The Circulatory, Respiratory, Digestive, and Excretory Systems

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The Circulatory, Respiratory, Digestive, and Excretory Systems

Outline

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**Pacing the Lessons**

Use the **Class Periods per Lesson** table below as a guide for the time required to teach the lessons of this chapter.
### Table 1.1:

<table>
<thead>
<tr>
<th>Lesson</th>
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<tbody>
<tr>
<td>23.1 The Circulatory System</td>
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</table>

- Class periods are assumed to be 60 minutes long.

### Online Resources

See the following Web sites for appropriate laboratory activities:

1. In this lab, students will determine their own blood type. (Lesson 23.1)

2. By solving this lung toxicology problem set, students will develop a better understanding of the physiology of the respiratory system. (Lesson 23.2)

3. Students will investigate the roles of amylase and pepsin in the digestion of different foods. (Lesson 23.3)

4. Students will use chemical reagents to test unknown food samples for specific nutrients. (Lesson 23.3)
   - [http://www.geocities.com/CapeCanaveral/Hall/1410/lab-B-09.html](http://www.geocities.com/CapeCanaveral/Hall/1410/lab-B-09.html)

These Web sites may also be helpful:

1. See this URL for more information about the heart and cardiovascular system.
   - [http://www.fi.edu/learn/heart/index.html](http://www.fi.edu/learn/heart/index.html)

2. This URL accesses games, puzzles, and other activities on the respiratory system.

3. This Web site provides numerous links to quizzes, animations, and articles on the digestive system.

4. This Web site provides easy online access to government information on nutrition.
1.1 The Circulatory System

Key Concept

The circulatory system includes the heart, blood, and blood vessels. The heart contracts rhythmically to pump blood through arteries, capillaries, and veins. The pulmonary circulation carries blood between the heart and lungs, and the systemic circulation carries blood between the heart and the rest of the body. Cardiovascular disease (CVD) is any disease of the heart or blood vessels. Its leading cause is atherosclerosis. Healthy lifestyle choices can reduce the risk of CVD. Blood consists of a fluid portion called plasma and a variety of cells. Red blood cells carry oxygen, white blood cells defend the body, and platelets help blood clot.

Standards

- CA.9–12.IE.1.d; CA.9–12.LS.9.a
- NSES.9–12.A.1.6; NSES.9–12.F.1.3

Lesson Objectives

- Explain how the heart pumps blood throughout the body.
- Compare different types of blood vessels and their roles.
- Outline pathways of the pulmonary and systemic circulations.
- Define cardiovascular disease, and list its risk factors.
- Describe blood, blood components, and blood pressure.

Lesson Vocabulary

- antigen: molecule that the immune system identifies as foreign and responds to by forming antibodies
- artery: type of blood vessel that carries blood away from the heart toward the lungs or body
- atherosclerosis: condition in which plaque builds up inside arteries
- blood: fluid connective tissue that circulates throughout the body through blood vessels
- blood pressure: force exerted by circulating blood on the walls of blood vessels
- blood type: genetic characteristic associated with the presence or absence of antigens on the surface of red blood cells
- capillary: smallest type of blood vessel that connects very small arteries and veins
- cardiovascular disease (CVD): any disease that affects the heart or blood vessels
- circulatory system: organ system consisting of the heart, blood vessels, and blood that transports materials around the body
- heart attack: blockage of blood flow to heart muscle tissues that may result in the death of cardiac muscle fibers
1.1. The Circulatory System

- **hypertension**: high blood pressure
- **plasma**: golden-yellow, fluid part of blood that contains many dissolved substances and blood cells
- **platelet**: cell fragment in blood that helps blood clot
- **pulmonary circulation**: part of the circulatory system that carries blood between the heart and lungs
- **red blood cell**: type of cell in blood that contains hemoglobin and carries oxygen
- **systemic circulation**: part of the circulatory system that carries blood between the heart and body
- **vein**: type of blood vessel that carries blood toward the heart from the lungs or body
- **white blood cell**: type of cell in blood that defends the body against invading microorganisms or other threats in blood or extracellular fluid

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**Teaching Strategies**

**Introducing the Lesson**

Show students how to feel the pulse in their neck or wrist. Call on volunteers to explain what they are feeling (the increased pressure of blood against artery walls each time the heart contracts, or beats). Tell students they will learn more about the heart and how it pumps blood in this lesson.

