30.1 Organization of the Human Body

Lesson Objectives

- Describe how the human body is organized.
- Explain homeostasis.

Lesson Summary

**Organization of the Body** The levels of organization in a multicellular organism include cells, tissues, organs, and organ systems.

- A cell is the basic unit of structure and function in living things. Specialized cells are uniquely suited to perform particular functions.
- Groups of similar cells that perform a single function are called tissues. There are four basic types of tissue in the human body: epithelial tissue lines the interior and exterior body surfaces; connective tissue provides support for the body and connects its parts; nervous tissue carries messages in the form of nerve impulses throughout the body; and muscle tissue is responsible for voluntary and involuntary movement.
- Groups of different kinds of tissue that work together to carry out complex functions are called organs.
- A group of organs that performs closely related functions is called an organ system.

**Homeostasis** The different organ systems work together to maintain a controlled, stable internal environment called homeostasis. Homeostasis describes the internal physical and chemical conditions that organisms maintain despite changes in internal and external environments.

- Feedback inhibition, or negative feedback, is the process in which a stimulus produces a response that opposes the original stimulus. An example of feedback inhibition is the way in which the body maintains a constant temperature.
- The liver is important for homeostasis. It converts toxic substances into compounds that can be removed from the body safely. It also helps regulate the body’s glucose levels.

**Organization of the Body**

*Complete each statement by writing the correct word or words.*

1. The tissue that lines the interior and exterior of the body is called **epithelial** tissue.
2. Connective tissue includes fat cells, **bone** cells, and blood cells.
3. The brain, **spinal cord**, and nerves are made up of nervous tissue.
4. Voluntary and involuntary movements are controlled by **muscle** tissue.
5. Complete the table about the organization of the human body.

<table>
<thead>
<tr>
<th>Level of Organization</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell</td>
<td>Basic unit of structure and function in living things</td>
<td>SAMPLE ANSWER: muscle cells</td>
</tr>
<tr>
<td>Tissue</td>
<td><em>Group of cells that perform a particular function</em></td>
<td>SAMPLE ANSWER: nervous tissue</td>
</tr>
<tr>
<td>Organ</td>
<td>Group of different types of tissue that function together</td>
<td>SAMPLE ANSWER: brain</td>
</tr>
<tr>
<td>Organ system</td>
<td><em>Group of organs that perform closely related functions</em></td>
<td>Nervous system</td>
</tr>
</tbody>
</table>

For Questions 6–16, match the function(s) with the organ system.

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
<th>Organ System</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.</td>
<td>Eliminates waste products from the body</td>
<td>A. nervous system</td>
</tr>
<tr>
<td>7.</td>
<td>Produces gametes</td>
<td>B. integumentary system</td>
</tr>
<tr>
<td>8.</td>
<td>Breaks down food</td>
<td>C. immune/lymphatic systems</td>
</tr>
<tr>
<td>9.</td>
<td>Protects the body from disease</td>
<td>D. muscular system</td>
</tr>
<tr>
<td>10.</td>
<td>Recognizes and coordinates the body’s response to changes</td>
<td>E. circulatory system</td>
</tr>
<tr>
<td>11.</td>
<td>Transports oxygen to cells</td>
<td>F. skeletal system</td>
</tr>
<tr>
<td>12.</td>
<td>Produces voluntary movement</td>
<td>G. respiratory system</td>
</tr>
<tr>
<td>13.</td>
<td>Guards against ultraviolet light</td>
<td>H. digestive system</td>
</tr>
<tr>
<td>14.</td>
<td>Brings in oxygen for cellular respiration</td>
<td>I. excretory system</td>
</tr>
<tr>
<td>15.</td>
<td>Protects internal organs</td>
<td>J. endocrine system</td>
</tr>
<tr>
<td>16.</td>
<td>Controls growth and metabolism</td>
<td>K. reproductive system</td>
</tr>
</tbody>
</table>
Homeostasis

17. All of the organ systems in the human body work together to maintain homeostasis. What is homeostasis?

*Homeostasis describes the relatively stable conditions the body maintains despite changes in the internal and external environments.*

18. What is a feedback inhibition? Give an example of how it is used in the human body.

*Feedback inhibition is the process in which a stimulus produces a response that opposes the original stimulus. One example is the maintenance of body temperature.*

19. Why is the liver important for homeostasis?

*The liver converts ammonia and many other dangerous substances, such as drugs, into compounds that can be removed from the body safely. It also regulates the body’s glucose levels.*

20. **THINK VISUALLY** Fill in the missing labels in the diagram to show how a thermostat uses feedback inhibition to maintain a stable temperature in a house.

