營養與老化 (00070115)
Nutrition and Aging
Musculoskeletal System and Nutrition

http://www.cob.unt.edu/slides/Peak/old%203615/Homework%20Master%20Folder/Oral%203/osteo.jpg

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Learning Objectives

- **Age-related changes in musculoskeletal system**
- **Nutrition suggestions**

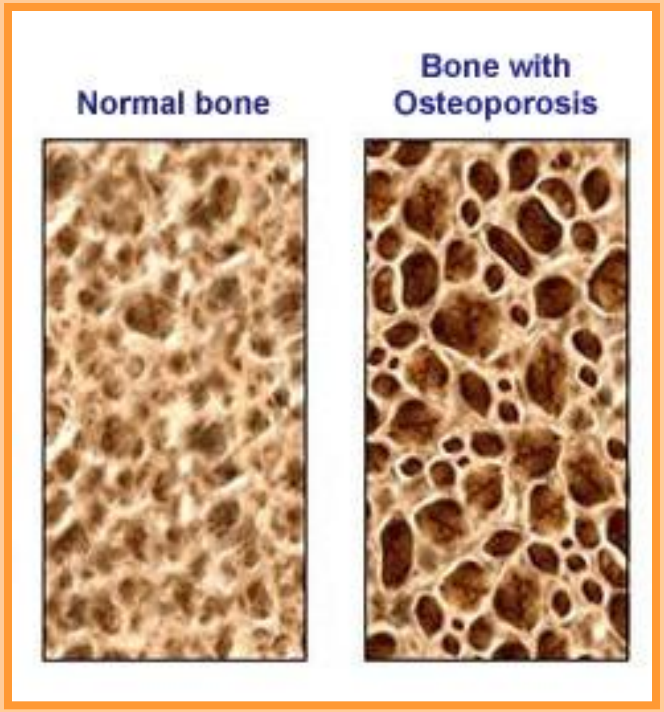
References

- **Geriatric Nutrition: The Health Professional's Handbook (2006, 3rd ed) Ronni Chernoff, Jones and Bartlett Publishers, Inc.**
- **Nutrition in Aging (1997, 3rd ed) Schlenker, ED. William C. Brown**

Age-Related Changes

- ↓ number and efficiency of muscle fibers
- low bone mass (↓ density of long bones and vertebrae)

  loss of calcium from bones



http://www.osteopathy.com.sg/articles/bone-density.html

Low Bone Mass

- **low peak bone mass**

  largely (60-70%) genetically determined

  20-30% is determined by environmental factors

  e.g. nutritional (calcium intake) and life-style (physical activity) factors can maximize the genetic potential

  ↑ 5% peak mass ⇒ ↓ 40-50% in fracture risk

- **increased bone loss**

  mature adults contain about 1200 g of calcium in their skeleton

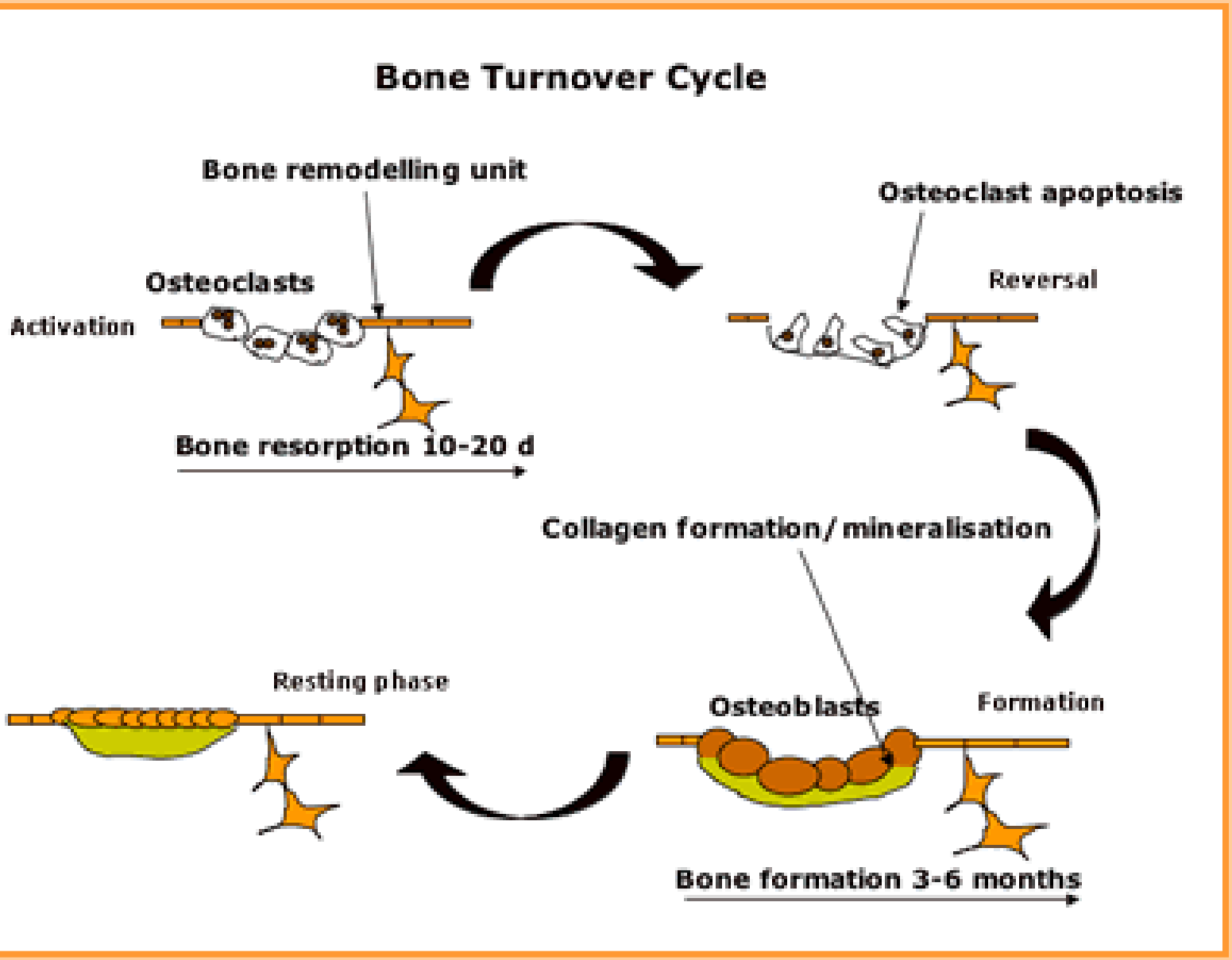
  minerals and the collagen matrix are removed more rapidly than new bone tissue is added

