THE MINERALS: CALCIUM, MAGNESIUM, PHOSPHORUS & SULPHATE
CALCIUM

- Most abundant mineral in the body
- Adequate intake
  - Grows a healthy skeleton in early life
  - Helps minimize bone loss in later life
- Majority of body’s calcium is in bones and teeth
  - Part of bone structure
  - Calcium bank
In bones
- Calcium salts form crystals
  - Hydroxyapatite
- Strength and rigidity to maturing bones
- Bone remodeling

In teeth
- Fluoride stabilizes calcium crystals in teeth
CALCIUM

- In body fluids
  - Helps to maintain normal blood pressure
  - Extracellular calcium
    - Participates in blood clotting
  - Intracellular calcium
    - Regulation of muscle contraction
    - Transmission of nerve impulses
    - Secretion of hormones
    - Activation of some enzyme reactions
Disease prevention
  - Hypertension
  - Blood cholesterol
  - Diabetes
  - Colon cancer
Obesity
  - May help maintain healthy body weight
    - Inverse relationship with food sources
CALCIUM

- Calcium balance
  - Involves system of hormones and vitamin D
    - Parathyroid hormone & calcitonin
  - Organ system response
    - Intestines
    - Bones
    - Kidneys
- Calcium rigor
- Calcium tetany
**CALCIUM BALANCE**

**Rising blood calcium** signals the thyroid gland to secrete calcitonin.*

1. **Calcitonin** inhibits the activation of vitamin D.
2. **Calcitonin** prevents calcium reabsorption in the kidneys.
3. **Calcitonin** limits calcium absorption in the intestines.
4. **Calcitonin** inhibits osteoclast cells from breaking down bone, preventing the release of calcium.

All these actions lower blood calcium levels, which inhibits calcitonin secretion.

**Falling blood calcium** signals the parathyroid glands to secrete parathyroid hormone.

1. **Parathyroid hormone** stimulates the activation of vitamin D.
2. **Vitamin D** and **parathyroid hormone** stimulate calcium reabsorption in the kidneys.
3. **Vitamin D** enhances calcium absorption in the intestines.
4. **Vitamin D** and **parathyroid hormone** stimulate osteoclast cells to break down bone, releasing calcium into the blood.

All these actions raise blood calcium levels, which inhibits parathyroid hormone secretion.

*Calcitonin plays a major role in defending infants and young children against the dangers of rising blood calcium that can occur when regular feedings of milk deliver large quantities of calcium to a small body. In contrast, calcitonin plays a relatively minor role in adults because their absorption of calcium is less efficient and their bodies are larger, making elevated blood calcium unlikely.
Absorption

- Adults absorb about 30% of the calcium ingested
  - Stomach’s acidity – calcium soluble
  - Vitamin D – calcium-binding protein

Efficiency and inadequate intakes

- Factors that enhance calcium absorption
- Factors that inhibit calcium absorption
CALCIUM

- Recommendations
  - Based on amount needed to retain calcium in bones
    - Peak bone mass
  - Set high enough to accommodate 30% absorption rate
  - UL has been established
  - Adverse effects from supplements
MAINTAINING BLOOD CALCIUM

With an adequate intake of calcium-rich food, blood calcium remains normal... 

...and bones deposit calcium. The result is strong, dense bones.

With a dietary deficiency, blood calcium still remains normal...

...because bones give up calcium to the blood. The result is weak, osteoporotic bones.
CALCIUM

- Milk products
  - Calcium is most abundant in milk products
  - Conceal milk products in foods
  - Consequences of drinking too little milk
- Other foods
  - Bioavailability
  - Fortified juices and foods
- Calcium and iron
BIOAVAILABILITY OF CALCIUM FROM SELECTED FOODS

- **≥50% absorbed**
  - Cauliflower, watercress, cabbage, brussels sprouts, rutabaga, kale, mustard greens, bok choy, broccoli, turnip greens

- **≈30% absorbed**
  - Milk, calcium-fortified soy milk, calcium-set tofu, cheese, yogurt, calcium-fortified foods and beverages

- **≈20% absorbed**
  - Almonds, sesame seeds, pinto beans, sweet potatoes

- **≤5% absorbed**
  - Spinach, rhubarb, Swiss chard
CALCIUM

- Deficiency
  - Peak bone mass by late 20s
  - All adults lose bone with age
    - Begins between 30 and 40 years of age
  - Osteopenia
  - Osteoporosis
    - Silent disease
    - Blood samples offer no clues
PHASES OF BONE DEVELOPMENT THROUGHOUT LIFE

Bone density

10  20  30  40  50  60  70  80 years

Active growth  Peak bone mass  Bone loss
PHOSPHORUS

- Second most abundant mineral in body
  - Hydroxyapatite crystals of bone and teeth
- Roles in body
  - Part of major buffer system
  - Part of DNA and RNA
  - Assists in energy metabolism
  - Helps transport lipids in the blood
  - Structural component of cell membranes
PHOSPHORUS

- Recommendations and intakes
  - Deficiencies are unlikely
  - Best sources
    - Foods rich in proteins
    - Phosphoric acid intake and bone density
  - UL has been established
MAGNESIUM

Body locations

- More than half is found in the bones
  - Reservoir
- Muscles and soft tissues
- Extracellular fluid
MAGNESIUM

Roles in body

- Maintains bone health
- Part of protein making machinery
- Necessary for energy metabolism
- Participates in enzyme systems
- Catalyst in ATP production
- Muscle contraction and blood clotting
- Supports normal function of immune system
MAGNESIUM

- **Intakes**
  - Average dietary intake for U.S. adults is below recommendations
  - Hard water contributions

- **Sources**
  - Legumes, seeds, and nuts
  - Leafy green vegetables
**MAGNESIUM**

- **Deficiency**
  - Rarely occurs
  - Occurs with diseases
  - Causes tetany and impair central nervous system activity

- **Hypertension**
  - Protective factor

- **Toxicity**
Sources of sulfate

- Food and beverages
- Amino acids
  - Methionine
  - Cysteine

No recommended intake

- Normal protein intake