![Thermostat diagram](image)

21. Which organ systems work together to maintain body temperature?

*The nervous system and the endocrine system work together to maintain body temperature.*
Lesson Objectives

- Explain how food provides energy.
- Identify the essential nutrients your body needs and tell how each is important to the body.
- Explain how to plan a balanced diet.

Lesson Summary

Food and Energy  Molecules in food contain chemical energy that cells use to produce ATP. Food also supplies raw materials cells need to build and repair tissues.

- The energy in food is measured in dietary Calories. One Calorie is equal to 1000 calories. A calorie is the amount of heat needed to raise the temperature of 1 gram of water by 1 degree Celsius.
- A healthy diet provides the body with raw materials to build and repair body tissues and make enzymes, lipids, and DNA.

Nutrients  Nutrients are substances in food that supply the body with energy and raw materials needed for growth, repair, and maintenance. The nutrients that the body needs are water, carbohydrates, fats, proteins, vitamins, and minerals.

- Many of the body’s processes take place in water. Water makes up a large part of blood and other body fluids.
- Simple and complex carbohydrates are the body’s main source of energy. Complex carbohydrates, such as starches, must be broken down into simple sugars to be used for energy.
- Fats are formed from fatty acids and glycerol. Fats help the body absorb fat-soluble vitamins and are a part of cell membranes, nerve cells, and certain hormones.
- Proteins supply raw materials for growth and repair of structures such as skin and muscle. Many enzymes and hormones are proteins.
- Vitamins are organic molecules that the body needs in very small amounts. They are needed to help the body perform chemical reactions.
- Minerals are inorganic nutrients the body needs in small amounts. Examples of minerals include calcium and iron.

Nutrition and a Balanced Diet  The science of nutrition is the study of food and its effects on the body. A balanced diet provides nutrients in adequate amounts and enough energy for a person to maintain a healthful weight.

- Food labels provide general information about nutrition as well as specific information about a food.
- Exercising about 30 minutes a day, eating a balanced diet, and controlling fat intake can help maintain a healthful weight.
Food and Energy

Write True if the statement is true. If the statement is false, change the underlined word or words to make the statement true.

1. A calorie is the amount of heat needed to _lower_ the temperature of 1 gram of water by 1 degree Celsius.

2. One dietary Calorie is equal to _2000_ calories.

3. The energy stored in food molecules is used to produce ATP.

4. The body needs raw materials from food to build body tissues and make enzymes, lipids and _DNA_.

Nutrients

For Questions 5–16, match each description with the nutrient. Each nutrient may be used more than once.

<table>
<thead>
<tr>
<th>Description</th>
<th>Nutrient</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Provide the body with building materials for growth and repair</td>
<td>A. water</td>
</tr>
<tr>
<td>6. Needed to build cell membranes, produce certain hormones, and store energy</td>
<td>B. carbohydrates</td>
</tr>
<tr>
<td>7. Major source of food energy</td>
<td>C. fats</td>
</tr>
<tr>
<td>8. Makes up the bulk of most body fluids</td>
<td>D. proteins</td>
</tr>
<tr>
<td>9. Inorganic nutrients</td>
<td>E. vitamins</td>
</tr>
<tr>
<td>10. Organic molecules used by the body to help regulate body processes</td>
<td>F. minerals</td>
</tr>
<tr>
<td>11. May be saturated or unsaturated</td>
<td></td>
</tr>
<tr>
<td>12. Required to produce the compound that makes up bones and teeth</td>
<td></td>
</tr>
<tr>
<td>13. May be fat-soluble or water-soluble</td>
<td></td>
</tr>
<tr>
<td>14. Polymers of amino acids</td>
<td></td>
</tr>
<tr>
<td>15. May be monosaccharides, disaccharides, or polysaccharides</td>
<td></td>
</tr>
<tr>
<td>16. The most important nutrient</td>
<td></td>
</tr>
</tbody>
</table>

17. What are three ways the body loses water?
   The body loses water through sweat, urine, and exhaling breaths.
Nutrition and a Balanced Diet

18. What is the science of nutrition?
   **the study of food and its effects on the body**

Complete each statement by writing the correct word or words.