Cortical and Trabecular Bones

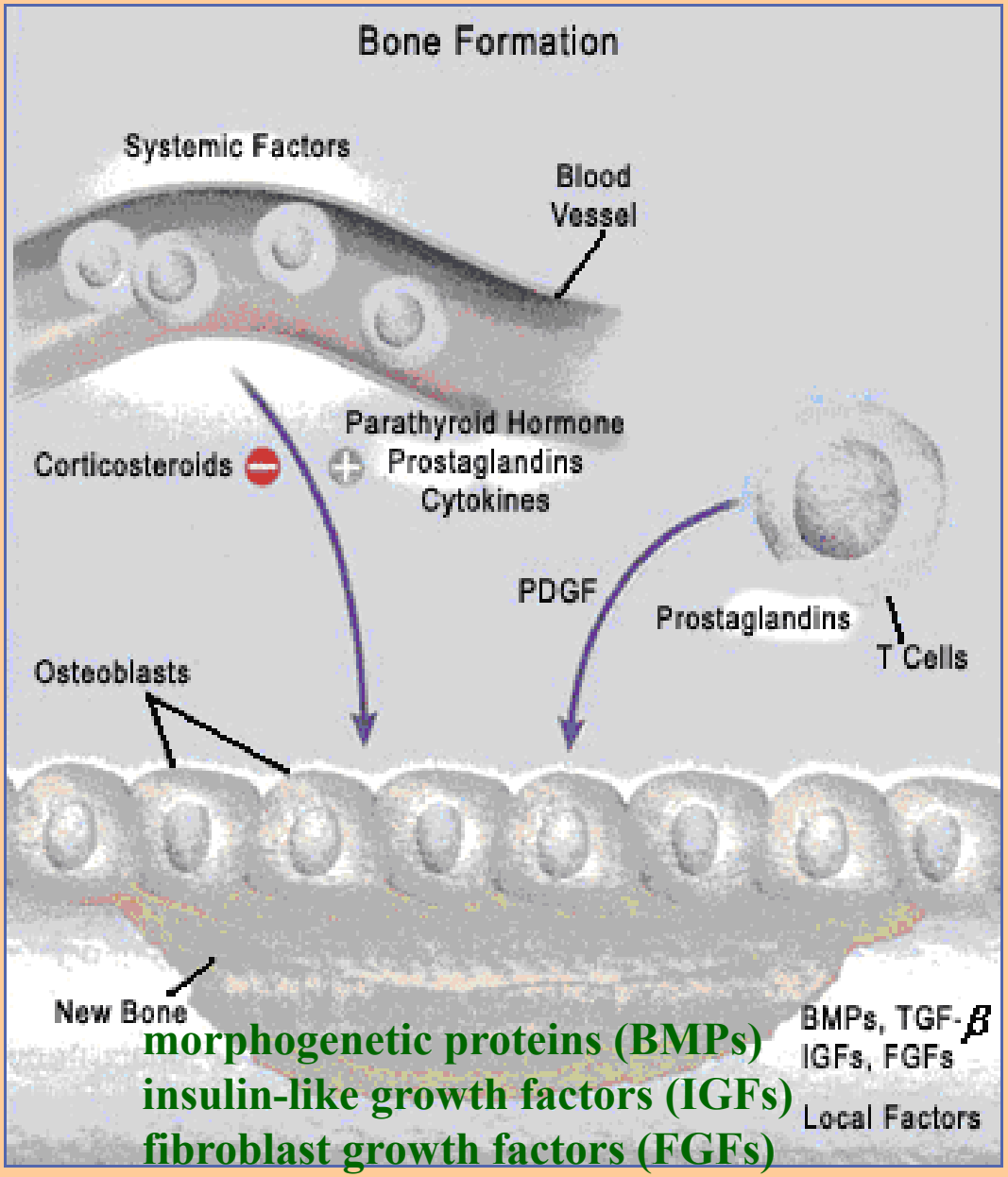
- **cortical bone is denser and more calcified than trabecular bone and is found on the outside of bones and along the length of the long bones (i.e. the arms and legs)**
- **trabecular bone is more spongy in appearance and it has a lower calcium content than cortical bone. It is primarily located at the ends of the long bones and in the spine**

