

Calcium-Phosphorus Metabolism

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A tale of ...

Calcium



Phosphorus

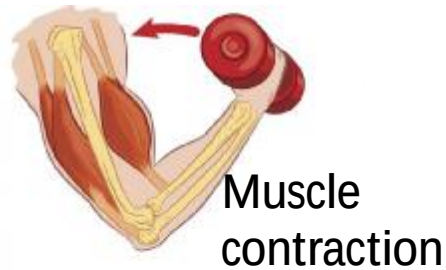
Magnesium



Calcium functions



Excitability

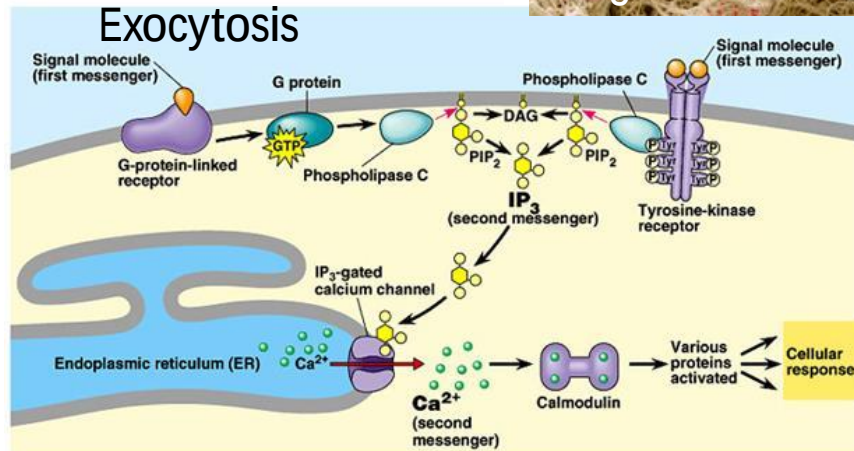


Muscle contraction



Coagulation

Second messenger
Exocytosis



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99.9%



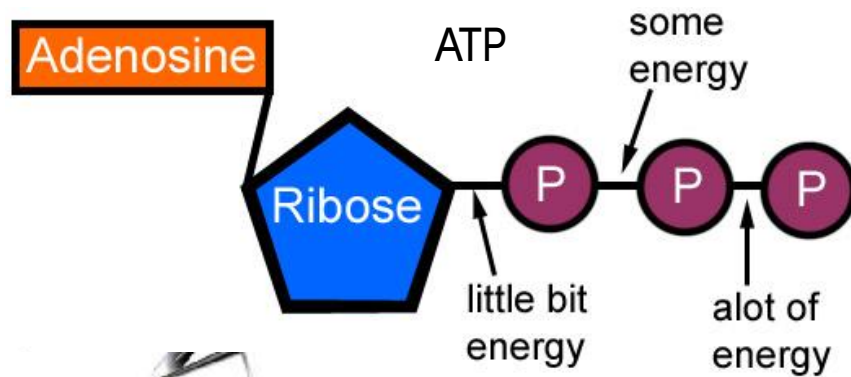
Teeth



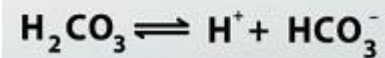
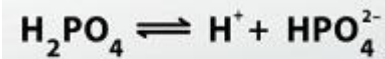
Bones



Phosphorus functions



DNA



Acid-base balance

99.9%

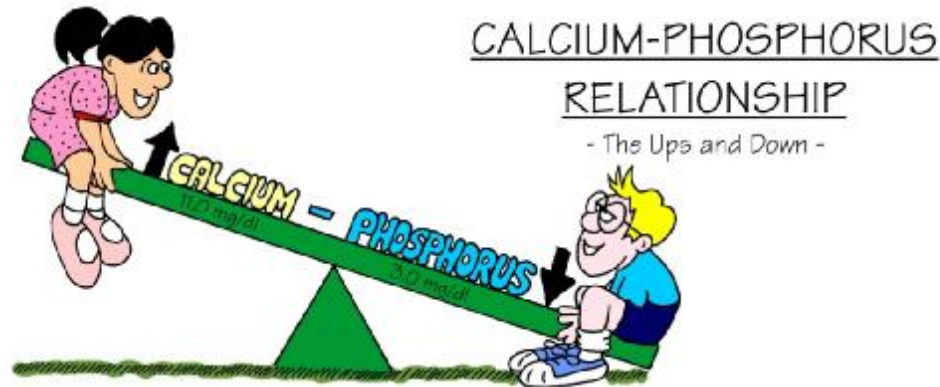


Teeth

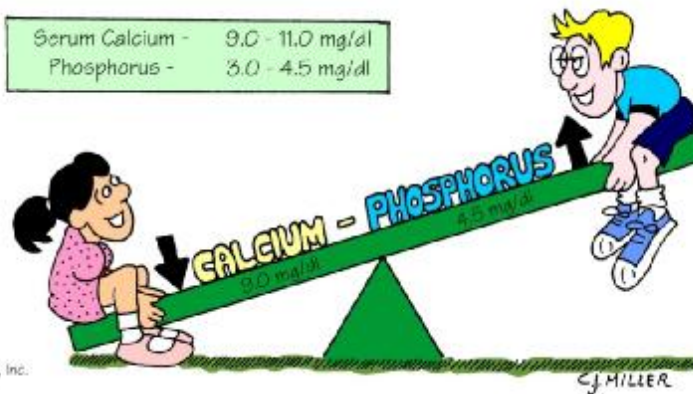
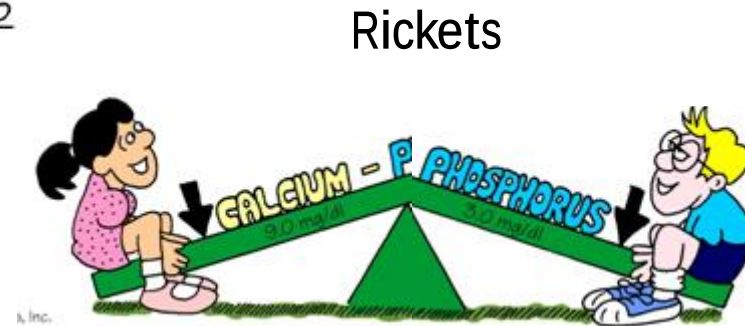


Bones

Up and Down



Serum Calcium - 9.0 - 11.0 mg/dl
Phosphorus - 3.0 - 4.5 mg/dl



Ionized calcium—50%
Protein-bound calcium—40%
Complex-bound calcium—10%

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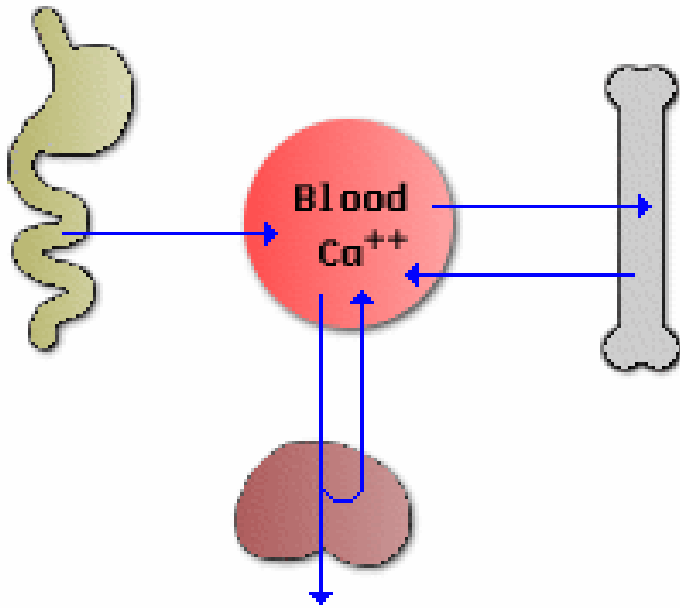
Ca – 2.12–2.62 mmol.L⁻¹
Ca²⁺ – 1.06–1.31 mmol.L⁻¹

Trinity(ies)

- Three ions
 - Ca, P, Mg
- Three organs
 - Bones, Kidneys, Intestines
- Three hormones
 - PTH, Calcitonin, Vitamin D3
- Three types of cells
 - Osteoblasts, Osteoclasts, Osteocytes



Three organs



- Intestines
(20-75% absorption)
- Kidneys
(re-absorption)
- Bones
(temporary bank; ± 500 mg)

The three tenors and the orchestra



- PTH
- Vitamin D3
- Calcitonin



- ¢ Estrogens
- ¢ Androgens
- ¢ Corticosteroids
- ¢ T3/T4
- ¢ STH
- ¢ Serotonin
- ¢ pH, Albumin, FFA



Agonist (PTH), Antagonist (Calcitonin) and ... why do we need a third one?