19. A gram of fat has more Calories than a gram of carbohydrate because carbon atoms in fat have more carbon to **hydrogen** bonds than the carbon atoms in carbohydrates.

20. Nutrient needs are affected by age, **gender**, and lifestyle.

21. When a person stops growing or becomes less active, energy needs **decrease**.

22. Percent Daily Values found on food labels are based on a **2000-Calorie** diet.

23. Eating a balanced diet and exercising **30 minutes** a day can help maintain a healthful weight.

24. Physical activity can **strengthen** the heart, bones, and muscles.

25. Diets that are high in **saturated fat** and trans fat increase a person’s risk of developing heart disease and Type II diabetes.

Apply the Big idea

26. How can poor food choices negatively affect a person’s health?
   
   The body requires particular nutrients for energy and raw materials. Someone who eats an unhealthy diet deprives their body of the materials needed to adequately build and repair body tissue, produce ATP for energy, and make enzymes, lipids, and DNA. Diets high in fats and sugars can lead to problems such as vitamin deficiencies, obesity, heart disease, and diabetes.
30.3 The Digestive System

Lesson Objectives

- Describe the organs of the digestive system and explain their functions.
- Explain what happens during digestion.
- Describe how nutrients are absorbed into the bloodstream and wastes are eliminated from the body.

Lesson Summary

Functions of the Digestive System  The digestive system converts food into small molecules that can be used by body cells. Food is processed by the digestive system in four phases: ingestion, digestion, absorption, and elimination.

- Ingestion is the process of putting food into your mouth.
- **Mechanical digestion** is the physical breakdown of large pieces of food into smaller pieces. During **chemical digestion**, enzymes break down food into molecules the body can use.
- Food molecules are absorbed into the circulatory system by cells in the small intestine.
- Materials the body cannot digest travel through the large intestine and are eliminated as feces.

The Process of Digestion  During digestion, food travels through the mouth, esophagus, stomach, and small intestine.

- Mechanical digestion begins as teeth tear and grind food. Saliva contains **amylase**, an enzyme that breaks down starches into sugars. This begins the process of chemical digestion. Once food is chewed, it is pushed into the pharynx.
- The tube leading from the pharynx to the stomach is called the **esophagus**. Contractions of smooth muscles, called **peristalsis**, move food through the esophagus to the **stomach**, a large muscular sac that continues digestion.
  - Glands in the stomach lining release hydrochloric acid and the enzyme **pepsin**, which breaks proteins into smaller polypeptide fragments.
  - Contractions of stomach muscles churn the stomach contents, which forms **chyme**, a mixture with an oatmeal-like consistency.
- As chyme moves out of the stomach, it enters the **duodenum**, the uppermost portion of the **small intestine**. Here, digestive fluids from the pancreas, liver, and lining of the duodenum are added to the chyme.

Absorption and Elimination  Most nutrients from food are absorbed by the small intestine. The large intestine absorbs water and prepares waste for elimination from the body.

- The small intestine has fingerlike projections (**villi**) that are covered with microvilli, which absorb nutrients. Most nutrients are absorbed into the blood, but fats are absorbed into the lymph.
- When chyme leaves the small intestine, it enters the **large intestine**, or colon. The large intestine absorbs water and some vitamins that are produced by bacteria in the large intestine. The remaining waste material leaves the body through the anus.
Functions of the Digestive System

1. What is the function of the organs of the digestive system?
   *Their function is to help convert foods into simpler molecules that can be absorbed and used by body cells.*

2. What are the four phases of digestion?
   *ingestion, digestion, absorption, and elimination*

3. What is mechanical digestion?
   *Mechanical digestion is the physical breakdown of large pieces of food into smaller pieces.*

4. How do absorbed food molecules travel to the rest of the body?
   *Once the molecules are absorbed by the small intestines, they enter the circulatory system. The circulatory system transports the molecules throughout the body.*

The Process of Digestion

Write the letter of the correct answer on the line at the left.

5. Where does chemical digestion begin?
   - A. the stomach
   - B. the small intestine
   - C. the mouth
   - D. the esophagus

6. Saliva eases the passage of food through the digestive system and contains
   - A. amylase.
   - B. pepsin.
   - C. sodium bicarbonate.
   - D. bile.

