Water

• 50 – 70% of a healthy adult’s body is composed of water

• About 2/3 of this water is within body cells (intracellular fluid)

• The remaining 1/3 is between cells and in blood plasma (extracellular fluid)
**Variation in Water Levels**

- **Tissue type:** lean tissues have higher fluid content than fat tissues

- **Gender:** males have more lean tissue and therefore more body fluid

- **Age:** lean tissue is lost with age and body fluid is lost with it

**Functions of Water**

- Dissolves and transport substances
- Makes up the majority of blood volume
- Helps maintain body temperature
- Protects and lubricates body tissues

**Water Dissolves Salts**

The structural arrangement of the two hydrogen atoms and one oxygen atom enables water to dissolve salts. Water’s role as a solvent is one of its most valuable characteristics.

**Water and Body Temperature**

Heat released from skin
- Sweat evaporates and cools skin and blood at skin surface
- Blood vessels
- Sweat gland
- Core heat
- Cooled blood flows back to body core
- Heat travels to skin
- Hair

Human skin diagram showing heat regulation mechanisms involving sweat glands and blood vessels.
Heat Stroke

- Heat stroke: A potentially fatal response to high temperature characterized by failure of the body’s heat-regulating mechanisms

- Is sometimes called sunstroke

Water: Recommended Intake

- Adult women: 2.7L/day
  - 2.2L (9 cups) as beverages
- Adult men: 3.7L/day
  - 3.0L (13 cups) as beverages
- Varies with
  - Activity Level: 1.0 to 1.5ml for each kcal expended
  - Environment: Hot and/or dry environments increase need for water

Heat Stroke

- Occurs in hot, humid environments
  - Limited ability to sweat
- Symptoms include rapid pulse; hot, dry skin; high body temp; weakness
- Has been fatal for athletes during exercise in extreme heat

Water Loss

- Most is lost through urine
  - Controlled by kidneys
- Some is lost through the lungs during exhalation
- Some is lost through the skin (sweat)
- Rest is lost in feces
Water Gain

- Most water enters the body through beverages
- Some foods have very high water contents
- Metabolic water is a product of many chemical reactions in the body and contributes 10-14% of the body’s needs

Maintaining Fluid Balance

For proper health, water gain MUST equal water loss.

Water Intake

- Too much?
  - Becoming over hydrated is rare
  - Can result in a dilution of sodium

- Too little?
  - Dehydration
  - Infants and the elderly are especially vulnerable

Table 12.2 Percentage of Water in Selected Foods

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Food Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>Water, diet sodas</td>
</tr>
<tr>
<td>90-99%</td>
<td>Fat-free milk, strawberries, watermelon, lettuce, cabbage, celery, spinach, broccoli</td>
</tr>
<tr>
<td>80-89%</td>
<td>Fruit juice, yogurt, apples, grapes, oranges, carrots</td>
</tr>
<tr>
<td>70-79%</td>
<td>Shrimp, bananas, corn, potatoes, avocados, cottage cheese, ricotta cheese</td>
</tr>
<tr>
<td>60-69%</td>
<td>Pasta, legumes, salmon, ice cream, chicken breast</td>
</tr>
<tr>
<td>50-59%</td>
<td>Ground beef, hot dogs, feta cheese</td>
</tr>
<tr>
<td>40-49%</td>
<td>Pizza</td>
</tr>
<tr>
<td>30-39%</td>
<td>Cheddar cheese, bagels, bread</td>
</tr>
<tr>
<td>20-29%</td>
<td>Pepperoni sausage, cake, biscuits</td>
</tr>
<tr>
<td>10-19%</td>
<td>Butter, margarine, raisins</td>
</tr>
<tr>
<td>1-9%</td>
<td>Crackers, cereals, pretzels, taco shells, peanut butter, nuts</td>
</tr>
<tr>
<td>0%</td>
<td>Oils</td>
</tr>
</tbody>
</table>
Dehydration

- **Dehydration**: Depletion of body fluid that results when fluid excretion exceeds fluid intake (Thompson and Manore)
- Commonly due to heavy exercise or high environmental temperatures
- Sometimes due to diarrhea or use of diuretics
- Infants and the elderly are more at risk