In Blood We Trust

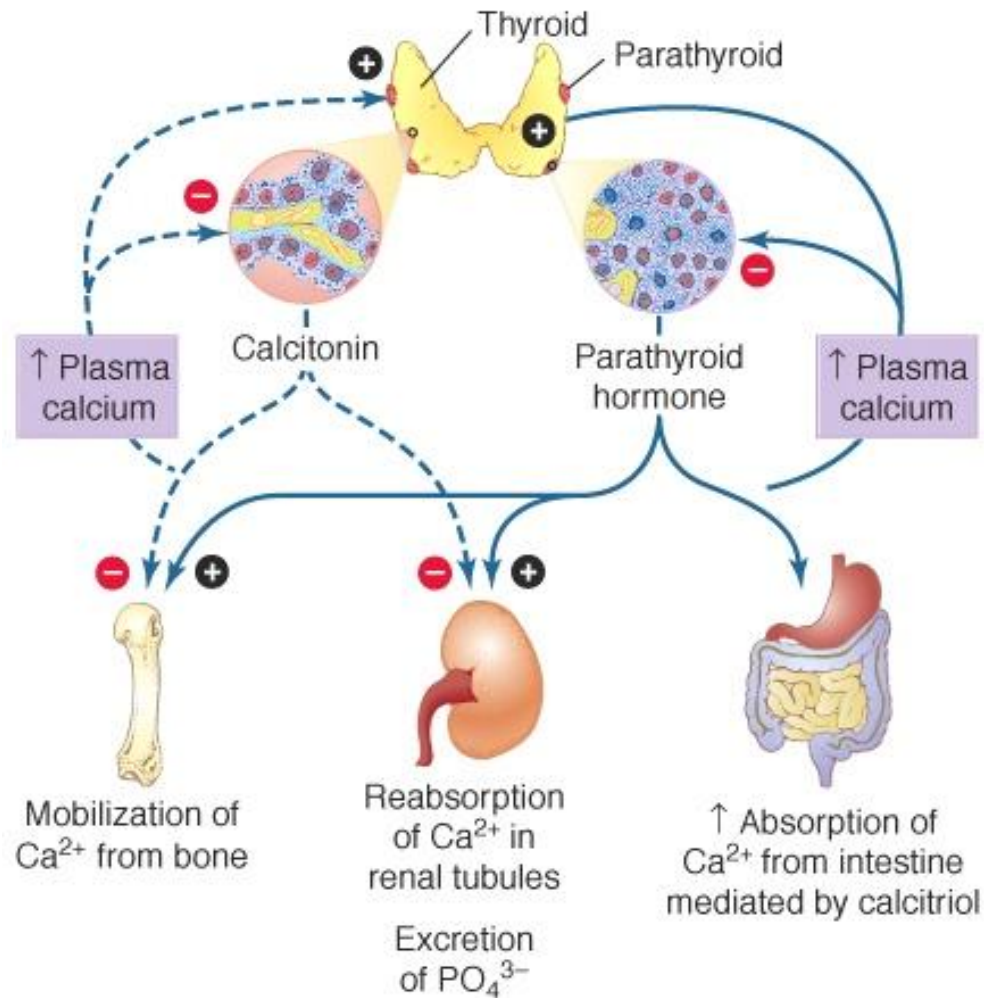


2.12



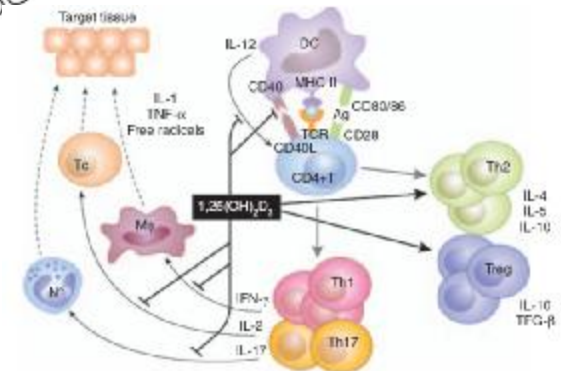
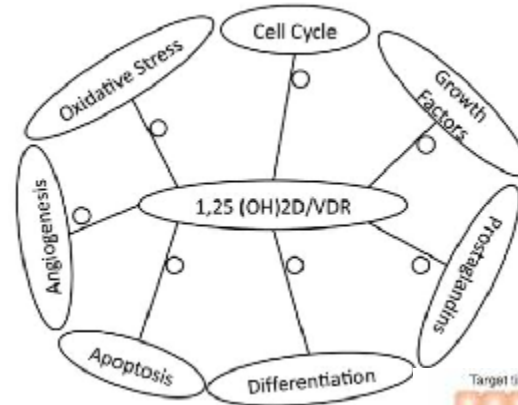
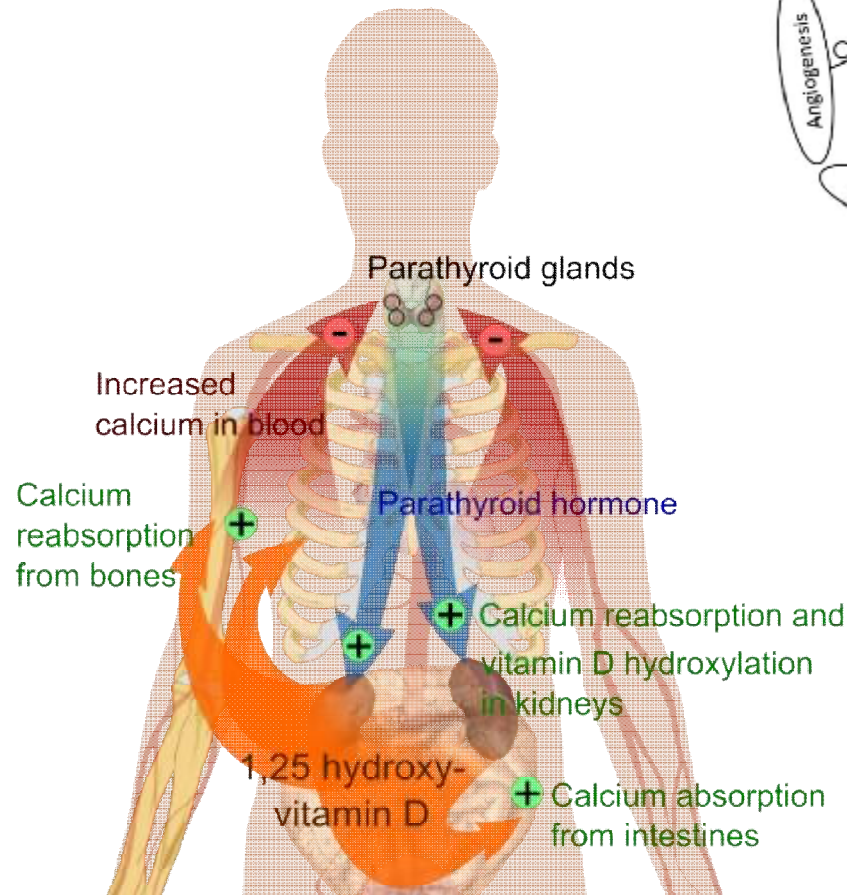
2.62

We don't care for the bones! The brain and the muscles are more important!



