

Chapter 8: Water and Minerals

BPK 110

- 60% of body weight = water
- found inside (2/3) and outside (1/3) of cells
- water content of intra/extracell. spaces depends on: **solute concentrations** (proteins, sodium, potassium etc); water moves by **osmosis** to achieve proper solute concentrations AND **blood pressure**, which forces water out of blood

Water balance: each day water loses approximately equal water gains

Functions of Water

- solvent
- metabolism and transport
- protection
- hydrolysis/dehydration reactions
- regulation of body temp. (sweating, where water within sweat is pushed to the skin's surface, and when it evaporates, it leaves behind a cooling sensation)

Water in Health and Disease: Dehydration

- deficiency causes symptoms more rapidly than any other nutrient! (also leads to deficiencies in electrolytes)
- dehydration reduces blood volume, impairing nutrient delivery, waste removal
- early symptoms: thirst, headache, fatigue, loss of appetite, dry eyes/mouth, dark urine
- late symptoms: nausea, difficulty concentration, confusion, disorientation, collapse

Water Intoxication

- leads to **hyponatremia** (too much water in relation to sodium= drop in Na concentration)
- water moves into tissues, leading to swelling

Water Needs

- low calorie diets increase water needs as more is needed to excrete wastes from fat/protein metabolism
- high fiber, high salt diets increase needs
- caffeine, alcohol act as *diuretics*, increasing urge to urinate

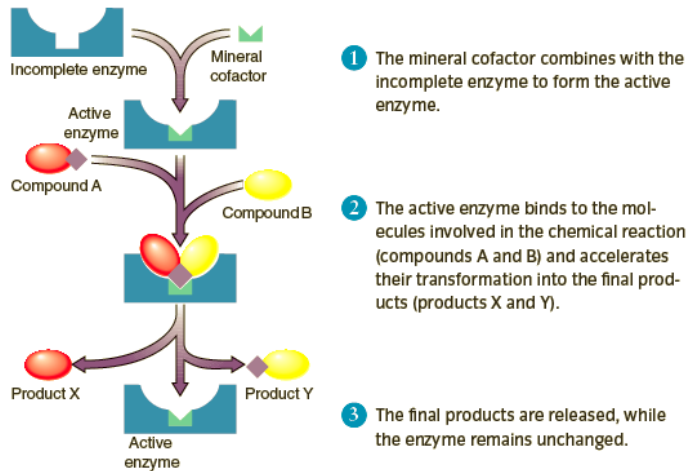
Minerals

- major minerals: need >100mg/ day, trace minerals: need <100mg/d
- high in animal products and more readily available to the body when found in animal products

Oxalates, Tannins and Phytates: Compounds that interfere with mineral absorption

- block mineral availability

Some minerals can function as cofactors, activating enzymes



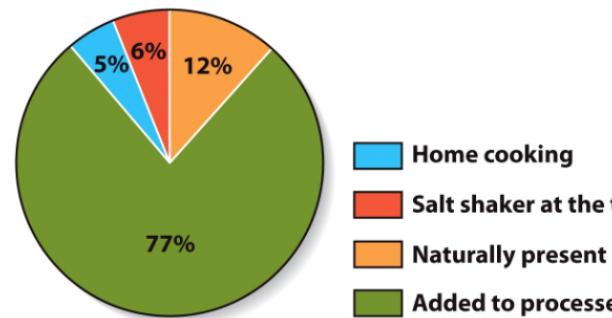
Just like vitamins can act as coenzymes, minerals can act as cofactors in a similar way— they are required to be attached to that protein enzyme in order to have that enzyme work

The Electrolytes: Sodium, Potassium, Chloride

- charged ions (+/-) that are responsible for the electrical activity of the body
 - sodium = main extracellular ion
 - potassium = main intracellular one
- regulate fluid balance
- deficiency typically associated w excessive sweating, diarrhea, vomiting
- natural sources of the electrolyse tend to be higher in potassium and lower in sodium

Sodium and Potassium

- diets higher in sodium and lower in potassium are associated w higher risk of hypertension
- sodium
 - found in salt and processed foods
 - recommended to stay below 2300mg/day



- deficiency can be evidenced in muscle cramps
- potassium
 - found in fruits, veggies, whole grains, legumes, meats
 - deficiency can lead to muscle cramps, irregular heartbeat

Electrolytes in Disease: Hypertension: the silent killer

- high BP (most common health problem related to minerals)
- can lead to atherosclerosis, heart attack, stroke, kidney disease, death
- affects 1/5 adult Canadians (15% of ppl with hypertension don't know they have it)
- risk factors: genetic factors, age, abdominal obesity, physical inactivity, alcohol, stress, diet
- diets high in salt (sodium chloride) increases risk
- diets high in K, Ca, Mg = decreases
- DASH diet is associated w a lower BP
 - high in whole grains, fibre, F/V, low in fat, lean meats, limited fats and sweets
 - these results are exacerbated by low sodium intake