**Using Visuals**

When you discuss the dynamics of the heart, tell students to trace the flow of blood through the heart (Figure 23.2 in FlexBook and reproduced below).

- **Ask**: What keeps blood flowing through the heart in just one direction? (One-way valves between heart chambers.)
Differentiated Instruction

Have students make a KWL chart for the lesson. They should fill in the first two columns (Know, Want to Know) before they start reading and the last column (Learned) after they finish reading. Discuss any of their questions that remain unanswered.

Enrichment

Ask interested students to investigate the problem of creating an artificial heart to treat people with heart failure. Students should learn about the history of artificial hearts and the greatest challenges in developing a successful artificial heart. Encourage the students to share what they learn with the rest of the class.

Science Inquiry

Have small groups of students design an investigation to determine the effects of exercise on heart rate. Ask groups to share and discuss their ideas. Make sure they have identified independent and dependent variables and controls.

Overcoming Misconceptions

Many people think that the circulatory system consists of a single large circuit. Make sure students understand that the circulatory system has two interacting circuits, the pulmonary and systemic. Explain why two circuits are necessary. Suggest that students view the video at the URL below. It shows animated models of the two circuits and how they are related.

- http://www.youtube.com/watch?v=0jznS5psypI

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the CK-12 Biology Workbook. Ask students to complete the worksheets alone or in pairs as a review of lesson content.

Review Questions

Have students answer the Review Questions that are listed at the end of the lesson in their FlexBook.

- Sample answers to these questions will be provided upon request. Please send an email to teachers-requests@ck12.org to request sample answers.

Points to Consider

An important function of the circulatory system is transporting oxygen to cells.
• Do you know where blood gets the oxygen cells it needs?
  – (Blood absorbs oxygen in the lungs.)

• How do you think blood is able to give up its oxygen to cells?
  – (Oxygenated blood has a greater concentration of oxygen than do body cells, so oxygen diffuses from the blood into the cells.)
1.2 The Respiratory System

Key Concept

Respiration is the process in which the lungs and other organs of the respiratory system bring oxygen into the body and release carbon dioxide into the atmosphere. Respiration includes the processes of ventilation, pulmonary gas exchange, transport, and peripheral gas exchange. Breathing occurs due to repeated contractions of the diaphragm. It is controlled by the brain stem. Respiratory diseases include asthma, pneumonia, and emphysema.

Standards

- CA.9–12.IE.1.d; CA.9–12.LS.9.a
- NSES.9–12.A.1.6

Lesson Objectives

- Define respiration, and explain how it differs from cellular respiration.
- Identify the organs of the respiratory system.
- Outline the processes of ventilation, gas exchange, and gas transport.
- Describe the role of gas exchange in homeostasis.
- Explain how the rate of breathing is regulated.
- Identify diseases of the respiratory system.

Lesson Vocabulary

- **asthma**: respiratory system disease in which air passages of the lungs periodically become too narrow, making breathing difficult
- **emphysema**: lung disease, usually caused by smoking, in which walls of alveoli break down, so less gas can be exchanged in the lungs
- **larynx**: organ of the respiratory system between the pharynx and trachea that is also called the voice box because it allows the production of vocal sounds
- **lung**: organ of the respiratory system in which gas exchange takes place between the blood and the atmosphere
- **pharynx**: long, tubular organ that connects the mouth and nasal cavity with the larynx, through which air and food pass
- **pneumonia**: disease in which the alveoli of the lungs become inflamed and filled with fluid as a result of infection or injury
- **respiration**: exchange of gases between the body and the outside air
- **respiratory system**: organ system that brings oxygen into the body and releases carbon dioxide into the atmosphere
• **trachea**: long, tubular organ of the respiratory system, also called the wind pipe, that carries air between the larynx and lungs
• **ventilation**: process of carrying air from the atmosphere into the lungs