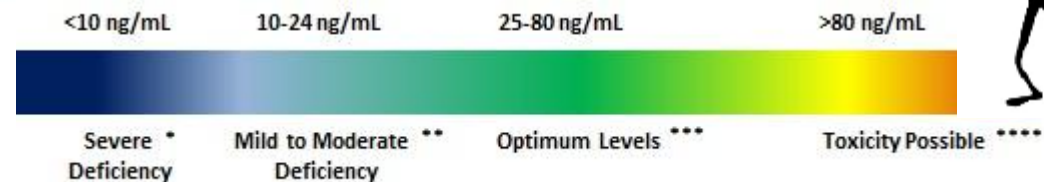
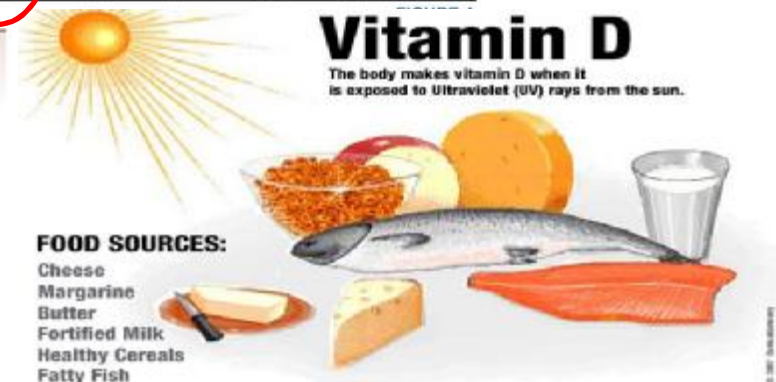
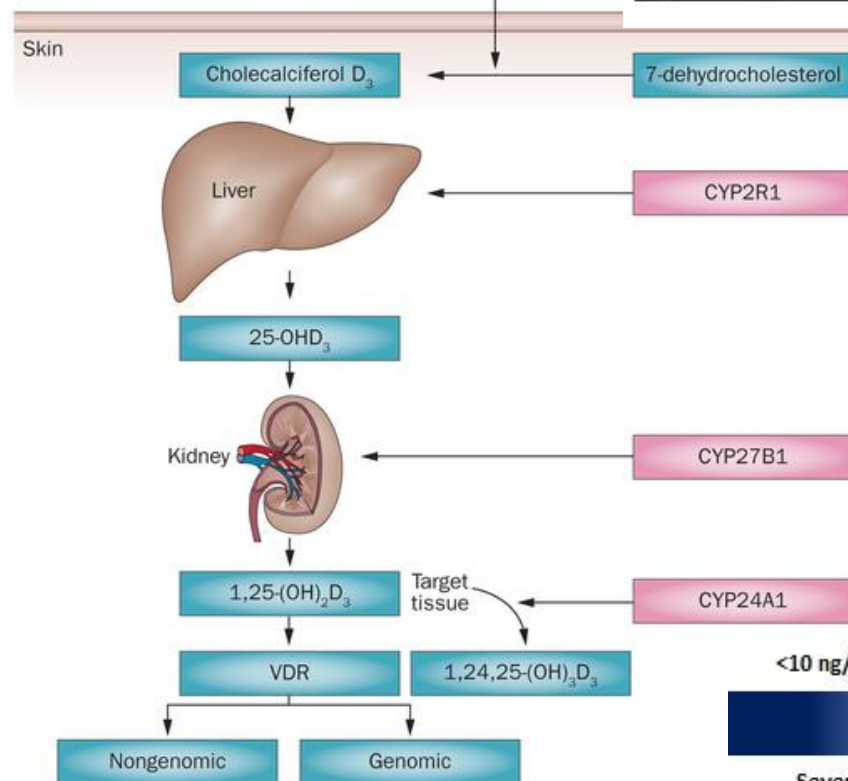
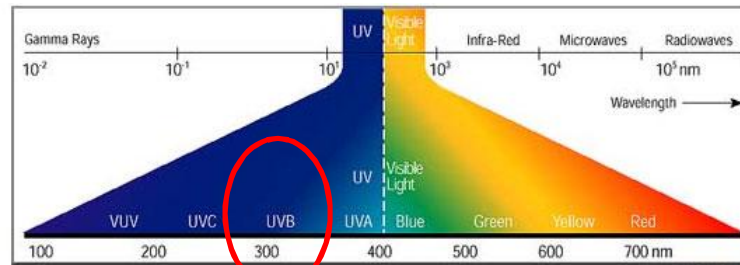
(Bad) to the bone Pleiotropic functions

Calcium regulation

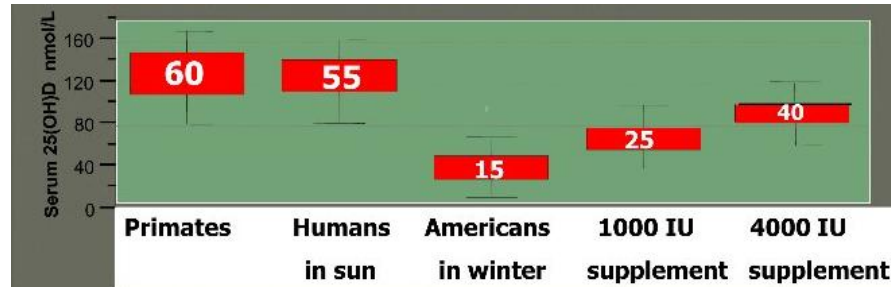


Haemmopoiesis
Anti-cancer
Anti-autoimmune

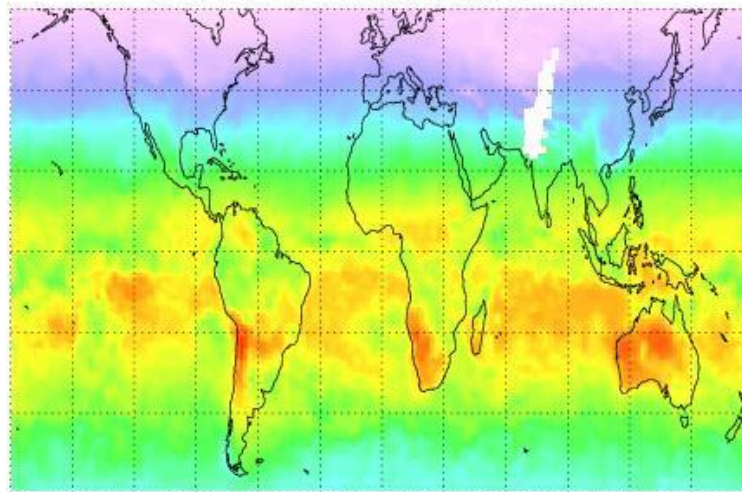
Qui vitam dat



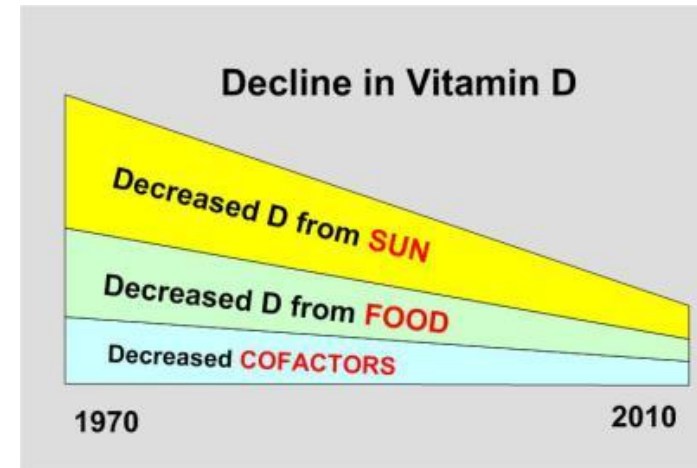
D(3)evolution



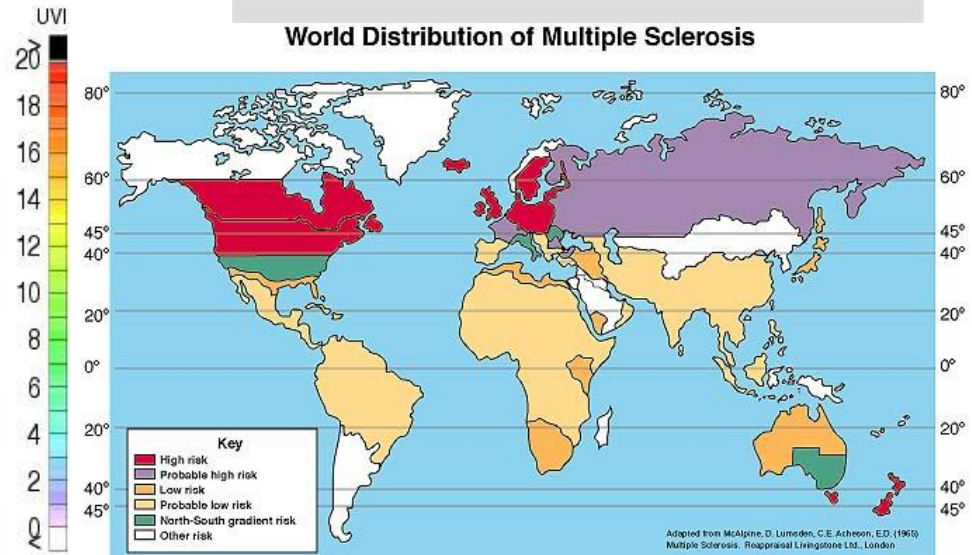
GOME UV-Index JAN-1998



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World Distribution of Multiple Sclerosis



