magnesium is in blood
- ✓ Red and white blood cell magnesium
- ✓ Buccal smear: ExaTest – IntraCellular Diagnostics
- ✓ Magnesium challenge: IV plus 24-hour urine
- ✓ Blood ionized magnesium
- ✓ Oral challenge
- ✓ Spectracell
- ✓ NutrEval by Genova / Metametrix
- ✓ Questionnaires and good history taking for signs and symptoms

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		

Magnesium Intake in US



Estimated U.S. Intake of Magnesium Recommended Daily Allowance

Methods of Magnesium Administration

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

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

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

Food Sources of Magnesium

Food	Serving Size	Magnesium (mg)
Spinach	1 cup	156.60
Swiss Chard	1 cup	150.50
Beet Greens	1 cup	97.92
Pumpkin Seeds	0.25 cup	190.92
Summer Squash	1 cup	43.20
Turnip Greens	1 cup	31.68
Soybeans	1 cup	147.92
Sesame Seeds	0.25 cup	126.36
Black Beans	1 cup	120.40
Quinoa	0.75 cup	118.40
Cashews	0.25 cup	116.80
Sunflower Seeds	0.25 cup	113.75
Navy Beans	1 cup	96.46
Tempeh	4 oz	87.32
Buckwheat	1 cup	85.68
Pinto Beans	1 cup	85.50
Brown Rice	1 cup	83.85
Lima Beans	1 cup	80.84
Millet	1 cup	76.56
Kidney Beans	1 cup	74.34

Food	Serving Size	Magnesium (mg)
Oats	0.25 cup	69.03
Tofu	4 oz	65.77
Almonds	0.25 cup	61.64
Papaya	1	57.96
Flaxseeds	2 TBS	54.88
Green Peas	1 cup	53.72
Tuna	4 oz	47.63
Scallops	4 oz	41.96
Collard Greens	1 cup	39.90
Beets	1 cup	39.10
Broccoli	1 cup	32.76
Brussels	1 cup	31.20
Raspberries	1 cup	27.06
Winter Squash	1 cup	26.65
Cabbage	1 cup	25.50
Asparagus	1 cup	25.20
Kale	1 cup	23.40
Green Beans	1 cup	22.50
Tomatoes	1 cup	19.80
Cantaloupe	1 cup	19.20

Food	Serving Size	Magnesium (mg)
Strawberries	1 cup	18.72
Bok Choy	1 cup	18.70
Mustard Greens	1 cup	18.20
Cumin	2 tsp	15.37
Parsley	0.50 cup	15.20
Watermelon	1 cup	15.20
Mustard Seeds	2 tsp	14.80
Fennel	1 cup	14.79
Leeks	1 cup	14.56
Basil	0.50 cup	13.57
Cucumber	1 cup	13.52
Romaine	2 cups	13.16
Cauliflower	1 cup	11.16
Celery	1 cup	11.11
Bell Peppers	1 cup	11.04
Cloves	2 tsp	10.88

http://www.drritamarie.com/go/WHFoodsMagnesium

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)

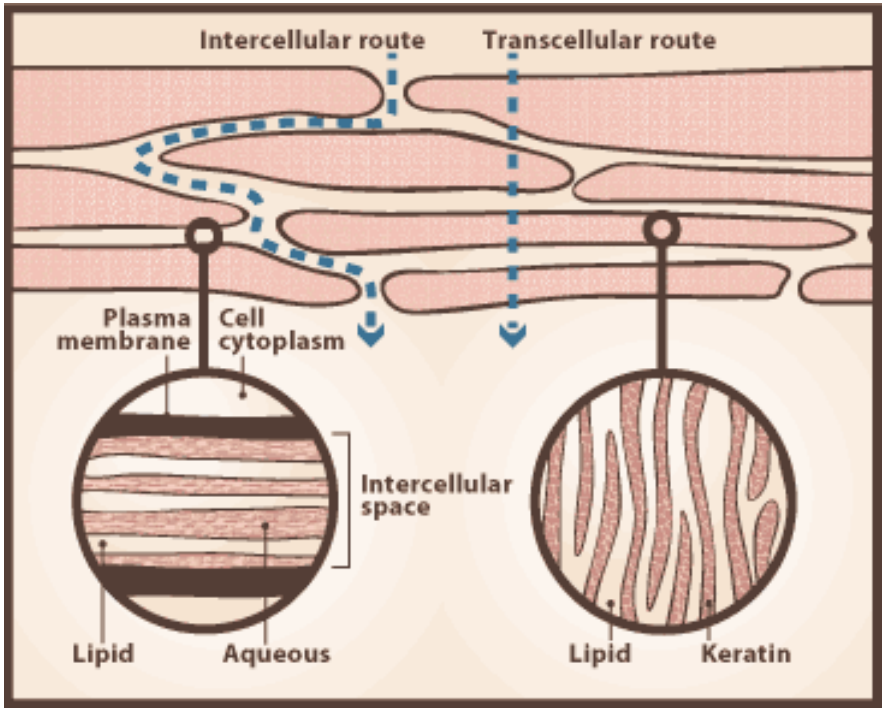
- ✓ Glycinate
- ✓ Lysinate
- ✓ Orotate
- ✓ Taurate

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

Ionic Magnesium Liquid

Topical Magnesium

- ✓ Magnesium chloride oil: 1 teaspoon ≈ 560 mg of elemental magnesium
- ✓ Magnesium chloride bath flakes: 1 cup ≈ 15 g of elemental magnesium
- ✓ Magnesium sulfate (Epsom salts): 2 cups dissolved in 15 gallons of water



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://www.drritamarie.com/go/InhaledMagnesiumSulfateAsthma
http://www.drritamarie.com/go/NebulizedMagnesiumSulphate

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://www.drritamarie.com/go/LPIMagnesium
- ✓ Ancient Minerals website: http://www.drritamarie.com/go/AMMagnesium
- ✓ Detailed article on magnesium function: http://www.drritamarie.com/go/BiochemistryOfMagnesium