**Urine color can intake body’s water state**

**Thirst**

- **Thirst**: Desire to drink, caused by physiology
- Triggered by
  - Decrease in blood pressure or volume
  - Increase in electrolyte concentration in blood
- Causes dryness in mouth and throat due to lower water levels in bloodstream
- An individual is already dehydrated when he/she becomes thirsty

### Table 12.1: Signs of Dehydration

<table>
<thead>
<tr>
<th>Body Weight Lost (%)</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤1</td>
<td>Thirst, fatigue, weakness, vague discomfort, loss of appetite</td>
</tr>
<tr>
<td>1–2</td>
<td>Impaired physical performance, dry mouth, reduction in urine, flushed skin, impatience, apathy</td>
</tr>
<tr>
<td>3–4</td>
<td>Difficulty in concentrating, headache, irritability, sleepiness, impaired temperature regulation, increased respiratory rate</td>
</tr>
<tr>
<td>5–6</td>
<td>Dizziness, spastic muscles, loss of balance, delirium, exhaustion, collapse</td>
</tr>
</tbody>
</table>

NOTE: The onset and severity of symptoms at various percentages of body weight lost depend on the activity, fitness level, degree of acclimation, temperature, and humidity. If not corrected, dehydration can lead to death.
Electrolytes

**Electrolyte**: A substance that disassociates in solution into positively and negatively charged ions and is thus capable of maintaining an electrical charge (Thompson and Manore)

Electrolytes in the body include:
- Sodium
- Potassium
- Chloride
- Phosphorus
- Calcium

Electrolytes carry electrical charges:
- Sodium and potassium are positively charged
- Chloride and phosphorus are negatively charged

Fluids have an overall neutral charge due to the balances between positively and negatively charged electrolytes

Location of Electrolytes

- Potassium and Phosphorus are the predominant electrolytes in intracellular fluid
- Sodium and Chloride are the predominate electrolytes in extracellular fluid
Electrolytes and Water

- Solutions in contact with each other “want” to be the same concentration
- Location of electrolytes determines the location of water

Osmosis

- Electrolytes and water find their balance in the body through the process of osmosis
- **Osmosis**: The movement of water across a membrane toward the side where the solutes (electrolytes) are more concentrated (Whitney and Rolfes)
When sprinkled with salt, vegetables “sweat” because water moves toward the higher concentration of salt outside the eggplant.

When immersed in water, raisins get plump because water moves toward the higher concentration of sugar inside the raisins.

Functions of Electrolytes

• Help regulate fluid and pH balance
• Signal our muscles to contract (Calcium)
• Help nerves respond to stimuli (Sodium and Potassium)

Sodium

• How much: Major mineral
• From where: Naturally in many foods and high in processed foods (sodium chloride = salt)
Sodium: Functions

- Fluid and electrolyte balance
  - blood pressure
  - pH balance
- Required for nerve impulse transmission
- Assists in the transport of certain nutrients (eg., glucose) into body cells

Sodium: Recommended intake

- 500mg/day is required
- Less than 2,400mg/day is recommended
- Most Americans consume too much salt

Sodium Too much sodium?

- Hypernatremia is abnormally high blood sodium concentration
- Can happen to patients with congestive heart failure or kidney disease
- Results in high blood volume, high blood pressure, and edema
**Sodium**

Too little sodium?
- Hyponatremia is an abnormally low blood sodium level
- Can result from prolonged vomiting, diarrhea, or sweating
- Has been seen in marathon runners who consume too much water (overhydration leads to water intoxication)

**Water Intoxication**

- The rare condition in which body water contents are too high in all body fluid compartments (Whitney and Rolfes)
- Intake of water is too high in comparison with retention of or intake of sodium and other electrolytes

**Chloride**

- How much: Major mineral
- From where: Fruits and vegetables, but mostly from salt in processed foods and table salt (sodium chloride - salt)

**Water Intoxication**

- Seen in marathon runners and other competitors in athletic events of long duration
  - 18% of long distance tri-athletes suffer from water intoxication
- Leads to headaches, confusion, seizures, coma and death
- Drinking water with electrolytes can help prevent water intoxication
Chloride: Functions

- Assists with maintaining fluid balance
- Assists the immune system
- Too much can be lost with excessive vomiting (loss of stomach’s hydrochloric acid)

Potassium: Functions

- Fluid and electrolyte balance
- Involved in muscle contractions
- Involved in transmission of nerve impulses
- High potassium intake helps to maintain a lower blood pressure

Potassium

- How much: Major mineral
- From where: Fresh fruits and vegetables, whole grains. Low in processed foods.