  has a higher turnover rate

  more vulnerable to bone loss

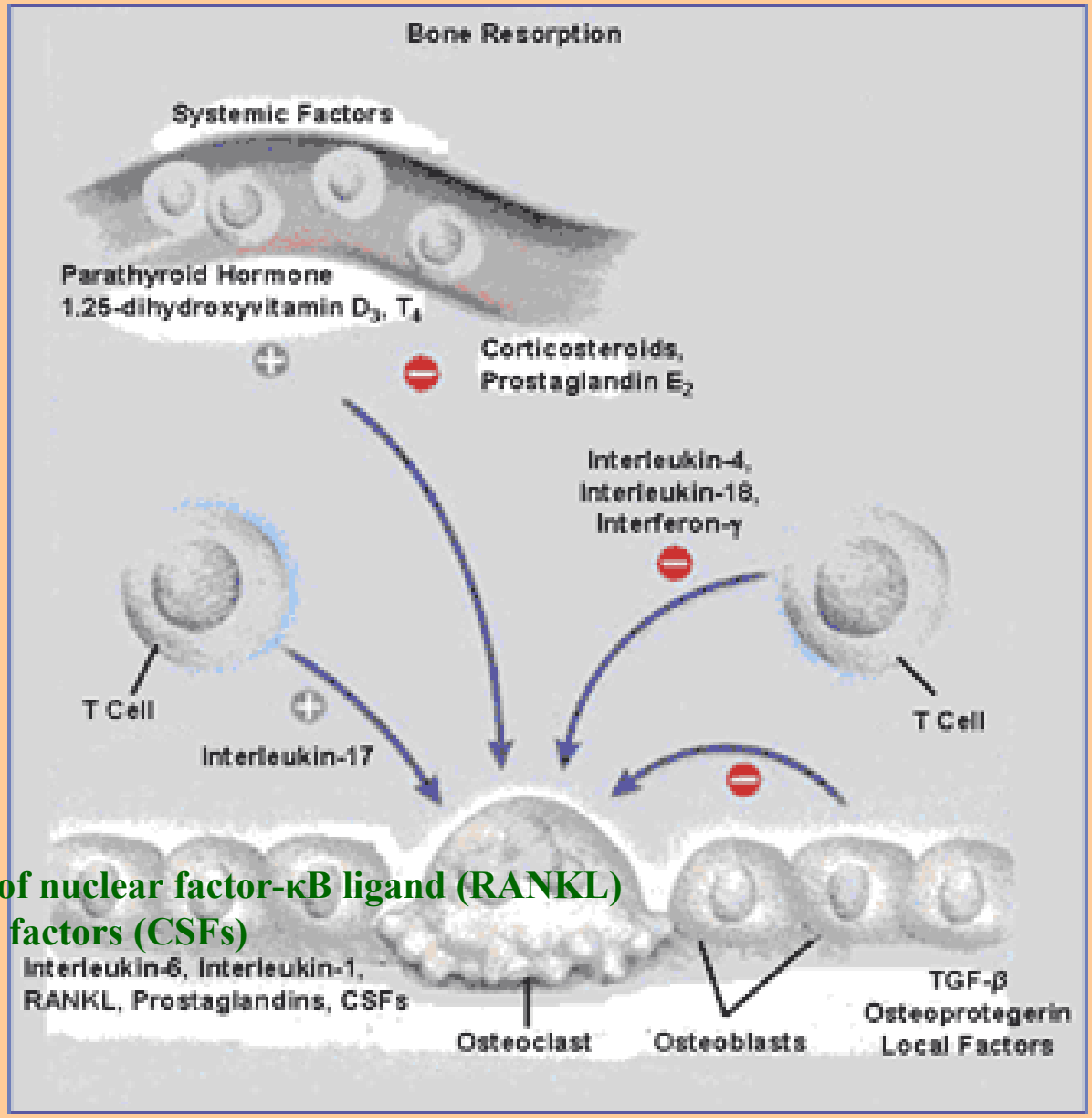


http://www.mrc-hnr.cam.ac.uk/research/bone_health/bcm.html#trabecular



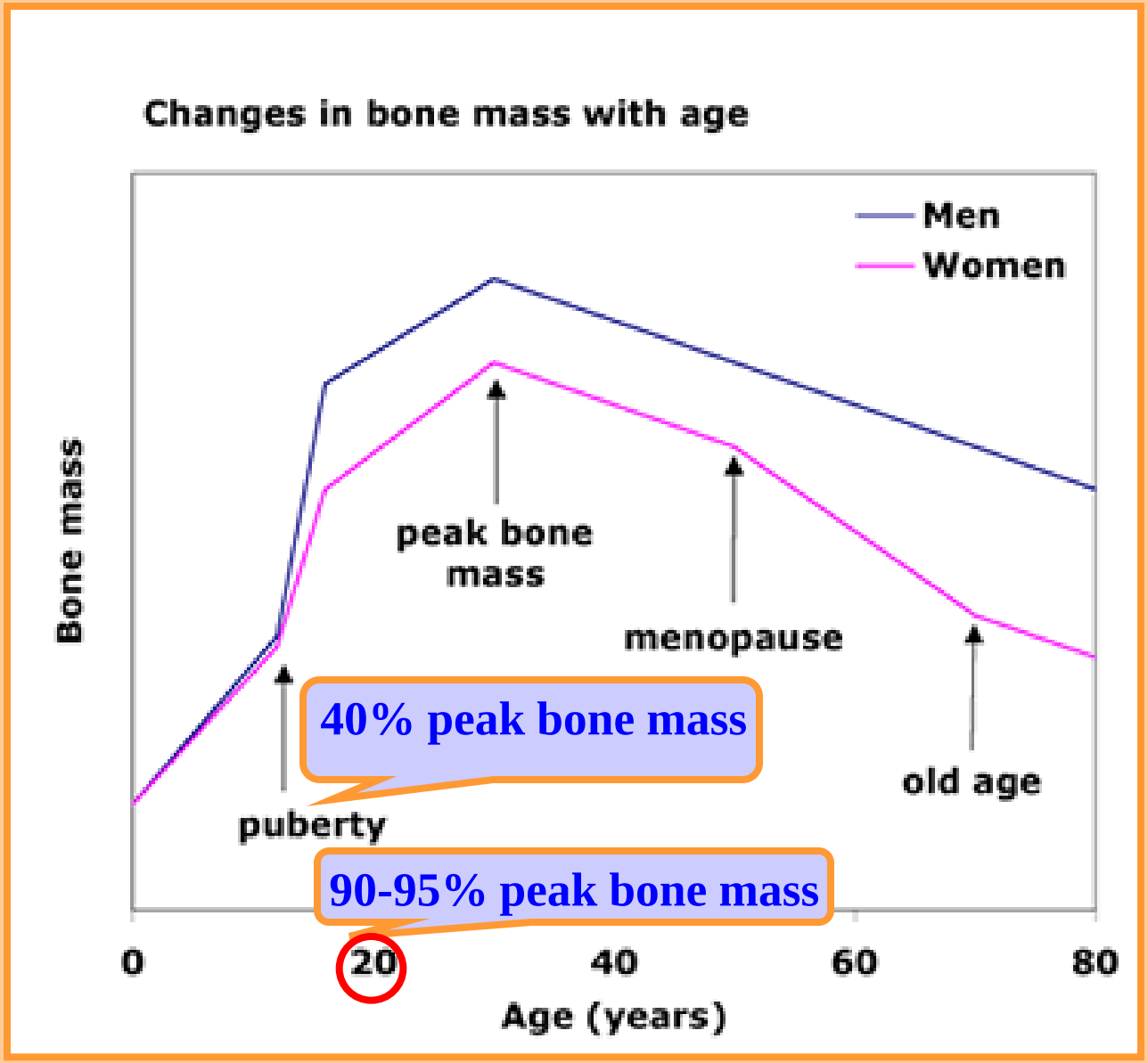
morphogenetic proteins (BMPs)
insulin-like growth factors (IGFs)
fibroblast growth factors (FGFs)

http://www.swicancer.org/healthcare/overviewbone.aspx



receptor activator of nuclear factor-κB ligand (RANKL)
colony-stimulating factors (CSFs)

http://www.swicancer.org/healthcare/overviewbone.aspx



http://www.mrc-hnr.cam.ac.uk/research/bone_health/pbm.html

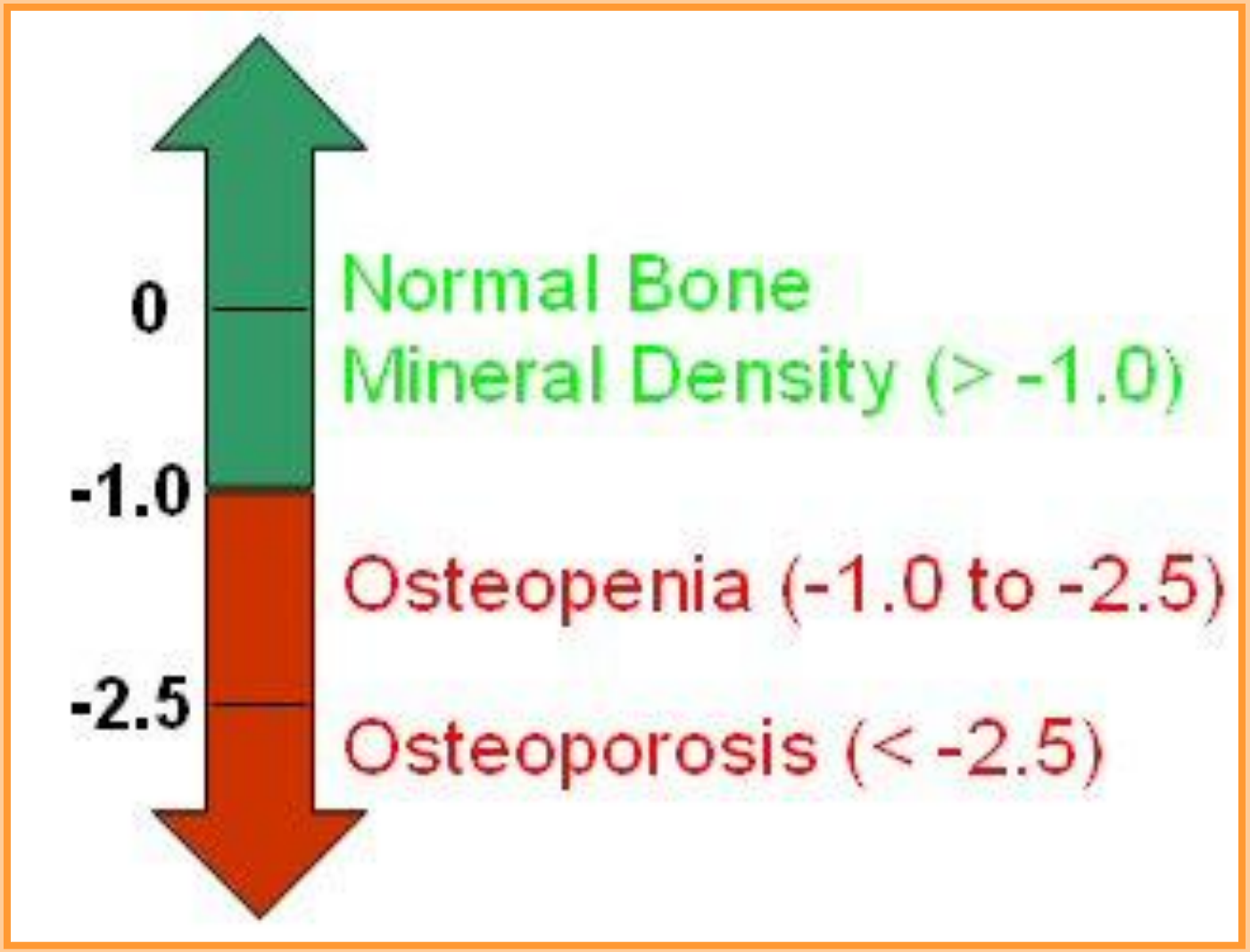
Bone Loss at Old Age

- **women have typically lost half of their trabecular and one-third of their cortical bone**