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### Teaching Strategies

#### Introducing the Lesson

Tell students to hold their breath until you tell them to start breathing again. When they start gasping for breath, ask them why they started to breathe. (The autonomic nervous system controls breathing, so it is under conscious control only up to a point.) Tell students they will learn more about breathing and the respiratory system in this lesson.

#### Demonstration

With the help of a student volunteer, demonstrate lung capacity using instructions at the URL below. Following the demonstration, discuss how lung capacity might be related to factors such as body size, gender, age, fitness, and activity level.

- [http://www.brighthub.com/education/k-12/articles/43891.aspx](http://www.brighthub.com/education/k-12/articles/43891.aspx)

#### Differentiated Instruction

Write the three questions below on the board. Tell students to think about how they would answer the questions. Then pair struggling students with students who are excelling in the class, and have partners share and discuss their answers.

a. What organs make up the respiratory system?

b. What is the main function of the respiratory system?

c. How do the organs of the respiratory system work together to perform this function?

#### Enrichment

Have advanced students investigate the issue of cigarette smoking and its negative effects on the health of nonsmokers as well as smokers. Then ask students to lead a class discussion of the issue. They might start the discussion with some facts and figures about the health risks of cigarette smoking to smokers and nonsmokers, and then ask questions such as:

- What if any rights do smokers have to smoke? Do you think smokers should be required to stop smoking for their own good? Or do you think they should have the right to smoke if it doesn’t harm others?
- What about the rights of nonsmokers? Do they have the right to breathe clean air? Is this right more important than any rights smokers might have to smoke?
- How can the risks of smoking be prevented? What can society, the law, and medicine do? What role should education play?

#### Science Inquiry

Explain how the density of air decreases with increasing altitude, so that a given volume of air contains fewer oxygen molecules at high altitude than the same volume of air at sea level. Ask students to hypothesize how this might affect
breathing at high altitude. Encourage them to speculate about adaptations that might evolve in human populations that live at high altitudes for many generations. Direct students to the URLs below to see if their ideas are correct.

- http://www.altitude.org/why_less_oxygen.php

Overcoming Misconceptions

Misconceptions about the lungs and the mechanics of breathing are common. For example, students commonly think the lungs are muscles that actively suck air into the body during inhalations and expel all the air during exhalations. To overcome these and similar misconceptions, use a simple model to demonstrate how the lungs really work (see URL below). You can make and exhibit the model as a class demonstration or assign it as a small-group project.


Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the CK-12 Biology Workbook. Ask students to complete the worksheets alone or in pairs as a review of lesson content.

Review Questions

Have students answer the Review Questions that are listed at the end of the lesson in their FlexBook.

- Sample answers to these questions will be provided upon request. Please send an email to teachers-requests@ck12.org to request sample answers.

Points to Consider

Oxygen is just one substance transported by the blood. The blood also transports nutrients such as glucose.

- What are nutrients? What other substances do you think might be nutrients?
  - (Nutrients are substances the body needs. In addition to glucose and other carbohydrates, nutrients include lipids, proteins, water, vitamins, and minerals.)
- Where do you think nutrients enter the bloodstream? How might this occur?
  - (Nutrients enter the bloodstream in the small intestine. They are absorbed by the blood across the thin walls of capillaries.)
1.3 The Digestive System

Key Concepts

The digestive system consists of organs that break down food, absorb nutrients, and eliminate waste. Mechanical digestion occurs in the mouth and stomach. Chemical digestion and absorption occur mainly in the small intestine, with the help of secretions from the liver and pancreas. The large intestine eliminates any remaining solid waste. Digestive system diseases include food allergies, ulcers, and heartburn. Macronutrients include carbohydrates, proteins, lipids, and water; micronutrients include vitamins and minerals. MyPyramid and food labels are important tools for balanced eating. Eating too much and exercising too little can lead to obesity.

