Chapter 8

Minerals and Water

PowerPoint® Lecture Slide Presentation
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Water

- Water is the most indispensable nutrient
- Makes up about 60 percent of an adult’s weight
What Is Water and Why Is It So Important?

Water is the most abundant substance in body.

- **Average healthy adult is about 60% water**
- Can only survive a few days without water. Food, however, we would last about 3 weeks without it.
- **Electrolytes:** minerals that help maintain fluid balance
Because ions dissolved in water can carry an electrical current, the charged ions are called electrolytes.

The electrolytes are sodium, chloride and potassium.
Why Is Water the Most Indispensable Nutrient?

- Water is nearly a universal solvent
- Dissolves amino acids, glucose, and minerals
- Serves as the solvent for chemicals in the body
- Cleanses the tissues and blood of wastes
- Its molecules resist being crowded together
- Acts as a lubricant around joints
- Serves as a shock absorber inside eyes, spinal cord, joints, and amniotic sac
- Aids in maintaining the body’s temperature
Why Is Water the Most Indispensable Nutrient?

Human life begins in water

Water provides the medium for temperature regulation and shock protection.
Quenching Thirst and Balancing Losses

- Thirst lags behind a lack of water
- To ignore thirst is to invite dehydration
- When a person is thirsty, they may already have lost up to 2 cups of total fluid
- Dehydration: Progression of symptoms: thirst → weakness → exhaustion and delirium → death

Water intoxication occurs when too much plain water floods the body’s fluids and disturbs their normal composition

- Can occur if several gallons of water are consumed in a few hours’ time
- Can be fatal
Water Helps Regulate Your Body Temperature

1. Heat is carried by the water in blood to the capillaries at the skin surface.
2. The heat is released at the skin surface. Evaporation of sweat cools the skin.
3. Cooled blood returns to the body core.
What Is Water Balance and How Do You Maintain It?

- **Water balance:** water consumed = water lost
- You take in water through beverages and food.
- You lose water through your kidneys (as urine), large intestine, lungs, and skin (as sweat).

- Losing too much water can cause dehydration.
  - Dehydration can result from inadequate water intake or too much water loss from diarrhea, vomiting, high fever, or use of diuretics.
What Is Water Balance and How Do You Maintain It?

Other ways to tell if you are dehydrated:

• **Cornerstone method**: measure body weight before and after high physical activity or labor
  - Changes in body weight due to loss or gain of body water

• **Urine color**: urine is more concentrated when dehydrated and darker in color

Consuming too much water can cause hyponatremia (sodium blood level too low).

• Sometimes this can happen during endurance athletic events or strenuous military training
Water Intake

- Eating a meal high in salt can temporarily increase the body’s water content; the body sheds the excess over the next day as the sodium is excreted.

- The brain and kidneys regulate water excretion.
  - Water intake is regulated by thirst and satiety.
Daily water needs vary depending on physical activity, environmental factors, and diet.

Recommendations based on reported total water intake of healthy Americans

- **Men:** 16 cups/day (about 13 cups of beverages)
- **Women:** 12 cups/day (about 9 cups of beverages)

About 80% from beverages, 20% from foods
Safety and Sources of Drinking Water

- Water is **practically** a universal solvent: it dissolves almost anything it encounters to some degree. (It will not dissolve oil.)

- Hundreds of contaminants have been detected in public drinking water
Safety of Public Water

- The Environmental Protection Agency (EPA) is responsible for ensuring that public water systems meet minimum standards for protection of health.

- Public water systems remove some hazards; treatment includes the addition of a disinfectant (usually chlorine) to kill most microorganisms.
ABC Video: Bottled Water
What Are Minerals and Why Do You Need Them?

- **Major minerals** *(macrominerals)*: needed in amounts >100 milligrams/day

- **Trace minerals** *(microminerals)*: need in smaller amounts <20 milligrams/day

- You need **major minerals** in larger amounts.
  - Sodium, chloride, potassium, magnesium, sulfur play key roles in fluid balance.
  - Calcium, phosphorus, magnesium work together to strengthen bones and teeth.
Sodium

- Sodium is the main positively charged ion outside the body’s cells.
- Sodium is a major part of the body’s fluid and electrolyte balance system.
- Helps maintain acid-base balance.
- Is essential to muscle contraction and nerve transmission.
Sodium

- The more processed a food the more sodium it contains and the less potassium it contains.
- Sodium chloride = table salt

- A deficiency of sodium would be harmful, but no known human diets lack sodium.
Sodium

- Sodium balance in your body
  - **Sodium level is maintained by kidneys** reducing or increasing sodium excretion as needed.
  - Smaller amounts lost in stool and sweat
- Daily needs: **1,500 µg/day for adults under 51**
- Food sources: about **77%** of sodium consumed by Americans is from processed foods.
Hypertension is a silent killer.