7. Which is the correct order of passage of food through the digestive system?
   - A. mouth, stomach, esophagus, large intestine, small intestine
   - B. mouth, stomach, esophagus, small intestine, large intestine
   - C. mouth, esophagus, stomach, small intestine, large intestine
   - D. mouth, esophagus, stomach, large intestine, small intestine

8. Which of the following is not a role of the pancreas?
   - A. produces sodium bicarbonate
   - B. produces bile
   - C. produces hormones that regulate blood sugar
   - D. produces enzymes that break down carbohydrates, proteins, lipids, and nucleic acids
9. Complete the table about the effects of digestive enzymes.

<table>
<thead>
<tr>
<th>Active Site</th>
<th>Enzyme</th>
<th>Effect on Food</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mouth</strong></td>
<td><em>Salivary amylase</em></td>
<td>Breaks down starches into disaccharides</td>
</tr>
<tr>
<td><strong>Stomach</strong></td>
<td>Pepsin</td>
<td><strong>Breaks down proteins into large peptides</strong></td>
</tr>
<tr>
<td>Small intestine (released from pancreas)</td>
<td><em>Pancreatic amylase</em></td>
<td>Continues the breakdown of starch</td>
</tr>
<tr>
<td></td>
<td>Trypsin</td>
<td><strong>Continues the breakdown of protein</strong></td>
</tr>
<tr>
<td></td>
<td><em>Lipase</em></td>
<td>Breaks down fat</td>
</tr>
<tr>
<td>Small intestine</td>
<td>Maltase, sucrase, lactase</td>
<td><strong>Breaks down remaining disaccharides into monosaccharides</strong></td>
</tr>
<tr>
<td></td>
<td><em>Peptidase</em></td>
<td>Breaks down dipeptides into amino acids</td>
</tr>
</tbody>
</table>

10. **THINK VISUALLY** Draw and label the digestive system. Include the salivary glands, mouth, epiglottis, esophagus, stomach, liver, gallbladder, small intestine, and large intestine.

   **Student drawings should show and label salivary glands, mouth, epiglottis, esophagus, stomach, liver, gallbladder, small intestine, and large intestine.**
Absorption and Elimination

For Questions 11–16, complete each statement by writing the correct word or words.

11. The folded surface and fingerlike projections of the **small intestine** provide a large surface area for absorption of nutrient molecules.

12. The fingerlike projections are called ____ **villi** ____.

13. Capillaries in the villi absorb the products of ____ **carbohydrate** ____ and ____ **protein** ____ digestion.

14. Fats and fatty acids are absorbed by ____ **lymph vessels** ____.

15. In some animals, the ____ **appendix** ____ processes cellulose, but not in humans.

16. Once chyme leaves the small intestine, it enters the large intestine, or ____ **colon** ____.

17. The small intestine is longer than the large intestine. How did the large intestine get its name?

   *Although the large intestine is much shorter than the small intestine, its diameter is much greater than the small intestine's diameter.*

18. What is the primary function of the large intestine?

   *The large intestine absorbs water from undigested material.*

19. What happens to waste materials when they leave the colon?

   *Wastes pass into the rectum and are released from the body through the anus.*

**Apply the Big Idea**

20. What role does the large intestine play in maintaining homeostasis?

   *The primary function of the large intestine is to absorb water. Water is the most important nutrient. The large intestine works with other organ systems to maintain water balance in the body.*
30.4 The Excretory System

Lesson Objectives

- Describe the structures of the excretory system and explain their functions.
- Explain how the kidneys clean the blood.
- Describe how the kidneys maintain homeostasis.

Lesson Summary

Structures of the Excretory System  
Cells produce wastes such as salts, carbon dioxide, and ammonia. For homeostasis to be maintained, these wastes need to be removed from the body. **Excretion** is the process by which metabolic wastes are eliminated from the body.

- The skin excretes excess water, salts, and a small amount of urea in sweat.
- The lungs excrete carbon dioxide and water vapor.
- The liver converts potentially dangerous nitrogen wastes to urea.
- The kidneys are the major organs of excretion. They remove excess water, urea, and metabolic wastes from the blood. **Ureters** carry urine from the kidneys to the **urinary bladder**, where it is stored until it leaves the body through the **urethra**.

Excretion and the Kidneys  
The kidneys remove excess water, minerals, and other waste products from the blood. The cleansed blood returns to circulation. Each kidney has nearly a million processing units called **nephrons**. Filtration and reabsorption occur in the nephrons.