- Too much potassium?
  - Hyperkalemia is a high blood potassium level
  - Can occur in patients with kidney disease
  - Can alter normal heart rhythm resulting in a heart attack
**Potassium**

- Too little potassium?
  - Hypokalemia is low blood potassium levels
  - Can be seen in patients with kidney disease or diabetic acidosis
  - Can occur when taking certain diuretic medications

**Phosphorus**

- How much: Major mineral
- From where: Widespread in foods, especially ones with protein

**Phosphorus: Functions**

- The major intracellular, negatively charged electrolyte
- Required for fluid balance
- Critical role in bone formation
- Regulates biochemical pathways by activating or deactivating enzymes
- Found in ATP, cell membranes, DNA

**Electrolytes and Water Balance**

Electrolytes in intracellular fluid compared to extracellular fluid.
- (a) Equal
- (b) More concentrated
- (c) More dilute
Phosphorus

• Too much phosphorus?
  - Causes muscle spasms and convulsions
  - High blood phosphorus can occur with:
    • Kidney disease
    • Taking too many vitamin D supplements

Calcium

• How much: Major mineral
  - Important in bones and blood

• From where: Dairy, green leafy vegetables, fortified foods

• Functions: 1) Bone and tooth health
  2) Electrolyte balance
  3) Needed for proper nerve and muscle function

Medical Disorders

Disorders related to fluid and electrolyte imbalance include:
- Dehydration
- Heat stroke
- Water intoxication
- Hypertension
- Muscle disorders

Hypertension

• Hypertension: a chronic condition characterized by high blood pressure (Thompson and Manore)
  - Increases a person’s risk of heart disease, stroke, kidney disease
  - May not show symptoms
Hypertension

- The cause of 95% of hypertension cases is unknown
- Increases with age
- May be linked with high salt intake in some people
  - Most health organizations recommend a reduced sodium intake

Muscle Disorders

- Can be caused by electrolyte imbalances
  - Causes changes in nervous system function
  - Nervous system changes can alter proper muscle function
- Can result in seizures or muscle cramps
- Can be linked with health problems or inappropriate intake of electrolytes, esp. by supplements

Ways to reduce hypertension:
- Lose weight
- Increase physical activity
- Reduce alcohol intake
- Reduce sodium intake
- Increase whole grains, fruits, vegetables, and low-fat proteins
Types of Water

- Distilled water: Is vaporized and condensed so is free of dissolved minerals.
- Mineral water: From well or spring that typically contains more than 250-500 ppm of minerals. Can be high in sodium.
- Public/Tap water: Water from a municipal or county water system than has been treated and disinfected. Often from reservoirs, rivers, and/or aquifers.

Whitney and Rolfes

Types of Water cont.

- Hard water: High in calcium and magnesium
- Soft water: High in sodium and potassium
- Filtered water: Treated by filtration, usually using activated carbon filters or reverse osmosis filters
- Artesian water: Drawn from a well that taps a confined aquifer in which the water is under pressure

Whitney and Rolfes

Bottled Water?

- Bottled water is not necessarily safer than tap water
  - Often is tap water
  - Look for brands that carry trademark of International Water Association of America
- Sometimes, people like the taste
  - Mineral water
  - Disinfected with ozone not chlorine

Sports Drinks

- Contain electrolytes and sugars
- Designed for athletes that expend great amounts of energy and sweat for extended periods of time (usually more than one hour)
- Active individuals already get enough sugar and electrolytes from diet
- Due to sugars, can cause weight gain in inactive people
Sports Drinks

Are appropriate for:

- Exercise when dehydration can occur
- Exercise or physical work in high heat or humidity, after diarrhea or vomiting, when unaccustomed to activity in heat
- Exercise at high altitude or in cold
- Rapid rehydration or for energy between exercise bouts when eating is difficult
- Long-duration exercise (>1hr) when blood glucose gets low
- Exercise in people with low glycogen stores due to illness, starvation, or inability to eat prior to exercise

Rehydration for the Sick

- Water
- Water with sugar
- Oral rehydration solution:
  - 1/2 L clean water
  - 4 tsp sugar
  - 1/2 tsp salt
- Intravenous fluids