- No symptoms – have blood pressure checked regularly
- Contributes to atherosclerosis, heart enlarges, weakens
- Damages arteries leading to brain, kidneys, legs, increasing risk of stroke, kidney failure, partial amputation of leg

To control hypertension:

- Reduce weight, increase physical activity, healthy, balanced diet
Potassium

• Potassium is the principal positively charged ion inside the body’s cells

• Plays a major role in maintaining fluid and electrolyte balance and cell integrity, and is critical in maintaining a heartbeat
Potassium

Food sources:

• Fruits and vegetables
  • Minimum of 7 servings/day will meet potassium needs
  • Dairy foods, nuts, legumes also good sources
Calcium - most abundant mineral in the body

- Nearly all (99%) of the body’s calcium is stored in the bones and teeth.
- Two important roles:
  - Integral part of bone structure
  - Serves as a bank that can release calcium to the body fluids if the slightest drop in blood concentration occurs
Calcium

Functions:

• Helps build strong bones and teeth
• Plays a role in muscles, nerves and blood
• May help lower high blood pressure
• May fight colon cancer
• May reduce risk of kidney stone
• May reduce risk of obesity
Calcium and the Bones

- Skeleton is a bank from which the blood can borrow and return calcium as needed
- If more calcium is needed in the body, the body can increase the absorption from the intestine and prevent its loss from the kidneys
- More calcium is needed for growth: infants and children absorb ≈60% of ingested calcium, pregnant women absorb ≈50%
  Adults absorb ≈25% of dietary calcium
• Bone loss is an inevitable consequence of aging.
• Sometime around age 30, or 10 years after adult height is achieved, the skeleton no longer adds to bone density.
• After about age 40, bones begin to lose calcium but the loss can be slowed somewhat by diet and regular physical activity.
Calcium and the Bones

- **Osteoporosis**, or adult bone loss, occurs if a person’s calcium savings bank is not sufficient.
- A diet low in calcium-rich foods during the growing years may prevent person from achieving **peak bone mass**.
- Calcium from low-fat milk and milk products may play a role in maintaining a healthy body weight.
Obtaining enough calcium in childhood helps ensure that the skeleton starts adulthood with a high bone density.

Authorities recommend foods as a source of calcium in preference to supplements.
Calcium

Food sources:

- Milk, yogurt, cheese, broccoli, kale, canned salmon (with bones), tofu processed with calcium, calcium-fortified juices and cereals
Calcium

Too much or too little:

- UL: 2,500 milligrams/day
- Too much calcium leads to **hypercalcemia**: impaired kidneys, calcium deposits in body
- Too little can lead to less dense, weakened, brittle bones and increased risk for osteoporosis
Phosphorus

Second most abundant mineral in body

• 85% in bones, rest in cells and fluids outside cells, including blood

Functions:

• Needed for bones and teeth
• Important component of cell membranes
• Needed for energy metabolism and stores
• Acts as a blood buffer
• Part of DNA and RNA
Phosphorus

Daily needs:

- Adults 700 µg/day

Food sources:

- Meat, fish, poultry, dairy
- Abundant in diet

Too much or too little:

- UL set at 4,000 µg/day for adults
- Too little can result in muscle weakness, bone pain, rickets, confusion, death; would need to be in state of near starvation to experience deficiency
Magnesium

• A major mineral and yet there is only about 1 ounce in a 130-pound person, over half in the bones.

• Most of the body’s magnesium is in the bones and can be drawn out for all the cells to use in building protein and using the energy nutrients.
Magnesium

Fourth most abundant mineral in body

- About half in bones, most of rest inside cells

Functions:

- Helps >300 enzymes, including energy metabolism
- Used in synthesis of protein
- Helps muscles and nerves function properly
- Maintains healthy bones and regular heartbeat
- May help lower high blood pressure and reduce risk of type 2 diabetes
Magnesium

Daily needs:

- 19-30 years: Males 400 µg/day; Females 310 µg/day
- >30 years: Males 420 µg/day; Females 320 µg/day
- Many Americans fall short (70-80% of needs)

Food sources:

- Whole grains, vegetables, nuts, fruits; also milk, yogurt, meat, eggs

Too much or too little:

- UL from supplements (not foods) is set at 350 µg/day to avoid diarrhea
- Deficiencies are rare, but diuretics and some antibiotics can inhibit absorption.
Chloride

- Chloride is the body’s major negative ion working both inside and outside the cell; it is responsible for stomach acidity and assists in maintaining body chemistry.