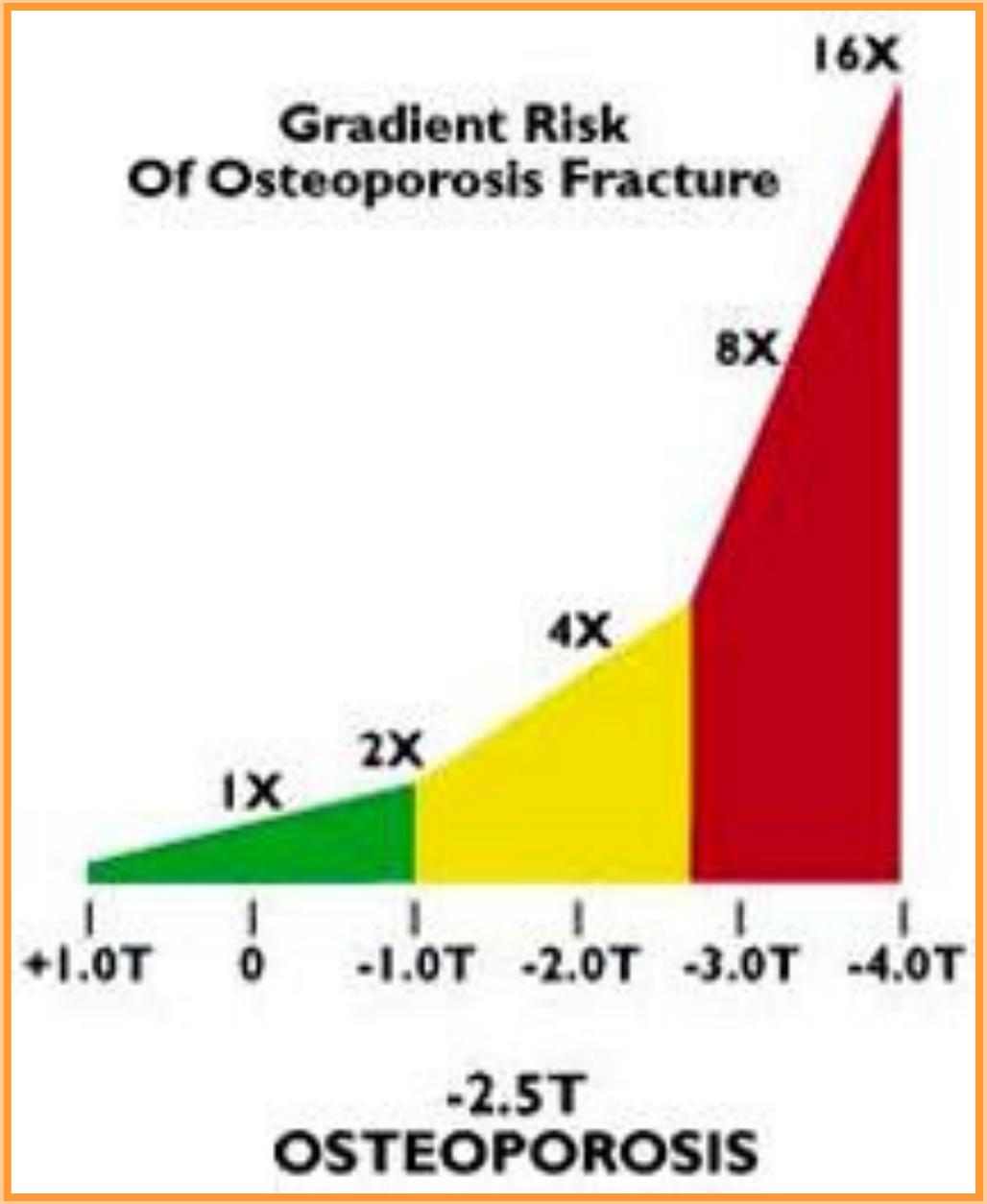
  bone loss accelerates sharply for about 5 years around the time of the menopause losses average 1–2 % per year from cortical bone and 2–3 % per year from trabecular bone

- **men typically lose one-third of trabecular bone and one-fifth of cortical bone**

Bone Mineral Density T-Score

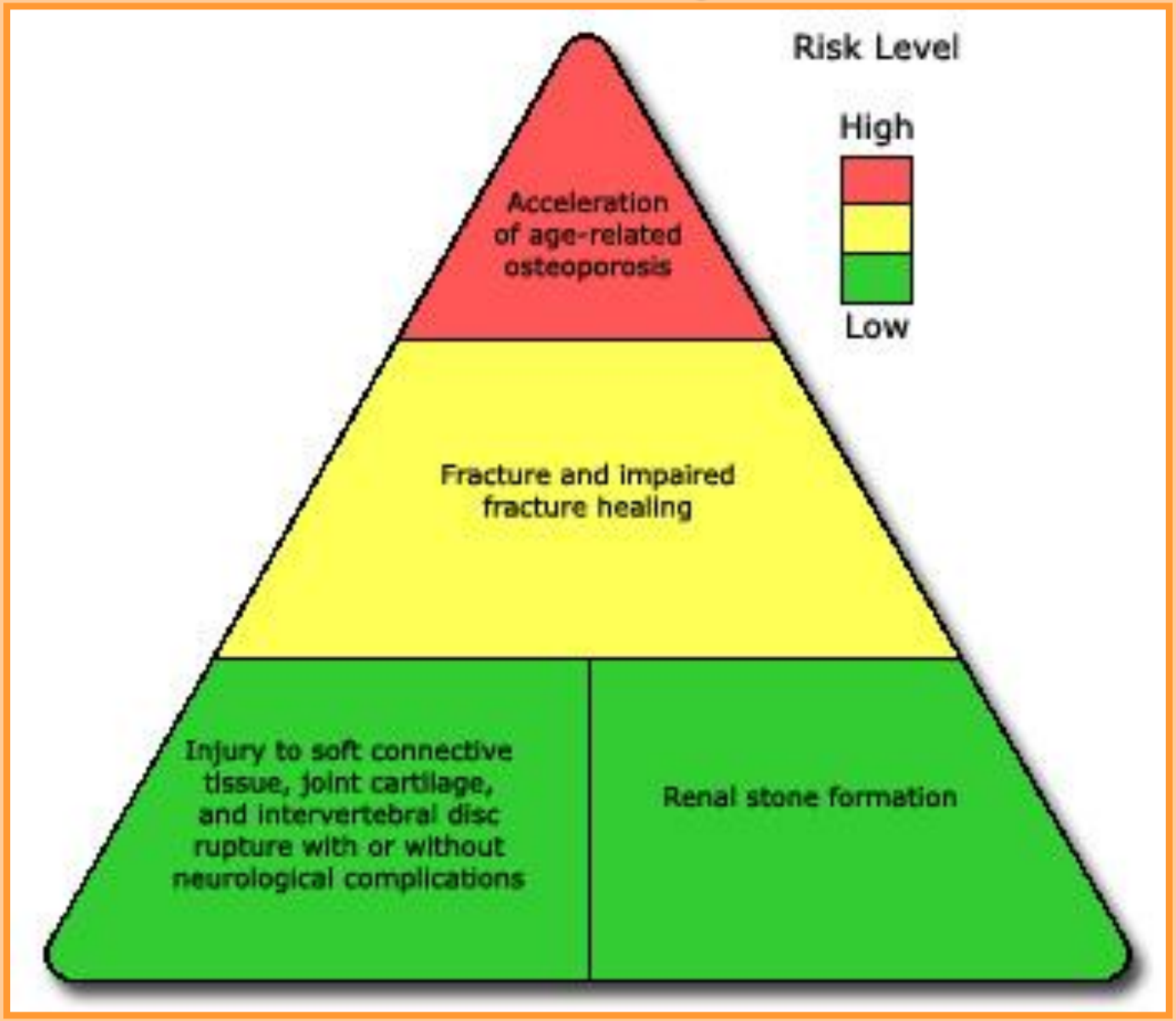


http://www.algaecal.com/images/Osteoporosis-Graph.jpg



http://www.gehealthcare.com/euen/bone-densitometry/products/osteoporosis/osteo_dens.html