The right to choose

- Rickets
- Osteoporosis
- Psoriasis
- Depression
- Immunity

OR

- ¢ Melanoma
- ¢ Cataract
- ¢ Skin aging
- ¢ Sunstroke
- ¢ Dehydration

heliophobia

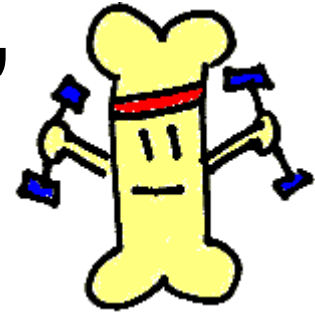
noun

a fear of sunlight

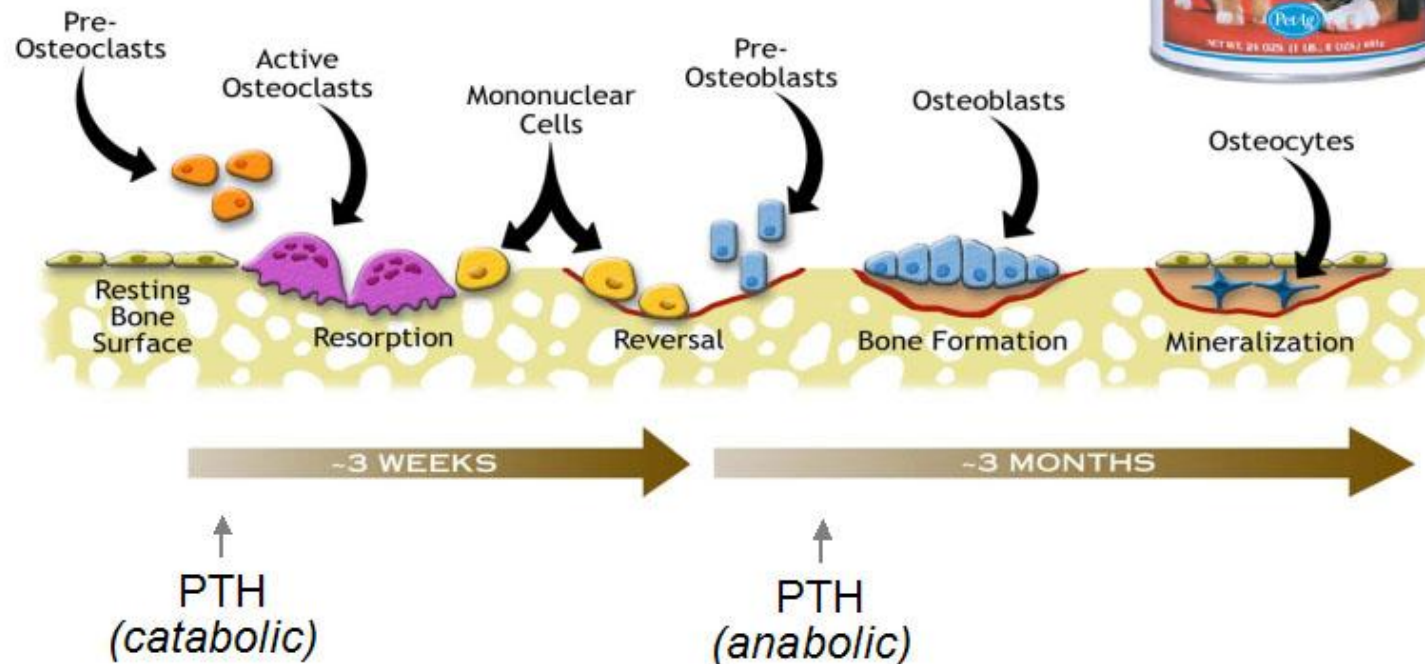
heliophilia

(n.) desire to stay in the sun; love of sunlight

“Can these bones live?”



Bone Remodeling Cycle

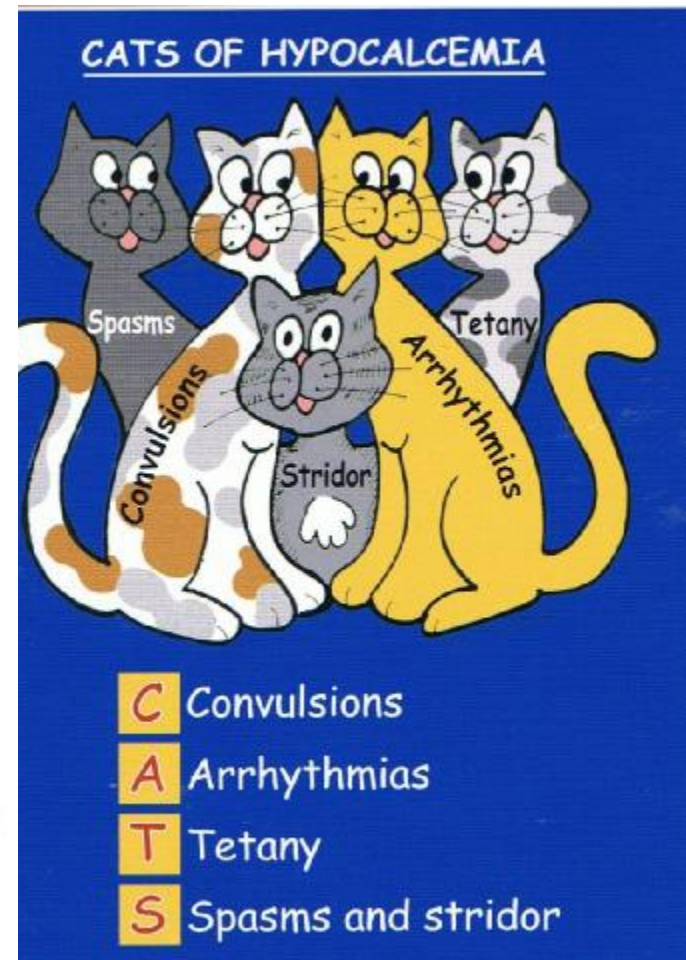
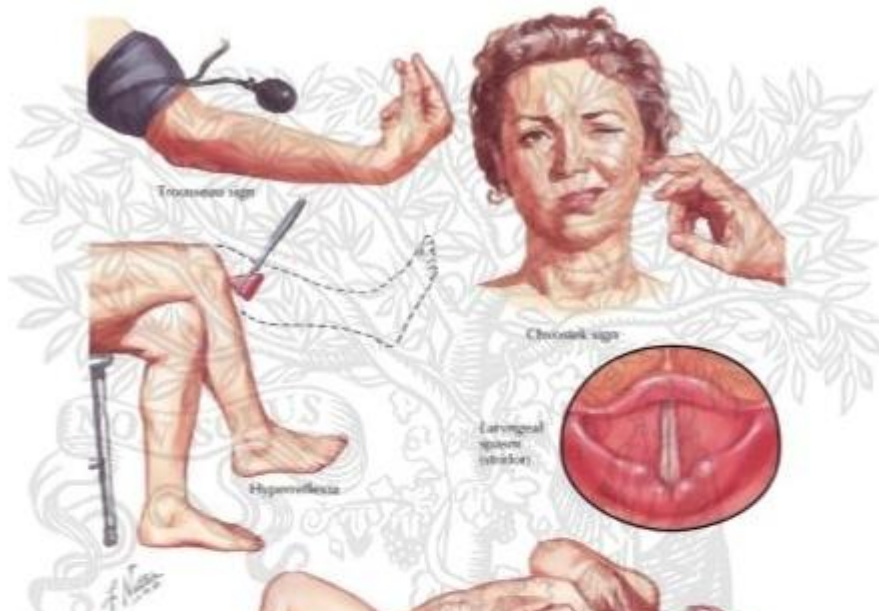


- RANKL – Receptor Activator of NFkB Ligand

Ca²⁺uses of hypoCa²⁺lcemia

- Hypoparathyroidism
- Vit D deficiency/ insufficiency
- Renal/ Hepatal diseases
- Pseudohypoparathyroidism
- Hypomagnesiemia or hypermagnesiemia
- Hungry bone syndrome
- Phosphate infusion
- Rapid citrated blood transfusion
- Medications

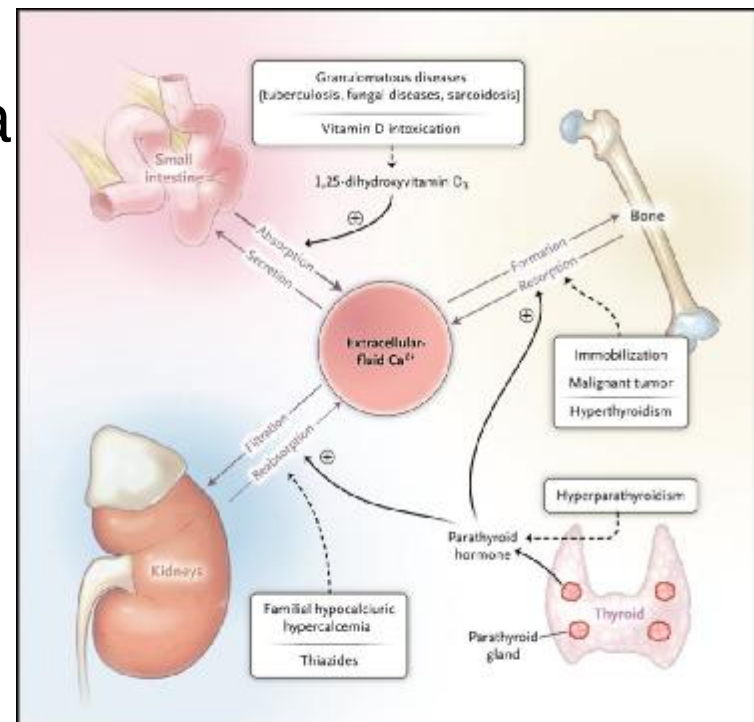
Felis Ca^{2+} tus



Chimpanzees

Causes of Hypercalcemia

- Calcium supplementation
- Hyperparathyroidism
- Iatrogenic, immobilization
- Multiple myeloma
- Parathyroid hyperplasia/ adenoma
- Alcohol
- Neoplasm (breast, lung cancer)
- Zollinger-Ellison Sy (gastrinomas)
- Excessive Vit D
- Excessive Vit A
- Sarcoidosis