- No known diet lacks chloride.
Chloride

Chloride is part of hydrochloric acid in the stomach that enhances protein digestion.

- **Functions:**
  - Acts as buffer to keep blood at normal pH
  - Daily needs: **Adults 2,300 µg/day**
  - Food sources: Salt (NaCl) is main source
  - Too much or too little: deficiencies rare
  - UL 3,600 µg/day to match sodium UL
Sulfate/Sulfur

- Sulfate is the oxidized form of sulfur as it exists in food and water.
- Used to synthesize sulfur-containing body compounds.
- Sources of sulfur are protein-containing foods
Osteoporosis: Not Just Your Grandmother’s Problem

• Bones are living tissue, constantly changing

• Peak bone mass occurs in early adulthood (20s).
  • Then slowly more bone is lost than added
  • As bones lose mass, become more porous and prone to fractures, leading to osteoporosis

• Bone mineral density (BMD) test measures bone density
  • Low score = osteopenia (low bone mass)
  • Very low score = osteoporosis
Osteoporosis: Not Just Your Grandmother’s Problem

Risk factors for osteoporosis:

• Gender (females at higher risk due to loss of estrogen after menopause)

• Ethnicity (Caucasian and Asian-American at higher risk)

• Body type (smaller-boned/petite women at higher risk)

• Family history of fractures increases risk

• Level of sex hormones (amenorrhea, menopause, or men with low levels of sex hormones)
Osteoporosis: Not Just Your Grandmother’s Problem

• Medications: glucocorticoids, antiseizure medications, aluminum-containing antacids, high amounts of thyroid replacement hormones

• Smoking

• Low physical activity: 30 min./day recommended

• Alcohol (more than one drink for women, two for men)

• Inadequate calcium and vitamin D (less than three cups/day of vitamin D-fortified milk or yogurt)
What Are Minerals and Why Do You Need Them?

Trace minerals (microminerals) are needed in small amounts: <20 μg/day

- Present even in smaller amounts in body
- However, play essential roles as important as major minerals
- Chromium and iodine help certain hormones.
- Iron maintains healthy red blood cells.
- Fluoride protects teeth.
- Iron, zinc, copper manganese and molybdenum are cofactors that work with enzymes in critical chemical reactions.
Iron

- Most iron in the body is contained in hemoglobin and myoglobin or occurs as part of enzymes in the energy-yielding pathways.
  - Hemoglobin is the oxygen-carrying protein of red blood cells
Iron

Functions:

- Hemoglobin in red blood cells transports oxygen from lungs to tissues and picks up carbon dioxide waste from cells.
- Myoglobin transports and stores oxygen in muscle cells.
- Helps enzymes that make neurotransmitters.

Daily needs:

- **Men and women >50:** 8 µg/day.
- **Women 19-50:** 18 µg/day: higher due to iron lost during menstruation.

Food sources:

- Iron-enriched bread and grain products; heme-iron in meats, fish and poultry.
Iron

Too much or too little:

- **Deficiency** is most common nutritional disorder in world
- Too much iron from supplements can cause constipation, nausea, vomiting, diarrhea.
- Leading cause of accidental poisoning deaths in children under 6 years
- Iron overload can damage heart, kidneys, liver, nervous system.
- **Hemochromatosis**, a genetic disorder, can cause iron overload
- Iron-deficiency anemia occurs when iron stores depleted and hemoglobin levels decrease
Copper

- Copper is needed to form hemoglobin and collagen and assists in many other body functions.
- Deficiency is rare.
- Good food sources include: organ meats, seafood, nuts, and seeds.
Zinc

- Involved in function of more than 100 enzymes

**Functions:**

- DNA synthesis, growth and development
- Healthy immune system and wound-healing
- Taste acuity
- May reduce risk of age-related macular degeneration

**Daily needs:**

- Men 11 µg/day; women 8 µg/day
- Vegetarians may need as much as 50% more
Zinc

Food sources:

- Red meat, some seafood, whole grains

Too much or too little:

- **UL = 40 µg/day**
- As little as 50 mg can cause stomach pains, nausea, vomiting, diarrhea
- 60 mg/day can inhibit copper absorption
- Excessive amounts can suppress immune system, lower HDL cholesterol
- **Deficiency**: hair loss, impaired taste, loss of appetite, diarrhea, delayed sexual maturation, impotence, skin rashes, impaired growth
Selenium