Standards

- NSES.9–12.A.1.6; NSES.9–12.B.3.5; NSES.9–12.C.5.3; NSES.9–12.F.1.3, 5
- AAAS.9–12.6.E.1

Lesson Objectives

- Identify the organs and functions of the digestive system.
- Outline the roles of the mouth, esophagus, and stomach in digestion.
- Explain how digestion and absorption occur in the small intestine.
- List functions of the large intestine.
- Describe common diseases of the digestive system.
- Identify classes of nutrients and their functions in the human body.
- Explain how to use MyPyramid and food labels as tools for balanced eating.

Lesson Vocabulary

- **absorption**: process in which substances such as nutrients pass into the blood stream
- **bile**: fluid produced by the liver and stored in the gall bladder that is secreted into the small intestine to help digest lipids and neutralize acid from the stomach
- **body mass index (BMI)**: estimate of the fat content of the body, calculated by dividing a person’s weight (in kilograms) by the square of the person’s height (in meters)
- **chemical digestion**: chemical breakdown of large, complex food molecules into smaller, simpler nutrient molecules that can be absorbed by the blood
- **digestion**: process of breaking down food into nutrients that can be absorbed by the blood
- **digestive system**: organ system that breaks down food, absorbs nutrients, and eliminates any remaining waste
• **eating disorder**: mental illness in which people feel compelled to eat in a way that causes physical, mental, and emotional health problems
• **elimination**: process in which waste passes out of the body
• **esophagus**: long, narrow digestive organ that passes food from the pharynx to the stomach
• **feces**: solid waste that remains after food is digested and is eliminated from the body through the anus
• **gall bladder**: sac-like organ that stores bile from the liver and secretes it into the duodenum of the small intestine
• **gastrointestinal (GI) tract**: organs of the digestive system through which food passes during digestion, including the mouth, esophagus, stomach, and small and large intestines
• **large intestine**: organ of the digestive system that removes water from food waste and forms feces
• **liver**: organ of digestion and excretion that secretes bile for lipid digestion and breaks down excess amino acids and toxins in the blood
• **macronutrient**: nutrient such as carbohydrates, proteins, lipids, or water that is needed by the body in relatively large amounts
• **mechanical digestion**: physical breakdown of chunks of food into smaller pieces by organs of the digestive system
• **micronutrient**: nutrient such as a vitamin or mineral that is needed by the body in relatively small amounts
• **mineral**: chemical element, such as calcium or potassium, that is needed in relatively small amounts for proper body functioning
• **MyPlate**: visual guideline for balanced eating, replacing MyPyramid in 2011
• **MyPyramid**: visual dietary guideline that shows the relative amounts of foods in different food groups that should be eaten each day
• **nutrient**: substance the body needs for energy, building materials, or control of body processes
• **obesity**: condition in which the body mass index is 30.0 kg/m² or greater
• **peristalsis**: rapid, involuntary, wave-like contraction of muscles that pushes food through the GI tract and urine through the ureters
• **small intestine**: long, narrow, tube-like organ of the digestive system where most chemical digestion of food and virtually all absorption of nutrients take place
• **stomach**: sac-like organ of the digestive system between the esophagus and small intestine in which both mechanical and chemical digestion take place
• **villi**: (singular, villus) microscopic, finger-like projections in the mucous membrane lining the small intestine that form a large surface area for the absorption of nutrients
• **vitamin**: organic compound needed in small amounts for proper body functioning

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**Teaching Strategies**

**Introducing the Lesson**

Call on one student after another to state anything they already know about digestion or the digestive system. Continue until no new information is forthcoming. Tell students they will learn more about digestion and the digestive system in this lesson.