HyperCa²⁺Icemia signs

Renal

- Nephrolithiasis
- Interstitial nephritis

Gastorintestinal

- Constipation
- Anorexia
- Nausea
- Peptic ulcer
- Pancreatitis

Ectopic calcification

- Pruritus
- Cerathopathy

Neuromuscular

- ¢ Muscle weakness
- ¢ Hyporeflexia

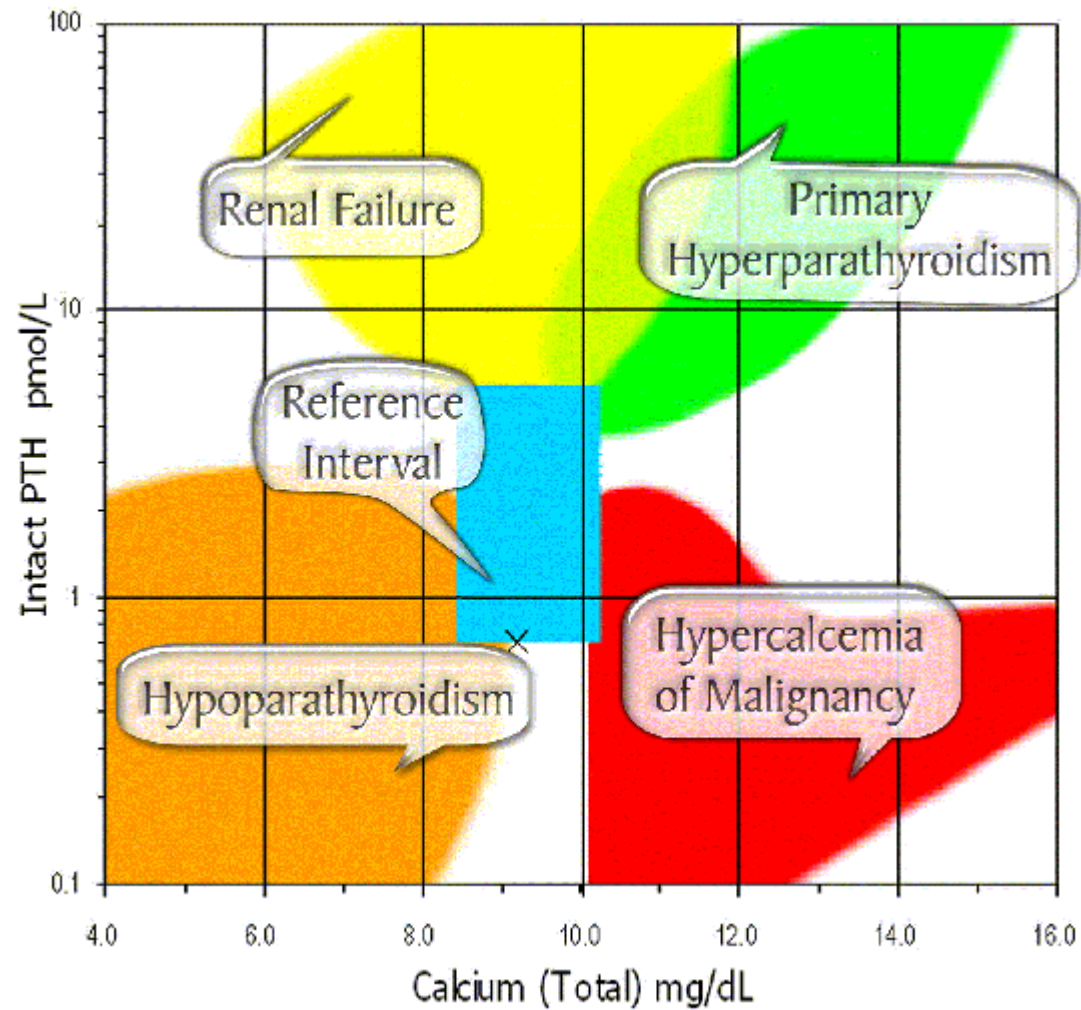
Psychiatric

- ¢ Lethargy
- ¢ Somnolence
- ¢ Depression
- ¢ Psychosis

Cardiovascular

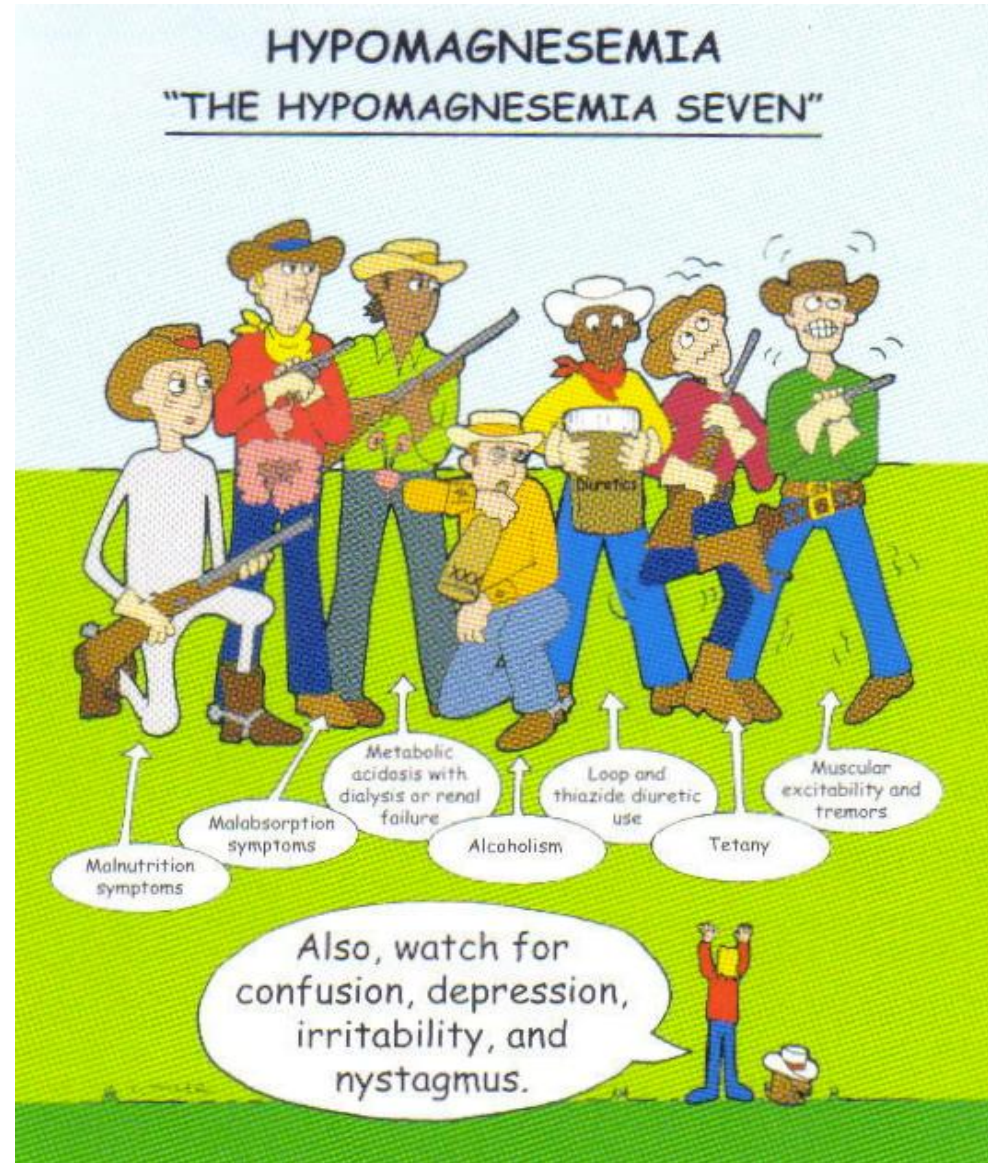
- ¢ Shortened QT interval
- ¢ Depressed T waves
- ¢ Heart block