Bone Loss Pyramid



http://lsda.jsc.nasa.gov/docs/research/bone.cfm

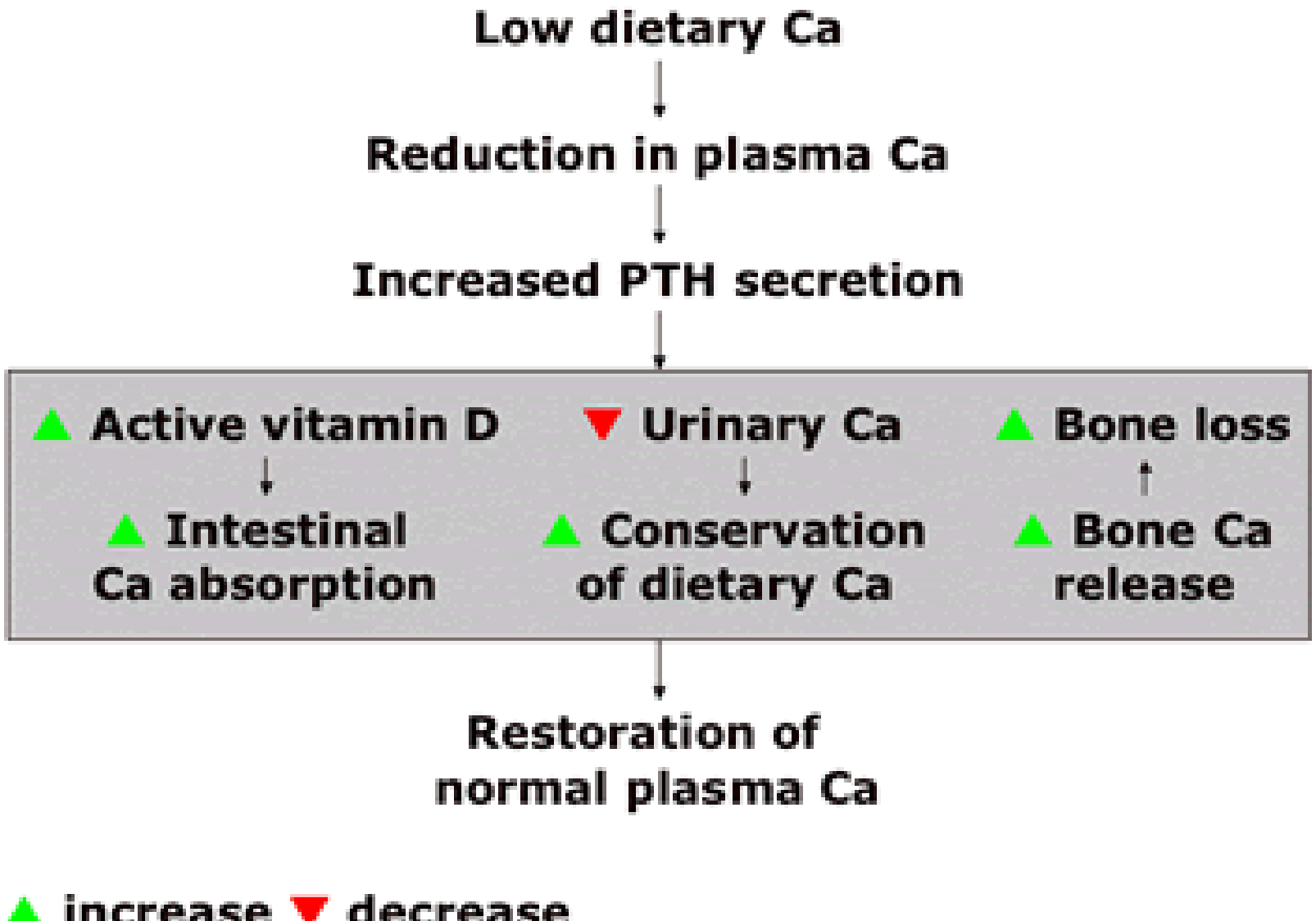
Nutritional Factor

- **high intake of calcium during childhood and adolescence ⇒ associated with higher bone mass later in life**

  produce a more positive calcium balance

  ↑ accumulation of bone

  ↓ prevalence of hip fracture
- **calcium intake shows differences of near 5%**
- **exercise shows differences of 6-8%**



http://www.mrc-hnr.cam.ac.uk/research/bone_health/bcm.html#trabecular

Increased Bone Loss in ♀

- estrogen deficiency at menopause
- low androgen production
- poor calcium absorption
- ↑ bone loss rate

  across menopause: ∴ ↓ estrogen

  after menopause: ∴ ↓ androgen

Increased Bone Loss in ♀

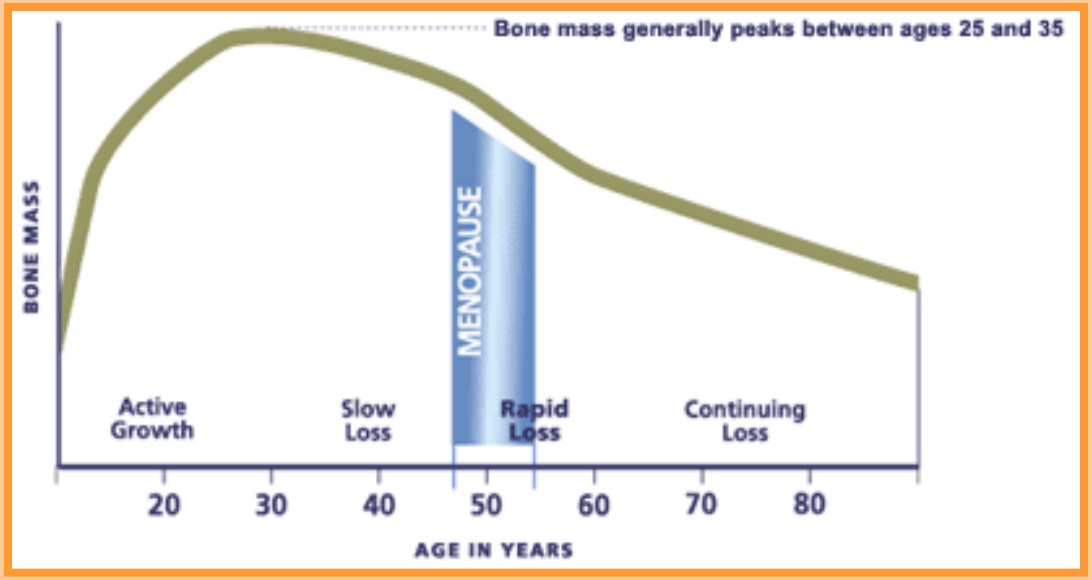
- **hormone replacement with estrogen alone or estrogen and progesterone prevents bone loss**

  estrogen supplements can have serious side effects, particularly risky for women with clotting disorders, undiagnosed vaginal bleeding, liver disease, a past history of breast cancer, or a strong family history of breast cancer

- **additional calcium may slow bone loss, esp. ♀ on a calcium intake less than 400 mg/d**

Increased Bone Loss in ♂

- **the causes of bone loss have not been well studied**
- **environmental factors (e.g. alcohol and tobacco abuse) ⇒ negative effect on bone loss**



http://www.rochestermedicalcenter.com/what_is_bone_density_testing.htm

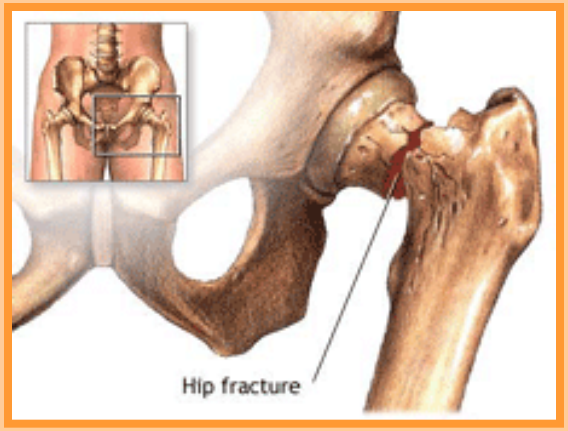
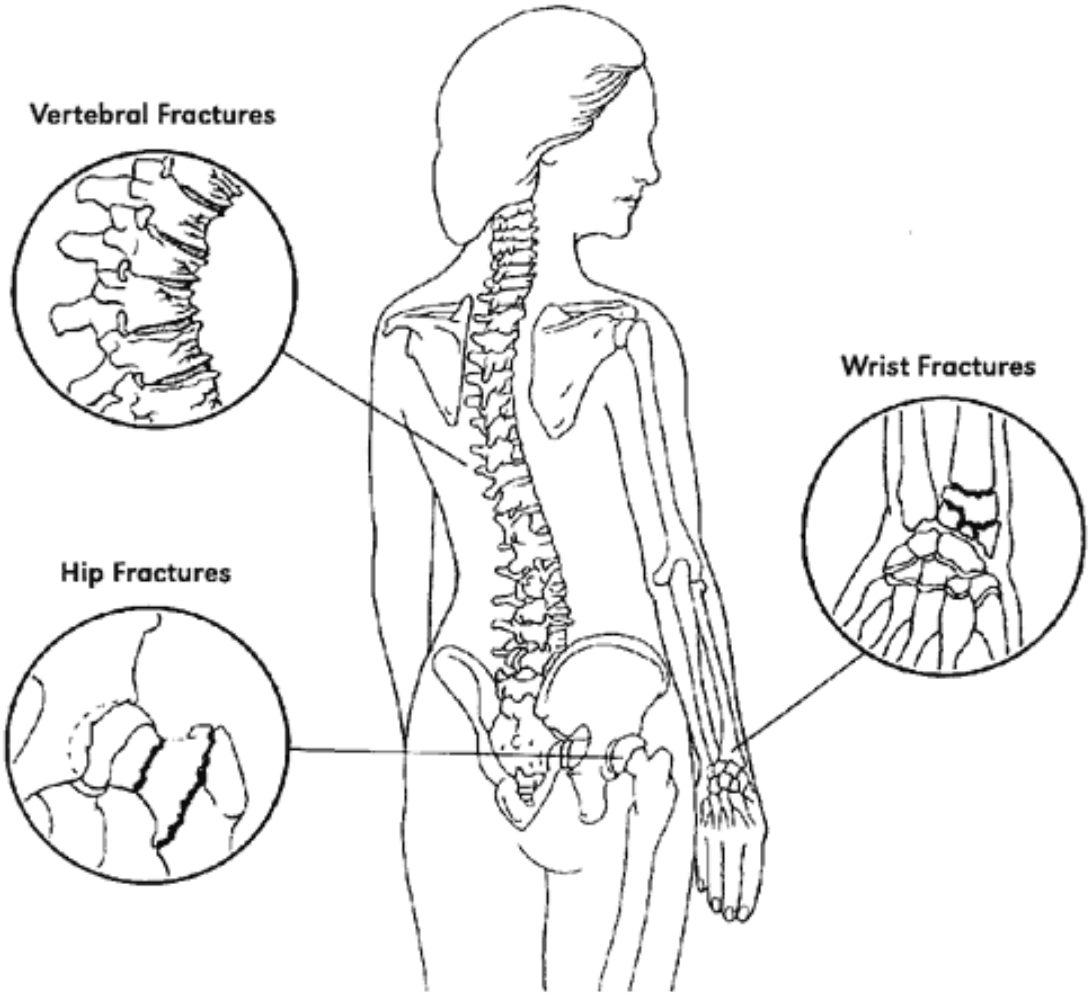