**Demonstration**

To underscore the importance of peristalsis in the digestive system, demonstrate the process by pushing a marble through a short length of rubber tubing. Tell the class that the tubing represents part of the digestive system, such as the esophagus, and the marble represents food. Keep squeezing the tubing just above the marble until the marble moves completely through the tubing and out the other end. Give a few students a chance to squeeze the marble
through the tubing as well. Remind the class that peristalsis moves food through the entire digestive system, not just the esophagus.

Differentiated Instruction

Use a gallery walk to help students learn about the six classes of nutrients. Post the names of the classes around the room on large sheets of paper or poster board. Place any English language learners in groups with native English speakers, and have groups travel around the room from nutrient to nutrient. At each station, students should list a good food source of the nutrient and one of the nutrient’s roles in the body. They can add any other relevant information as well. They should also read what other groups have posted and correct any errors. ELL

Enrichment

Ask students who need extra challenges to take a survey of the nutritional knowledge of friends or family members. They should first prepare a list of questions to assess what respondents know about nutrients and their role in good health. They might ask questions such as:

- How many calories does the average person need each day?
- What are examples of high-fiber foods?
- Why is it important to limit the amount of fat that you eat?

After students finish their survey, have them summarize the results and present the summary to the class. As a class, discuss the role of nutritional knowledge in healthful eating.

Science Inquiry

Explain to the class that people who exercise regularly are less likely to be obese than people who do not exercise. Point out that regular exercisers may also tend to be more careful about what they eat, and this might affect their weight as well. Ask students to develop a research plan that would allow them to correlate the effects of exercise alone on weight, without the possible confounding effects of diet.

(Student plans should compare the weights of a sample of people who exercise regularly with the weights of a sample of people who do not exercise. They should control for the effects of diet on weight by including in the samples only people who eat a similar diet.)

Overcoming Misconceptions

There are several common misconceptions about the digestive system. Some of these include:

- The stomach makes up most of the digestive system, and most digestion takes place there.
- Food goes from the stomach into the blood stream.
- Most of the food we eat is excreted through the anus.
- Foods that the body does not need stay in the intestine and are eliminated from the body.

Read these misconceptions to the class, and ask students which if any of them they think are true. Call on students who think they are false to explain why.
Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the CK-12 Biology Workbook. Ask students to complete the worksheets alone or in pairs as a review of lesson content.

Review Questions

Have students answer the Review Questions that are listed at the end of the lesson in their FlexBook.

- Sample answers to these questions will be provided upon request. Please send an email to teachers-requests@ck12.org to request sample answers.

Points to Consider

In this lesson, you learned that the large intestine eliminates solid wastes that are left after digestion occurs.

- Wastes are also produced when cells break down nutrients for energy and building materials. How do you think these wastes are removed from the body? Do you think they are eliminated by the large intestine as well?  
  - (Sample answer: They might be eliminated by other organs, such as the kidneys.)
- Might there be other ways to remove wastes from the body? What about liquid wastes and excess water?  
  - (Sample answer: They might be removed in urine or other body fluids.)
1.4 The Excretory System

Key Concept

Excretion is the process of removing wastes and excess water from the body. The major organs of excretion are the kidneys, which filter blood and form urine. The kidneys are part of the urinary system, which also includes the ureters, bladder, and urethra. Each kidney has more than a million nephrons, which are the structural and functional units of the kidney. The kidneys maintain homeostasis by controlling the amount of water, ions, and other substances in the blood. They also secrete hormones that have other homeostatic functions. Kidney diseases include kidney stones, infections, and kidney failure due to diabetes.

Standards

- CA.9–12.IE.1.d; CA.9–12.LS.9.a, g, i
- NSES.9–12.A.1.6; NSES.9–12.F.1.2
- AAAS.9–12.
- McREL.9–12

Lesson Objectives

- Define excretion, and identify organs of the excretory system.
- Explain how the urinary system filters blood and excretes wastes.
- Describe the roles of the kidneys in homeostasis.
- Identify kidney diseases, and describe dialysis.