Primary vs Secondary



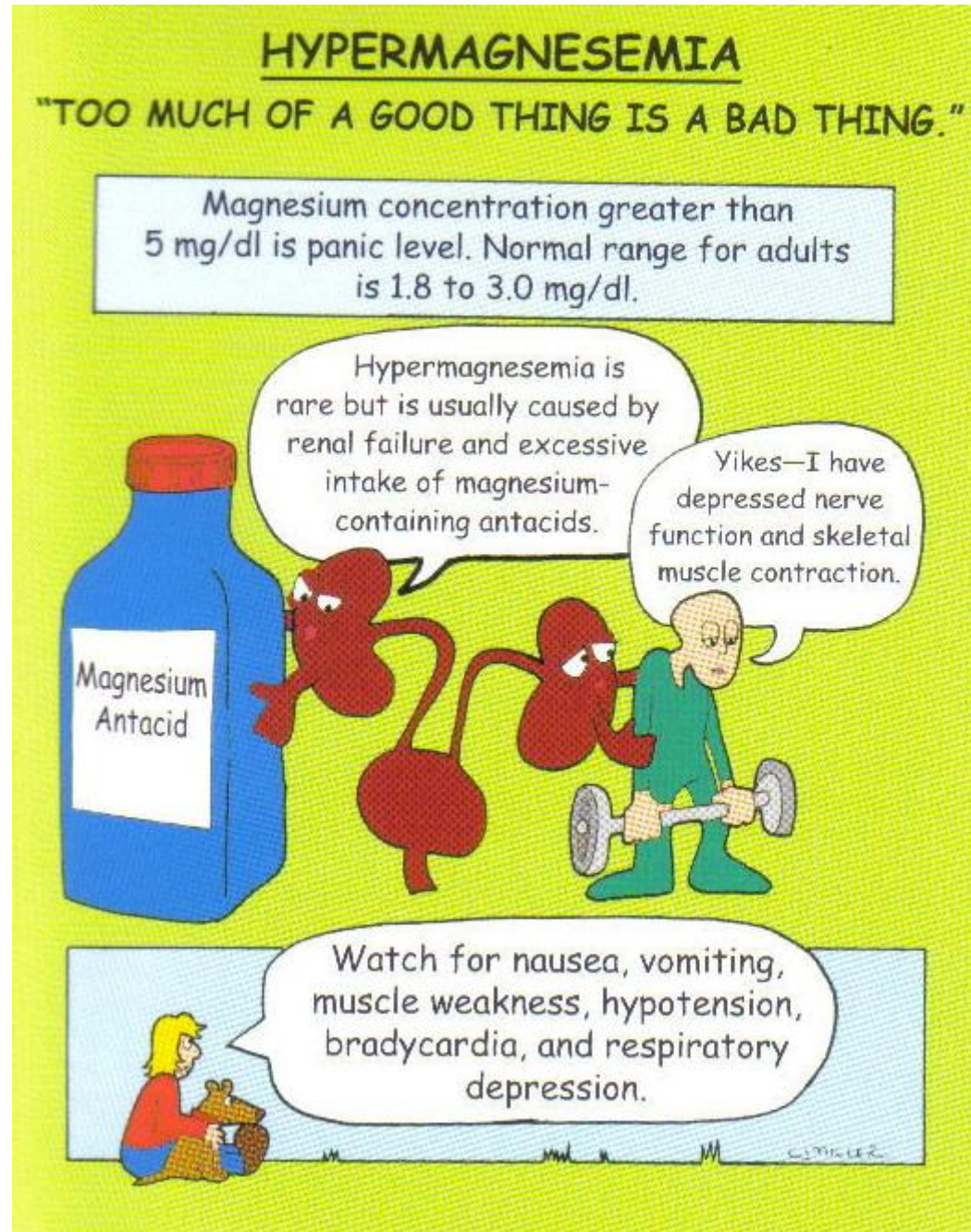
Let Mg^{2+} enter the game

- Malnutrition Sts
- Malabsorption Sts
- Renal failure
- Alcoholism
- Diuretics
- Tetany
- Muscle excitability and tremors

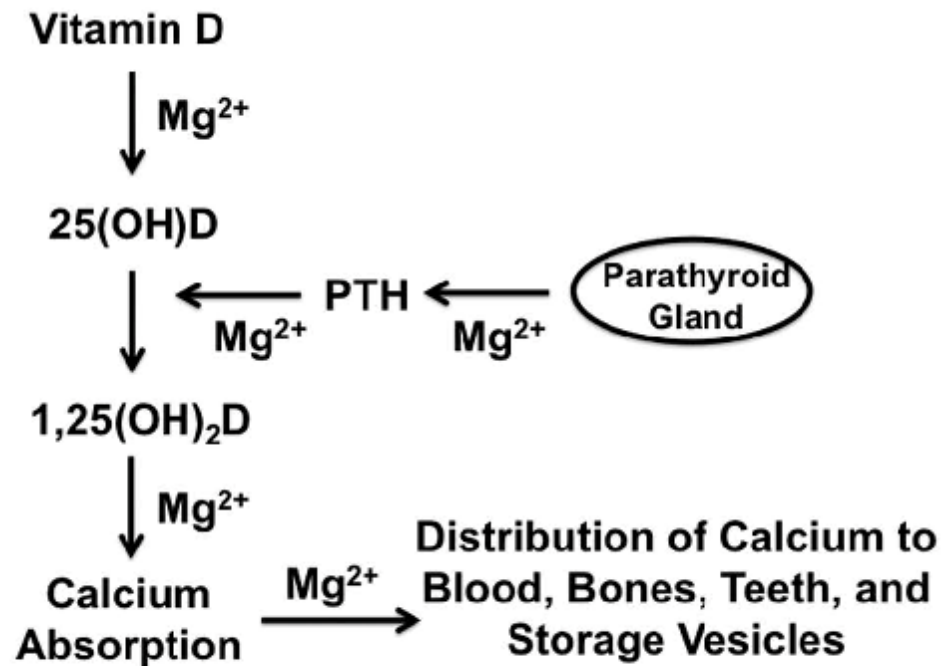


Too Much

- Depression
- Hyporeflexia
- Muscle weakness
- Nausea
- Vomiting
- Hypotension
- Bradycardia
- Respiratory depression



The Gray Cardinal



The Gray Cardinal



MAGNESIUM

BODILY FUNCTIONS



Regulates Calcium

- Strong Bones and Teeth
- Helps Excrete Excess Calcium



Regulates Heart Contractility

- Blocks Calcium from Heart Muscle
- Heart has 20x Greater Concentration



Relaxes Skeletal Muscle

- Helps Relieve Muscle Cramping and Pain



Cleans the Bowel

- Unabsorbed Magnesium Causes Laxative Effect



Energy Production

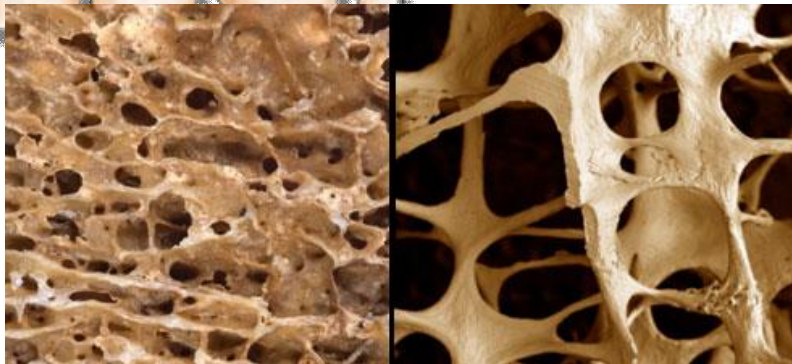
- Require by Over 300 Energy Producing Reactions