Figure 3–1. Bone Fracture Areas in Osteoporosis



Source: NOF 2004.

http://www.surgeongeneral.gov/library/bonehealth/chapter_3.html
http://www.fluoridealert.org/health/bone/fracture/

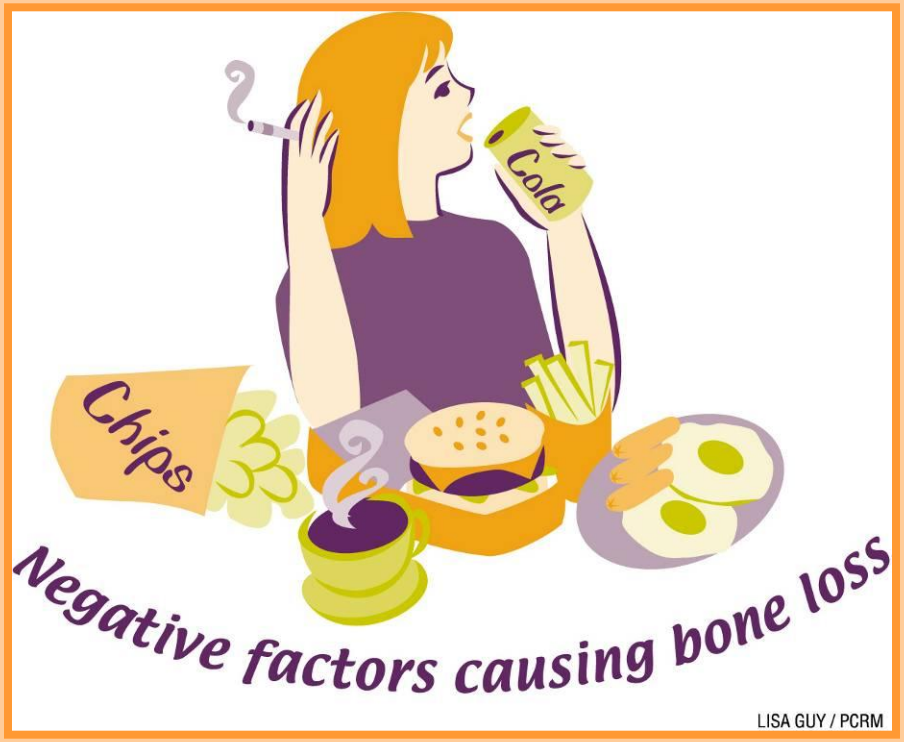
Build Better Bones

- **get moving! Regularly exercise**
- **eat a diet rich in fruits and vegetables**

  vitamin C, vitamin K, potassium, and magnesium
- **get vitamin D from the sun or from supplements**
- **get calcium from plant foods and fortified products**

Avoid Excess Bone Loss

- limit salty foods
- avoid protein from animal sources
- keep away from smoking
- avoid caffeine



http://www.strongbones.org/factsheets.html

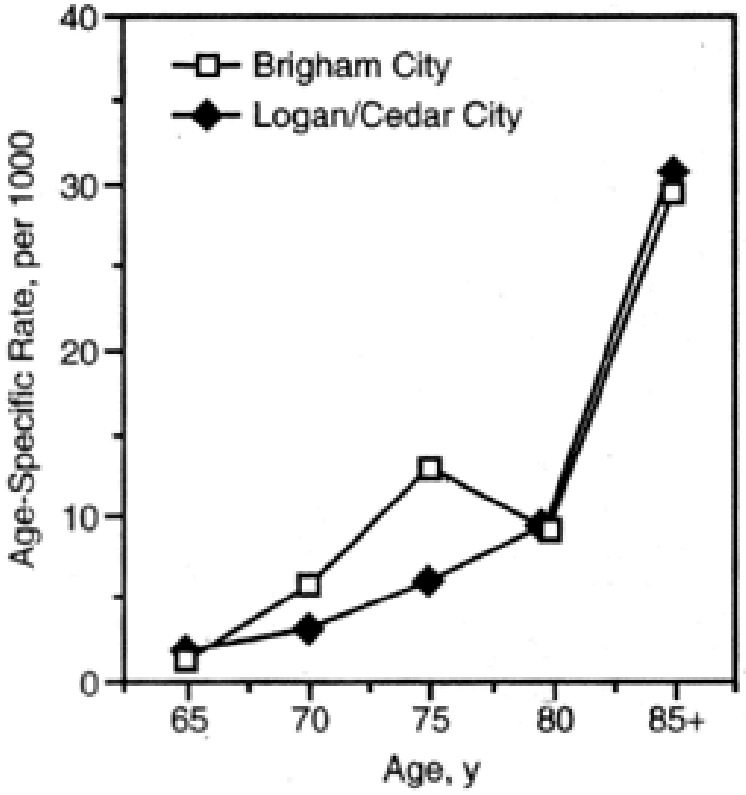


Fig 1.—Age-specific rate per 1000 for hip fractures, women. Brigham City has fluoridated water; Logan and Cedar City have nonfluoridated water.