- **Filtration** is the passage of a fluid or gas through a filter to remove wastes. The filtration of blood in the nephron takes place in the **glomerulus**, a small, dense network of capillaries. Each glomerulus is encased by a cuplike structure called **Bowman’s capsule**. Pressure in the capillaries forces fluids and wastes from the blood into Bowman’s capsule. This fluid is called filtrate.

- Most of the material that enters Bowman’s capsule is returned to circulation. The process by which water and dissolved substances are taken back into the blood is called **reabsorption**.

- A section of the nephron tubule, called the **loop of Henle**, conserves water and minimizes the volume of filtrate. The fluid that remains in the tubule is called urine.

The Kidneys and Homeostasis  
The kidneys remove wastes, maintain blood pH, and regulate the water content of the blood.

- The activity of the kidneys is controlled in part by the composition of blood. For example, if blood glucose levels rise well above normal, the kidneys excrete glucose into the urine.

- Disruption of kidney function can lead to health issues such as kidney stones and serious health issues such as kidney damage, and kidney failure.
  - Kidney stones occur when minerals or uric acid salts crystallize and obstruct a ureter.
  - Kidney damage is often caused by high blood pressure or diabetes.
  - When a patient’s kidneys can no longer maintain homeostasis, the patient is said to be in kidney failure.
Structures of the Excretory System

1. Why does the body need an excretory system?
   
   The human body produces chemical waste products. Some of these waste products can be toxic and may cause death if they are not eliminated from the body. The excretory system eliminates these harmful waste products.

2. What is excretion?
   
   Excretion is the process by which metabolic wastes are eliminated from the body to maintain homeostasis.

3. What waste compounds are produced by every cell in the body?
   
   excess salts, carbon dioxide, and ammonia

4. What organs are included in the excretory system?
   
   skin, lungs, liver, kidneys, ureters, urinary bladder, and the urethra

5. Complete the table about the excretory system.

<table>
<thead>
<tr>
<th>Organ</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin</td>
<td>Excretes excess water, salts, and urea in sweat</td>
</tr>
<tr>
<td>Lungs</td>
<td>Excrete carbon dioxide and water vapor when you exhale</td>
</tr>
<tr>
<td>Liver</td>
<td>Converts dangerous nitrogen wastes into urea</td>
</tr>
<tr>
<td>Kidneys</td>
<td>Remove excess water, urea, and metabolic wastes from the blood; produce urine</td>
</tr>
<tr>
<td>Ureters</td>
<td>Transport urine from kidneys to the bladder</td>
</tr>
<tr>
<td>Urinary bladder</td>
<td>Stores urine</td>
</tr>
<tr>
<td>Urethra</td>
<td>Releases urine from the body</td>
</tr>
</tbody>
</table>
Excretion and the Kidneys

6. Complete the concept map.

For Questions 7–10, write True if the statement is true. If the statement is false, change the underlined word or words to make the statement true.

7. Each kidney has nearly a million individual processing units called capillaries.

8. The material that is filtered from the blood contains water, urea, glucose, salts, amino acids, and some vitamins.

9. A number of materials, including salts, are removed from the filtrate by osmosis and reabsorbed by the capillaries.

10. The glomerulus is responsible for conserving water and minimizing the volume of the filtrate.
11. THINK VISUALLY Label the diagram of a nephron.

![Diagram of a nephron]

**The Kidneys and Homeostasis**

12. Describe three ways that the kidneys help maintain homeostasis.

The kidneys help maintain homeostasis by regulating water balance, pH, and blood glucose.

13. Explain how the kidneys regulate the levels of salt in the blood.

The kidneys respond to the composition of the blood. If the level of salt in the blood is too high, the kidneys will return less salt to the blood during reabsorption.

14. How does dialysis work?

During dialysis, a machine performs the role of the kidneys. The patient’s blood is pumped through the machine, cleansed, and pumped back into the body.

15. Urine testing is a common way that doctors can monitor a patient’s health. Suppose a urine test reveals that there are proteins in the patient’s urine. What might be wrong with this patient? What part of the excretory system might not be functioning properly?

The presence of protein in the urine can indicate high blood pressure or diabetes.

Within each nephron is a cluster of capillaries, called a glomerulus, that filters blood. Usually, proteins do not pass through the walls of the capillaries and into the filtrate in the Bowman’s capsule. If proteins are found in the urine, this indicates that the capillaries may be damaged.