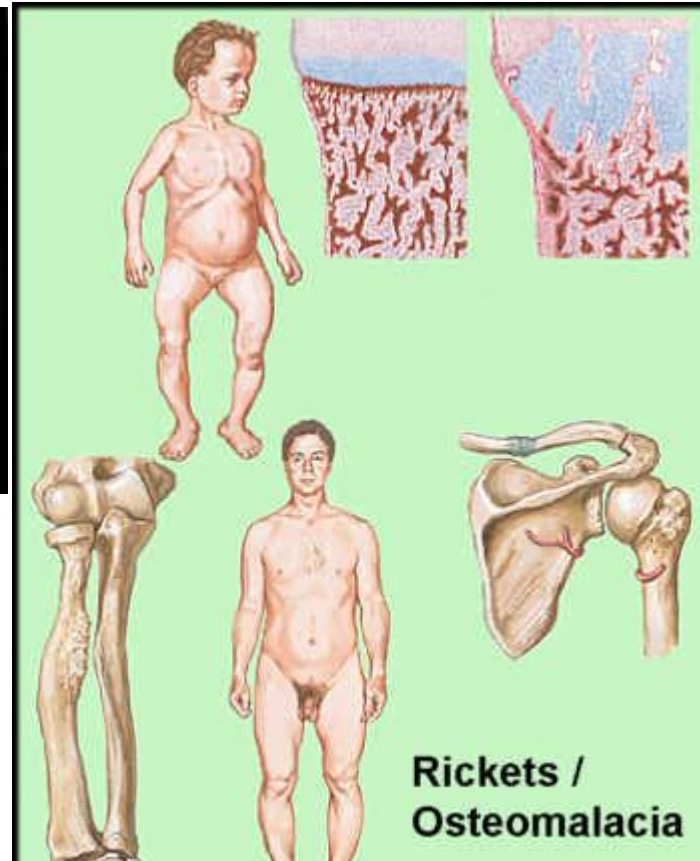
Relaxes Smooth Muscle

- Relaxes Bronchioles and Arterioles
- Relaxes Uterine Muscle

Osteoporosis vs Osteomalacia



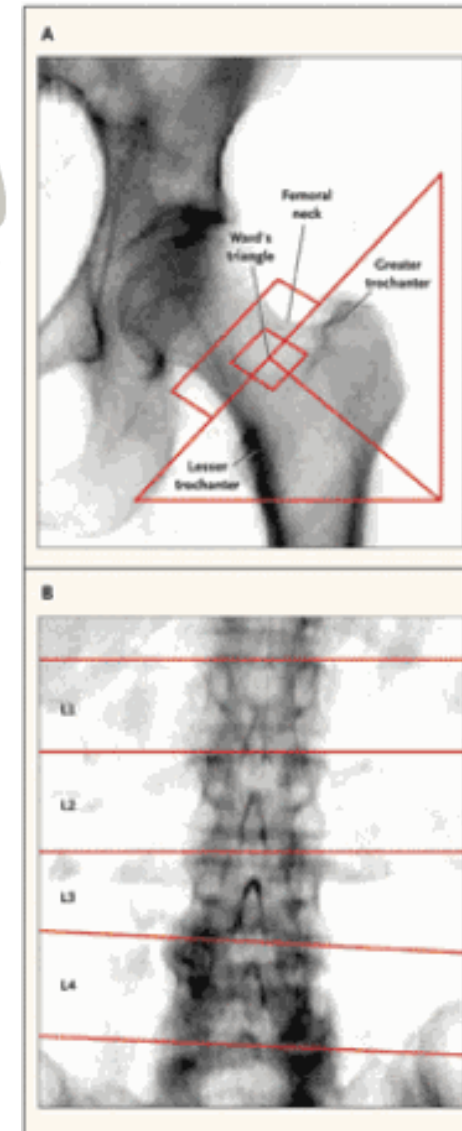
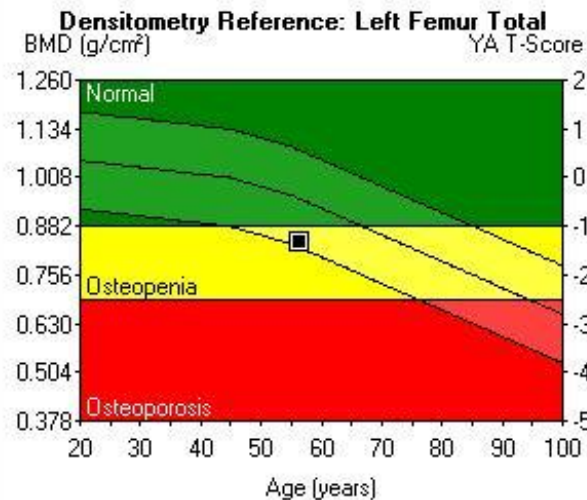
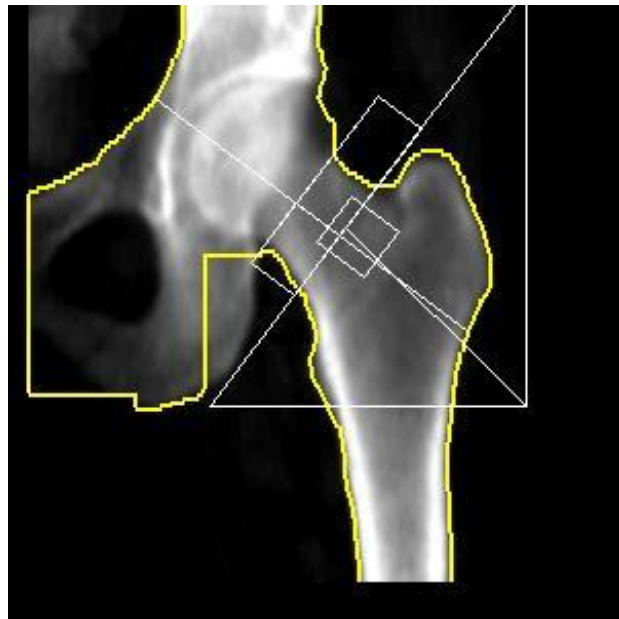
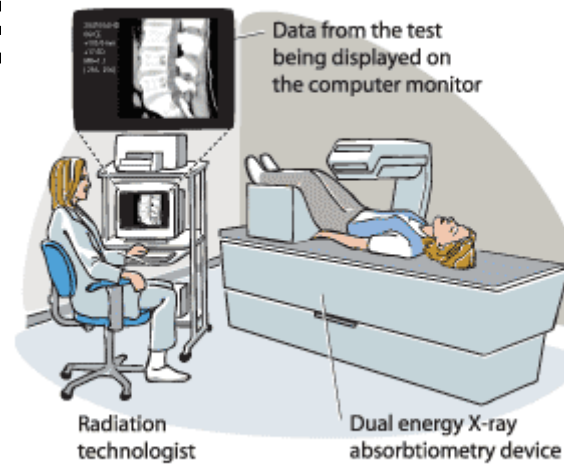
- Normal mineralization
- Decreased bone mass



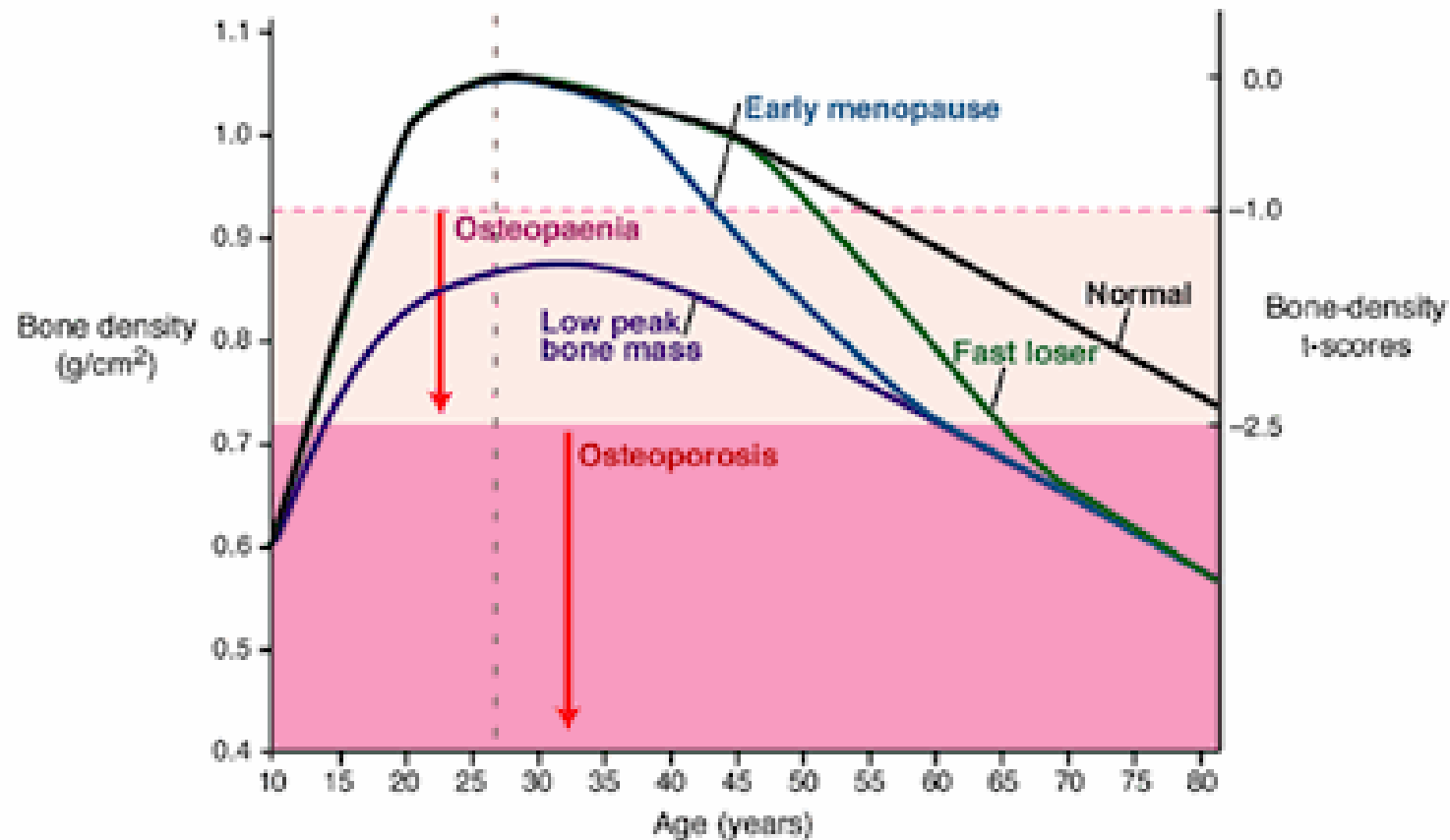
- ¢ Decreased mineralization
- ¢ Normal bone mass

X-ray crossfire

T-score



Be Bone Greedy!