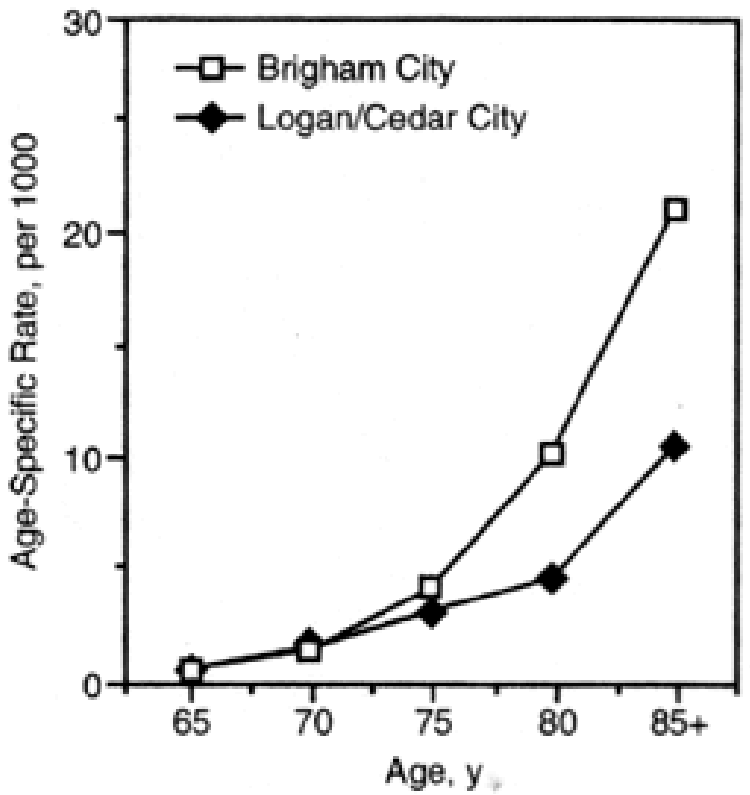
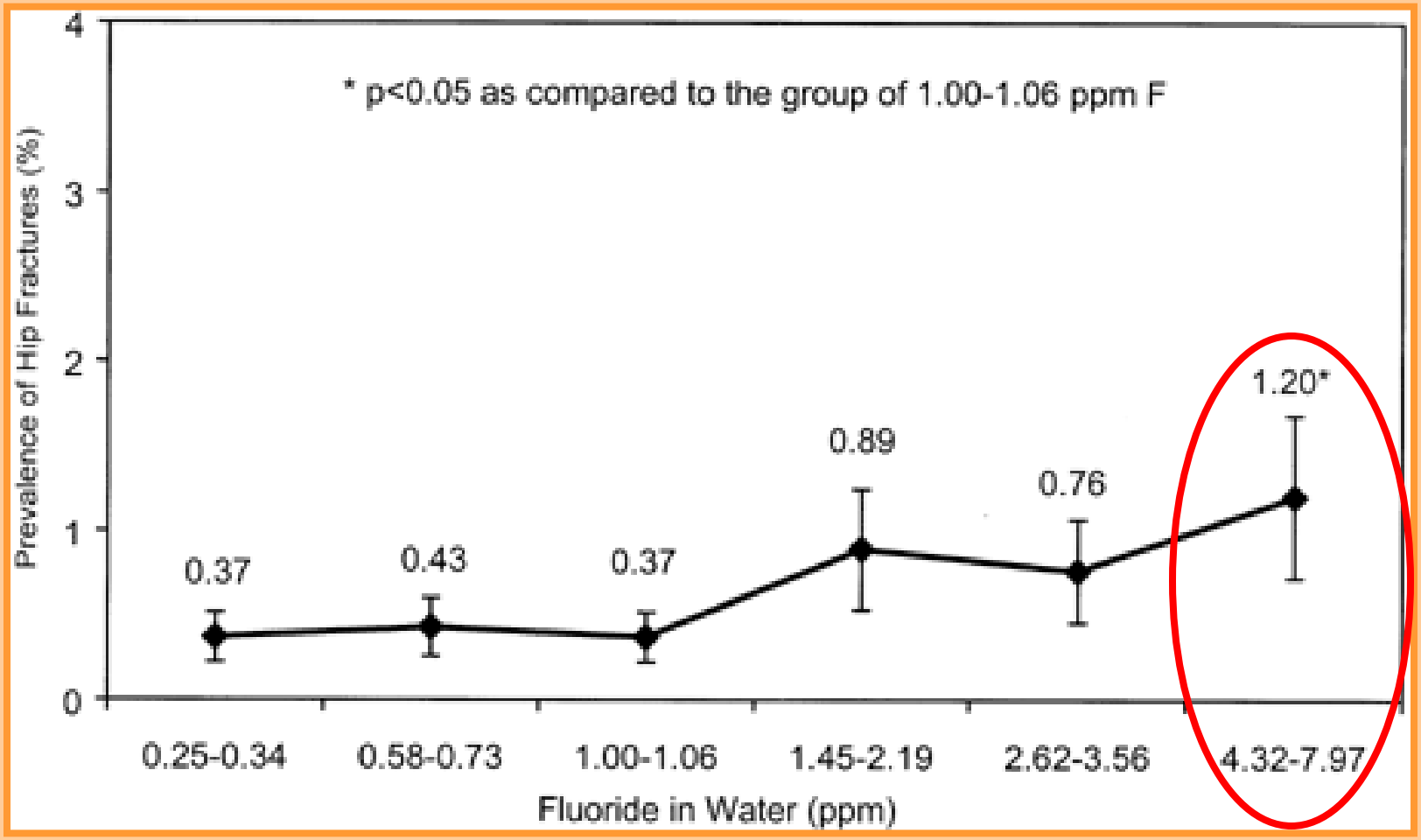


Fig 2.—Age-specific rate per 1000 for hip fractures, men. Brigham City has fluoridated water; Logan and Cedar City have nonfluoridated water.

http://www.fluoridealert.org/health/bone/fracture/



http://www.fluoridealert.org/health/bone/fracture/

Bone-Building Foods

- not an acid-forming food
- not high in fluoride
- low in salt (low sodium)
- Rich in calcium
- rich in potassium
- rich in vitamin C
- rich in vitamin K
- rich in magnesium
- rich in vitamin D

Calcium Requirement in Elderly

- **calcium balance = net intake – net output**
- **intake of calcium necessary to maintain 0 balance in 95% of the population**
- **≥ 19 yr: 1000 mg calcium/d (DRIs in Taiwan)**

http://fast2.mediamatic.nl/f/rgxv/image/545/60674-225-177.jpg

Table: Recommended Adequate Intake by the IOM for Calcium

Male and Female Age	Calcium (mg/day)	Pregnancy & Lactation
0 to 6 months	210	N/A
7 to 12 months	270	N/A
1 to 3 years	500	N/A
4 to 8 years	800	N/A
9 to 13 years	1300	N/A
14 to 18 years	1300	1300
19 to 50 years	1000	1000
51+ years	1200	N/A

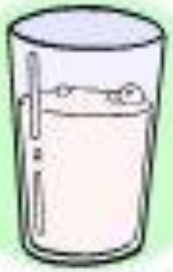
http://ods.od.nih.gov/factsheets/calcium.asp

Good Food Sources of Calcium

FOOD SOURCE	SERVING SIZE	CALCIUM (mg)
Milk & Yogurt	8 oz or 1 cup	300 - 450
Cheese	3 ounces	300 - 450
Bones in canned sardines and salmon	3 ounces	181 - 325
Calcium fortified foods (i.e. orange juice, soy milk, tofu)	8 ounces	200 - 300
Dark green, leafy vegetables	1/2 cupcooked, 1 cup raw	50 - 100
Nuts and Seeds	1 ounce	25 - 75