- Part of *selenoproteins*, many are enzymes

**Functions:**
- Selenoproteins:
  - Help regulate thyroid hormones
  - Act as antioxidants
  - May help fight cancer
- Daily needs: *adults: 55 micrograms/day*
- Food sources: meat, seafood, cereal, grains, dairy foods, fruits, vegetables
- Amount varies depending on soil content
Selenium deficiency rare in U.S.
Fluoride

Functions:

• Protects against dental caries
• Helps repair enamel eroded by acids from bacteria
• Reduces amount of acid bacteria produce
• Provides protective barrier
• Fluoridated drinking water has reduced dental caries in U.S.

Daily needs:

• Men 3.8 µg/day; women 3.1 µg/day
Fluoride

Sources: **Foods are not a good source.**

- Fluoridated drinking water and beverages made with this water

Too much or too little:

- Too little increases risk of dental caries.
- Too much can cause **fluorosis** (mottling/staining) when teeth are forming during infancy/childhood.
  - Fluorosis of bones can occur when >10 μg/day is consumed for 10 or more years.
  - UL adults = 10 μg/day, much lower for infants and children
Chromium

- Chromium works with the hormone insulin to control blood glucose concentrations.
- Chromium is present in a variety of unrefined foods.
Iodine

• Iodine is part of thyroxine, the hormone made by the thyroid gland that is responsible for regulating the basal metabolic rate.

• Iodine in food varies because it reflects the soil in which the plants are grown or on which animals graze.
Iodine

- **Functions:** needed by thyroid to make essential hormones
  - Thyroid hormones regulate metabolic rate; help heart, nerves, muscle and intestines function properly
- Daily needs: adults: 150 micrograms/day
- **Food sources:** iodized salt (400 µg/tsp)
Iodine

- Too much or too little: UL = 1,100 µg/day
  - Excess iodine can impair thyroid function, decrease synthesis and release of thyroid hormones
- Early sign of deficiency = goiter (enlarged thyroid gland)
  - Mandatory iodization of salt has decreased iodine deficiency in U.S. but not in other parts of world
  - Iodine deficiency during early stages of fetal development can cause cretinism (congenital hypothyroidism).
Iodine Deficiency

Goiter is an early sign of iodine deficiency.

Cretinism can result from an iodine deficiency during the early stages of fetal development.
<table>
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<th>Mineral</th>
<th>Foods that have it</th>
<th>What it does</th>
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| **Calcium** | 1. milk & dairy products  
2. green leafy vegetables, beans, tofu  
3. shellfish, bony fish | 1. bone, teeth, nerves  
2. blood clotting  
3. muscle contraction |
| **Chromium** | 1. meat  
2. dairy product  
3. whole grains, nuts & seeds | 1. regulation of blood sugar |
| **Copper** | 1. liver  
2. shellfish  
3. peas, beans, nuts seeds | 1. production of RBCs  
2. absorption of iron |
| **Fluoride** | 1. fluoridated toothpaste & H2O  
2. tea  
3. fish | 1. teeth enamel  
2. prevent cavities |
| **Iodine** | 1. seafood  
2. iodized salt | 1. cell function  
2. production of thyroid |
| **Iron** | 1. red meat  
2. whole grains  
3. dark vegetables, peas, beans, eggs | 1. hemoglobin production |
| **Magnesium** | 1. milk & dairy products  
2. green, leafy vegetables  
3. peas & beans | 1. bone growth  
2. muscle contraction  
3. heart muscle contraction |
| **Potassium** | 1. meat, poultry, fish  
2. bananas, oranges dried fruits  
3. peas & beans | 1. fluid balance in cells  
2. nerve & muscle contraction |
| **Phosphorus** | 1. cereals, meats, milk & poultry | 1. bone & cell reproduction |
| **Selenium** | 1. seafood, tuna  
2. whole grains  
3. liver, meat, eggs | 1. heart function  
2. thyroid function  
3. antioxidant |
| **Sodium** | 1. table salt  
2. processed foods (fast foods)  
3. meats, ham, dairy products  
4. Soy Sauce, salsa's | 1. regulates H2O balance  
2. nerve transmission |
| **Sulfur** | 1. meat & eggs  
2. Milk, nuts, & grains | 1. protein metabolism |
| **Zinc** | 1. meat & poultry  
2. seafood  
3. eggs | 1. growth & healing  
2. production of digestive enzymes |