Lesson Vocabulary

- **bladder**: hollow, sac-like organ that stores urine until it is excreted from the body
- **dialysis**: medical procedure in which blood is filtered through a machine in patients with kidney failure
- **excretion**: process of removing wastes and excess water from the body
- **excretory system**: organ system that removes wastes and excess water from the body and includes the kidneys, large intestine, liver, skin, and lungs
- **kidney failure**: loss of the ability of nephrons of the kidney to function fully
- **nephron**: structural and functional unit of the kidney that filters blood and forms urine
- **ureter**: muscular, tube-like organ of the urinary system that moves urine by peristalsis from a kidney to the bladder
- **urethra**: muscular, tube-like organ of the urinary system that carries urine out of the body from the bladder; in males, it also carries sperm out of the body
• **urinary system**: organ system that includes the kidneys and is responsible for filtering waste products and excess water from the blood and excreting them from the body

• **urination**: process in which urine leaves the body through a sphincter at the end of the urethra

• **urine**: liquid waste product of the body that is formed by the kidneys and excreted by the other organs of the urinary system

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### Teaching Strategies

#### Introducing the Lesson

Spark interest in the excretory system by sharing with the class the following kidney facts and figures:

a. Each kidney is only about the size of a computer mouse.
b. Each kidney contains more than one million tiny filters.
c. The two kidneys filter all the body’s blood (about 1.5 gallons) many times each day.

Tell students they will learn more about the kidneys and excretory system in this lesson.

#### Demonstration

Bring to class a fresh beef kidney (available at a meat market or the meat department of a supermarket). First, point out the ureter and the renal artery and vein. Then, using a scalpel or sharp knife, dissect the kidney lengthwise so the medulla and cortex are visible. Give students a chance to inspect these structures. Discuss the function of each structure in the filtration of blood and formation of urine.

#### Differentiated Instruction

Use cloze prompts to help less proficient readers focus on key content. Provide students with a list of main idea sentences from the lesson that have important terms left blank. Ask students to complete the sentences as they read the lesson. Suggest that students compare their completed sentences with those of another student. If any of the completed sentences differ significantly, they should reread relevant portions of the lesson to resolve the differences.

**LPR**

#### Enrichment

Ask interested students to do an online search for a local kidney dialysis center. Then have them contact the center to obtain a brochure, flyer, or other written information about dialysis and the center. If possible, arrange for students to visit the center and interview nurses, technicians, or other personnel about the dialysis process. Ask them to report what they learn to the class.

#### Science Inquiry

Tell the class that high blood pressure is a leading cause of kidney failure. Then challenge students to formulate a hypothesis to explain why high blood pressure may cause kidney failure. (High blood pressure may damage capillaries in the kidneys so the kidneys can no longer do their job of removing wastes and excess water from the blood.)
1.4. The Excretory System

Real-World Connection

State that a person with kidney failure may receive a kidney transplant. Have students do a Web quest of kidney transplantation. Suggest that they start with the URL below. They will quickly realize that there are a plethora of social, economic, and legal issues related to this medical procedure. Discuss some of the issues with the class.


Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the **CK-12 Biology Workbook**. Ask students to complete the worksheets alone or in pairs as a review of lesson content.

Review Questions

Have students answer the Review Questions that are listed at the end of the lesson in their FlexBook.

- Sample answers to these questions will be provided upon request. Please send an email to teachers-requests@ck12.org to request sample answers.

Points to Consider

Infections caused by microorganisms may affect any of the organ systems described in this chapter. For example, you have just read that bacterial infections of the bladder are common.

- What defenses do you think the body has to keep out microorganisms?
  - *(Sample answer: The skin keeps out most microorganisms.)*

- Do you know if there are other defenses against microorganisms if they manage to get inside the body?
  - *(Sample answer: White blood cells fight microorganisms in the blood.)*
1.5 Worksheet Answer Keys

- The worksheet answer keys are available upon request. Please send an email to teachers-requests@ck12.org to request the worksheet answer keys.