Major Minerals and Bone Health (Ca, P, Mg, S)

- calcium
 - found in dairy products, fish with bones, leafy greens
 - functions in nerve transmission, muscle contraction, bone and tooth structure
- phosphorus
 - found in meat, dairy, cereal
 - functions in bones and tooth health, ATP and DNA structure

Bone Overview

- bone is composed of a protein matrix (collagen) hardened by mineral deposits of calcium and phosphorus
 - calcium and phosphorus form **hydroxyapatite crystals**, which mineralize bones and teeth
- bone is always **remodelling**: breaking down and building up
 - this process involves three cell types
 - osteoclasts- bone breaking cells
 - osteoblasts - bone building cells (immature bone cells)

- become osteocytes (mature bone cells) when incorporated into bone

Peak Bone Mass: Avoiding Osteoporosis

- until age 30, limited time to build up bone mass, after that it declines (esp for women after menopause due to drop in estrogen)
- weight bearing activity, calcium, vit. D important to prevent osteoporosis: reduced bone mass

Prevention of Osteoporosis

- changeable risk factors: low weight-bearing exercise, diet low in calcium/vit D, smoking, etc
- non changeable risk factors: gender (2x more likely in women) age, race (africans)
- treatment: estrogen, calcium/vit D supplements, weight bearing activity

Calcium Regulation

- Drop in blood calcium levels = \uparrow parathyroid hormone release, which stimulates

- Bone reabsorption: \uparrow osteoclast activity to release Ca^{2+} from bone

- Reduced Ca^{2+} loss in urine at the kidneys

- \uparrow activity of Vitamin D

- Increases Ca^{2+} absorption at kidneys

- Increase in blood calcium levels = \uparrow calcitonin release

- Primarily works on bone to inhibit Ca^{2+} release into blood

- bone reabsorption = bone breakdown— when bone breaks down, calcium is released

Trace Minerals

Iron

- found in red meats, leafy greens, legumes, enriched grains
- iron is part of the iron-containing protein hemoglobin and myoglobin; crucial for oxygen transport
- iron toxicity is a common form of poisoning in children <6 , who may mistake their caregiver's iron capsules for candies

Iron Absorption and bioavailability

- bioavailability depends on type of iron in food
- **hemo iron**- part of hemo/myoglobin; in animal sources (more easily absorbed and 2x that of non-heme iron)
- **non-heme iron**- found in plant sources which are harder to absorb
 - absorption improved when eaten with sources of heme iron, vitamin C
- absorption decreased by fibre, phytates, tannins, oxalates
- vegetarians esp females are at increased risk for iron deficiency

Iron Deficiency anemia (most common nutritional deficiency in the world) = late stage iron def.

- results in pale, small tbs'x fatigue, weakness, headache
- without enough iron to make enough functional red blood cells; a person's ability to shuttle oxygen around the body is compromised — leaving them feeling weak and tired
 - Sprinkles fight micronutrient deficiencies

Copper

- found in organ meats, nuts, seeds, whole grains
- combines w proteins to produce functional enzymes that work in lipid metabolism, collagen synthesis
- copper deficiency can lead to iron-deficiency anemia bc a copper-containing protein is required for iron absorption

Zinc— most abundant trace mineral, has many roles

- found in meat, seafood
- crucial role in gene expression as it regulates protein synthesis
- part of antioxidant **zinc superoxide dismutase**

Selenium

- found in meats, seafood, eggs, whole grains
- part of **glutathione peroxide**; an antioxidant
- deficiency can lead to **Keshan's Disease** (heart disease) in areas where soil is low in selenium

Iodine

- part of thyroid hormones: regulate metabolic rate
 - if deficiency occurs, cannot synthesize enough thyroid hormone at **thyroid gland**
 - symptoms include: slower metabolic rate, fatigue, weight gain
 - can lead to a goiter; reversible (thyroid gland tries to synthesize enough TH, but cannot, gland enlarges)
 - can lead to cretinism; irreversible
 - due to inadequate maternal levels during pregnancy
 - impairs mental function, growth

Fluoride

- found in toothpaste, fish, tea, etc
- functions to strengthen teeth, enhances remineralization of tooth enamel
- helps prevent dental caries as it helps form **fluorapatite crystals** that harden tooth enamel
- too much can lead to fluorosis, which can leave a mottled appearance on teeth