http://ag.arizona.edu/pubs/health/az1296.html

OR



1 cup of yogurt

1 ½ ounces of Cheddar cheese

8 fl oz of milk

=

OR

OR

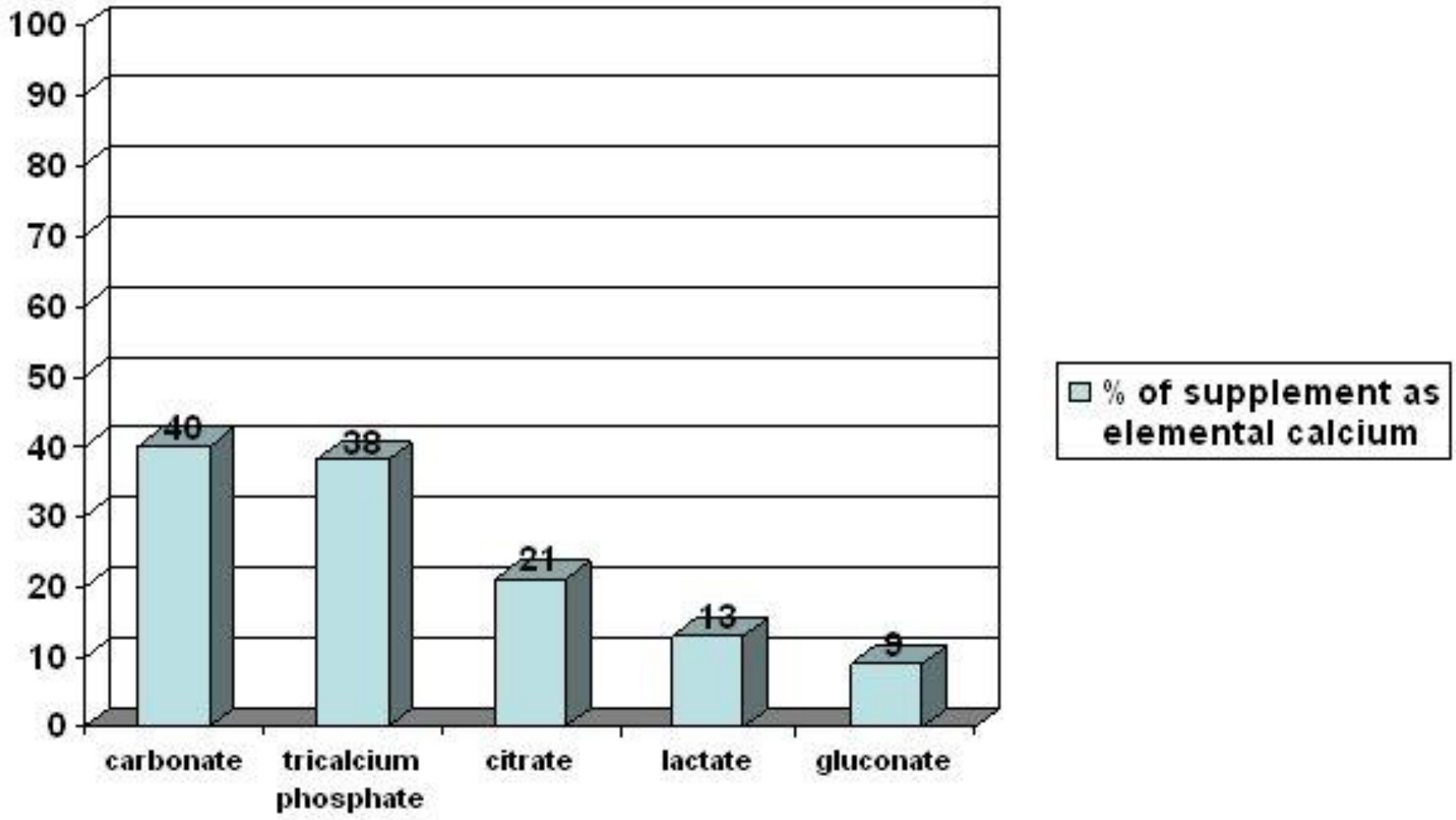
1 ½ cups of cooked kale

2 ¼ cups of cooked broccoli

8 cups of cooked spinach

http://ods.od.nih.gov/factsheets/calcium.asp

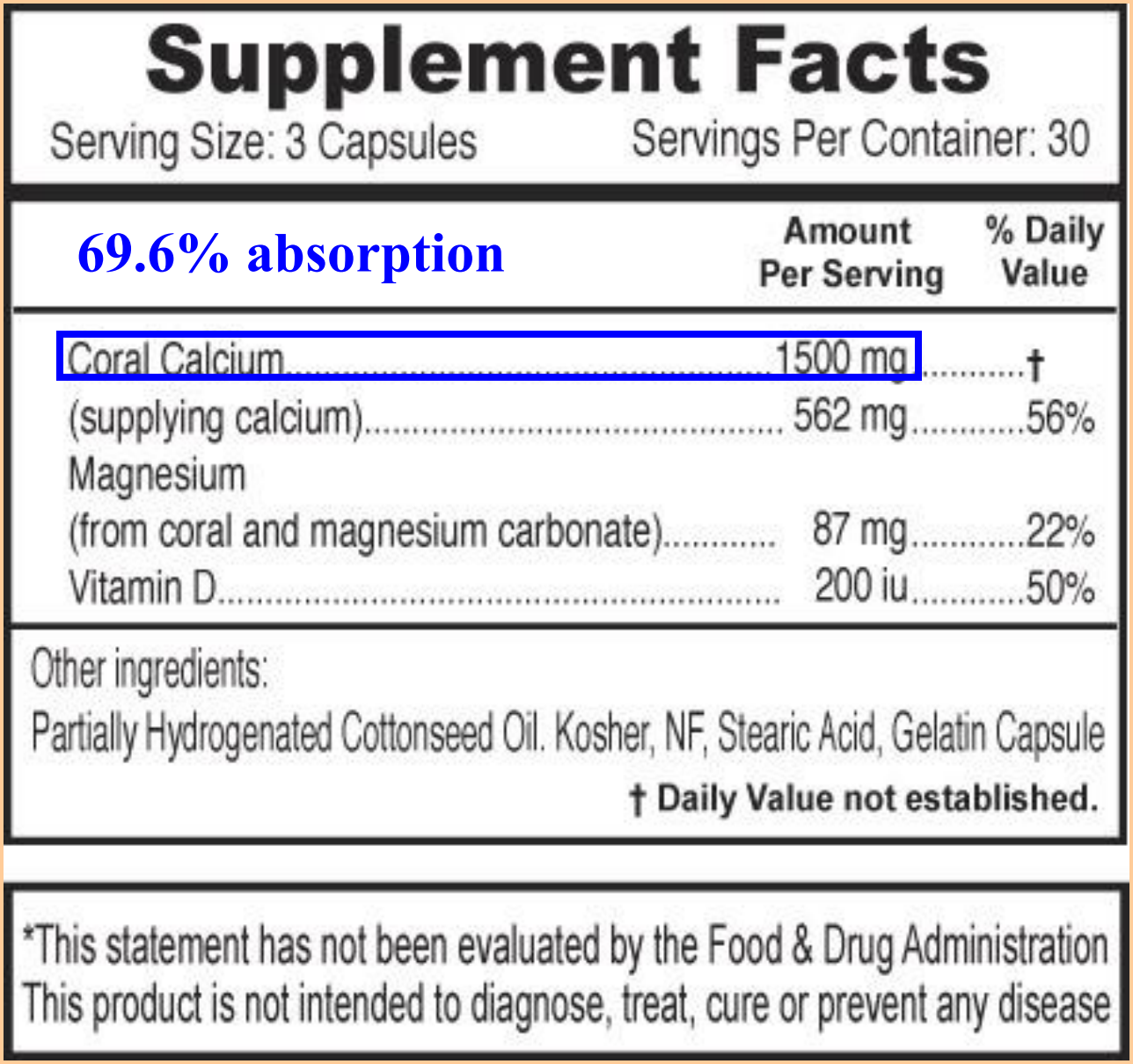
Calcium Supplement



http://ods.od.nih.gov/factsheets/calcium.asp

Supplemental Form	% Ca	Comments
Calcium Citrate	21%	Best absorbed supplemental form of calcium. It does not require the presence of extra stomach acid to dissolve. Calcium citrate can come in colloidal form. This is a liquid form of calcium that may be less irritating to the intestinal wall.
Calcium Carbonate	40%	Most common type of calcium supplement on the market. Usually requires extra stomach acid for digestion, so should be taken with a meal.

http://www.healthgoods.com/Education/Nutrition_Information/Nutritional_Supplements/calcium_guidelines.htm



Supplement Facts

Serving Size: 3 Capsules — Servings Per Container: 30

69.6% absorption

	Amount Per Serving	% Daily Value
Coral Calcium	1500 mg	†
(supplying calcium)	562 mg	56%
Magnesium (from coral and magnesium carbonate)	87 mg	22%
Vitamin D	200 iu	50%

Other ingredients:
Partially Hydrogenated Cottonseed Oil. Kosher, NF, Stearic Acid, Gelatin Capsule

† Daily Value not established.

*This statement has not been evaluated by the Food & Drug Administration
This product is not intended to diagnose, treat, cure or prevent any disease

http://www.humangh.com/coral-calcium-1000mg.htm

Not Recommended Calcium Supplement

- **Dolomite, Oyster shell, and Bone Meal are naturally occurring calcium carbonate sources which may contain heavy metals, including lead. Minimizing lead intake is especially important for pregnant and nursing women, and children. The Food and Drug Administration (FDA) has set an upper limit for the amount of lead a calcium supplement can contain (7.5 μg/1000 mg calcium)**

Not Recommended Calcium Supplement

- **Calcium Phosphate (38%), Calcium Lactate (13%), and Calcium Gluconate (9%) have very small percentages of elemental calcium in each supplement tablet. Therefore it is necessary to take a large number of tablets to consume an adequate amount of calcium every day**

Bottom Line for Calcium Supplement

- **Avoid taking more than 500 mg of elemental calcium at one time to increase absorption. To avoid toxicity, do not take more than 2,500 mg of elemental calcium per day**
- **Try to consume calcium from foods or beverages. If you take calcium supplements, calcium citrate and calcium carbonate are the best choices**

Bottom Line for Calcium Supplement

- **Vitamin D is required for calcium absorption and get it from vitamin D fortified milk and milk products, from exposure to sun-light on your skin, and from some foods, including fish, and egg yolks. Do not take more than 50 μg/d or 2000 IU/d**

http://www.naturepulse.com/images/VitaminD_7-2.jpg

Summary

- **Low peak bone mass**
- **Increased bone loss**
- **Hormone replacement with estrogen alone or estrogen and progesterone prevents bone loss**
- **Intake of calcium**