Types of Osteoporosis

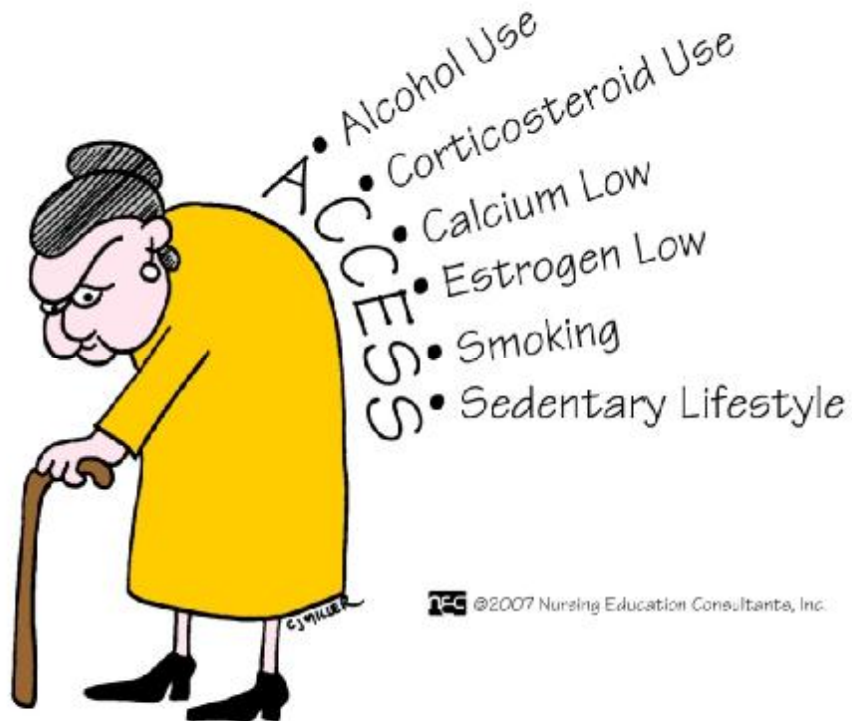
- Senile
- Drug-induced
- Immobilization-related
- Haemmatologic
- Congenital
- Endocrine

Senile osteoporosis pathogenesis

- Menopause (the orchestra)
- Decreased sun exposure (Vit D)
- Decreased physical activity
- Decreased sensitivity to Vit D
- Impaired renal function and calcium loss
- Poor diet
- Drugs

Access Osteoporosis

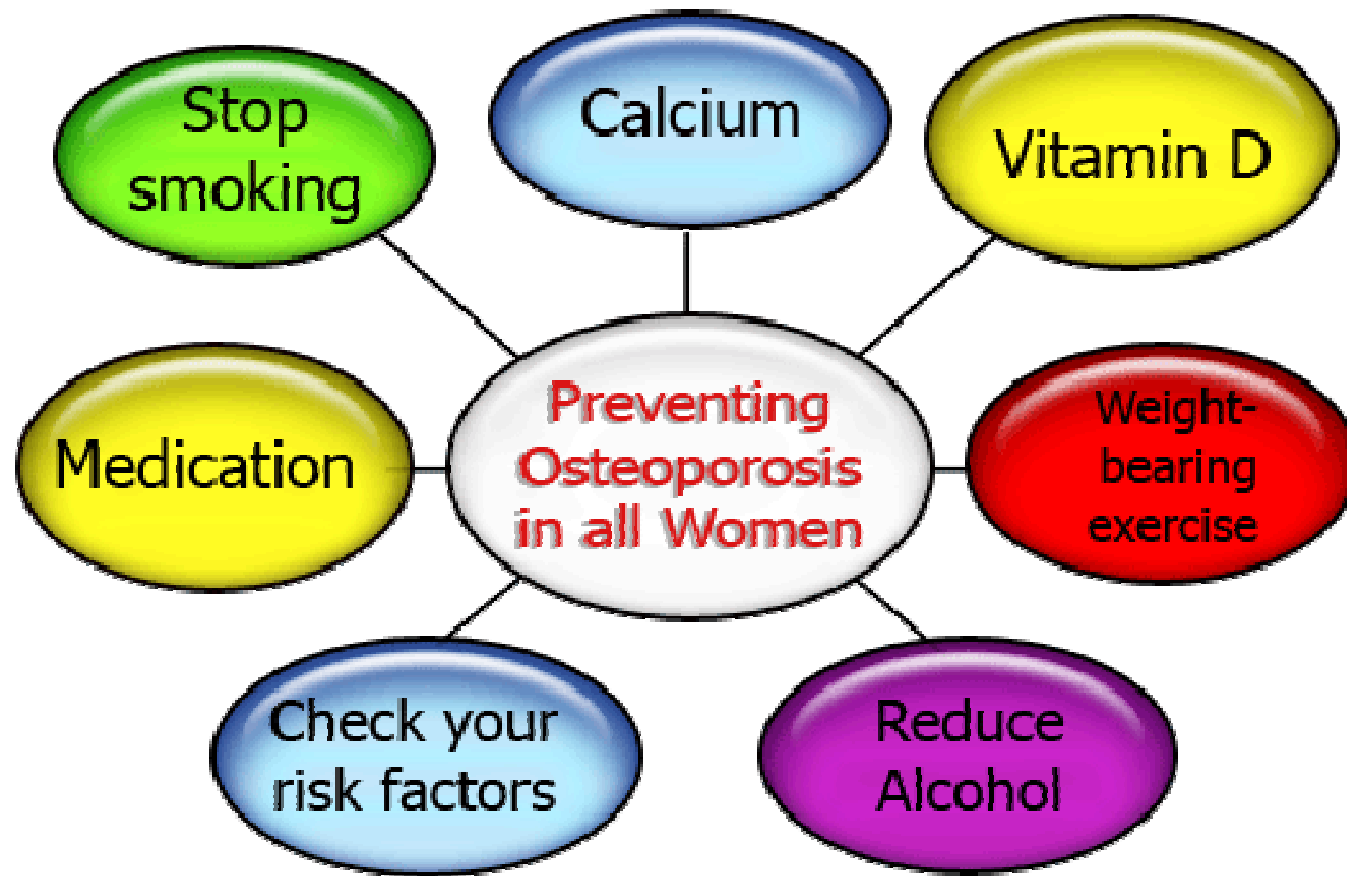
OSTEOPOROSIS RISK FACTORS



“Access” (leads to) Osteoporosis

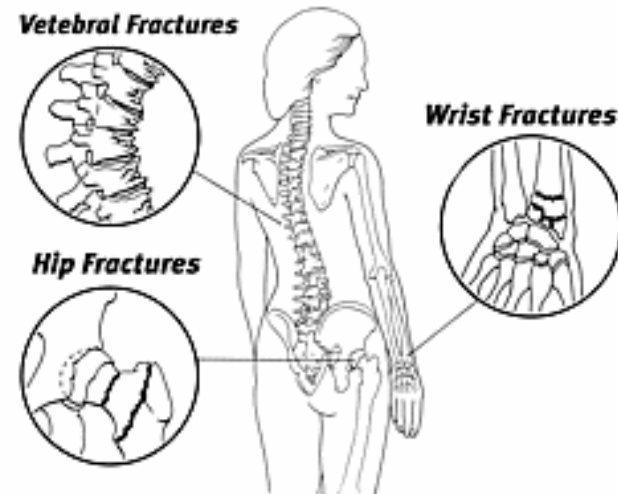
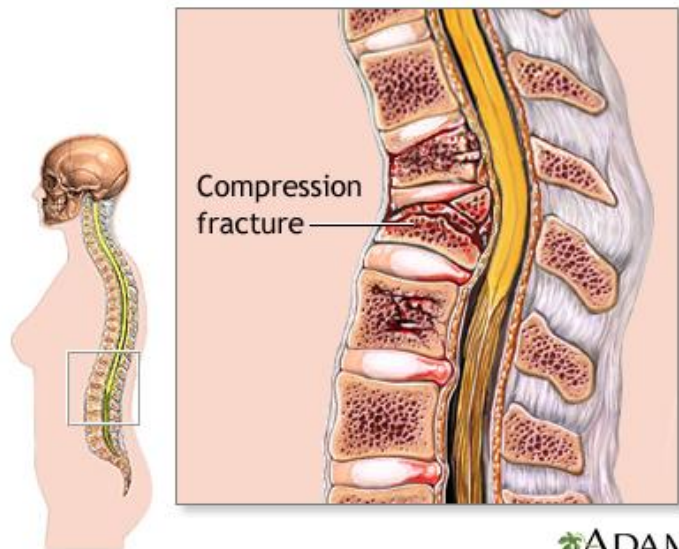


Access denied



The Fall of Life

- Osteoporosis
- Locomotor instability
- Impaired vision
- Decreased strength
- Ortostatism
- Medications





**KEEP
CALM
AND
ENJOY
THE SUN**