Chapter 37 Organizer

Refer to pages 4T-5T of the Teacher Guide for an explanation of the National Science Education Standards correlations.

Section	Objectives	Activities/Features
Section 37.1 **The Respiratory System** National Science Education Standards UCP.1, UCP.2, UCP.5; B.3; C.1, C.5; F.1, F.4, F.5 ($1\frac{1}{2}$ sessions, 1 block)	1. **List** the structures involved in external respiration. 2. **Explain** the mechanics of breathing. 3. **Contrast** external and cellular respiration.	**Problem-Solving Lab 37-1,** p. 1005 **Careers in Biology:** Registered Nurse, p. 1006 **Investigate BioLab:** Measuring Respiration, p. 1020
Section 37.2 **The Circulatory System** National Science Education Standards UCP.1, UCP.2, UCP.5; A.1, A.2; B.3; C.1, C.5; E.1, E.2; F.1, F.5; G.1, G.2 ($1\frac{1}{2}$ sessions, 1 block)	4. **Distinguish** among the various components of blood and among blood groups. 5. **Trace** the route blood takes through the body and heart. 6. **Explain** how heart rate is controlled.	**MiniLab 37-1:** Checking Your Pulse, p. 1013 **Inside Story:** Your Heart, p. 1014 **Problem-Solving Lab 37-2,** p. 1015
Section 37.3 **The Urinary System** National Science Education Standards UCP.1, UCP.2, UCP.3, UCP.5; A.1, A.2; C.5; E.1, E.2; F.1, F.6; G.1 (2 sessions, 1 block)	7. **Describe** the structures and functions of the urinary system. 8. **Explain** the kidneys' role in maintaining homeostasis.	**MiniLab 37-2:** Testing Urine for Glucose, p. 1019 **Biology & Society:** Finding Transplant Donors, p. 1022

Need Materials? Contact Carolina Biological Supply Company at 1-800-334-5551 or at **http://www.carolina.com**

MATERIALS LIST

BioLab

p. 1020 round balloon, string, metric ruler, watch with second hand

MiniLabs

p. 1013 pencil, paper, watch with second hand
p. 1019 microscope slide, grease pencil, droppers (2), normal "urine," abnormal "urine," glucose test paper, pencil, paper

Alternative Lab

p. 1014 distilled water, 250 mL flask, plastic straw, droppers (2), phenolphthalein indicator, 0.04% NaOH solution

Quick Demos

p. 1004 respiratory system model
p. 1010 watch with second hand, drinking glasses, water
p. 1019 preserved sheep kidney

Key to Teaching Strategies

- **L1** Level 1 activities should be appropriate for students with learning difficulties.
- **L2** Level 2 activities should be within the ability range of all students.
- **L3** Level 3 activities are designed for above-average students.
- **ELL** ELL activities should be within the ability range of English Language Learners.
- **COOP LEARN** Cooperative Learning activities are designed for small group work.
- **P** These strategies represent student products that can be placed into a best-work portfolio.
- These strategies are useful in a block scheduling format.

Respiration, Circulation, and Excretion

Teacher Classroom Resources

Section	Reproducible Masters	Transparencies
Section 37.1 **The Respiratory System**	Reinforcement and Study Guide, p. 163 L2 Critical Thinking/Problem Solving, p. 37 L3 Content Mastery, pp. 181-182, 184 L1 Tech Prep Applications, pp. 51-52 L2	Section Focus Transparency 90 L1 ELL
Section 37.2 **The Circulatory System**	Reinforcement and Study Guide, pp. 164-165 L2 Concept Mapping, p. 37 L3 ELL Critical Thinking/Problem Solving, p. 37 L3 BioLab and MiniLab Worksheets, pp. 163-164 L2 Laboratory Manual, pp. 269-276 L2 Content Mastery, pp. 181, 183-184 L1 Inside Story Poster ELL	Section Focus Transparency 91 L1 ELL Basic Concepts Transparency 70 L2 ELL Basic Concepts Transparency 71 L2 ELL Basic Concepts Transparency 72 L2 ELL Reteaching Skills Transparency 54 L1 ELL
Section 37.3 **The Urinary System**	Reinforcement and Study Guide, p. 166 L2 Critical Thinking/Problem Solving, p. 37 L3 BioLab and MiniLab Worksheets, pp. 165-168 L2 Content Mastery, pp. 181-182, 184 L1	Section Focus Transparency 92 L1 ELL Basic Concepts Transparency 73 L2 ELL

Assessment Resources

Chapter Assessment, pp. 217-222
MindJogger Videoquizzes
Performance Assessment in the Biology Classroom
Alternate Assessment in the Science Classroom
Computer Test Bank
BDOL Interactive CD-ROM, Chapter 37 quiz

Additional Resources

Spanish Resources ELL
English/Spanish Audiocassettes ELL
Cooperative Learning in the Science Classroom COOP LEARN
Lesson Plans/Block Scheduling

NATIONAL GEOGRAPHIC Teacher's Corner

Products Available From Glencoe

To order the following products, call Glencoe at 1-800-334-7344:

CD-ROM
NGS PictureShow: Human Body 2
Curriculum Kit
GeoKit: Human Body 1
Transparency Set
NGS PicturePack: Human Body 2
Videodisc
STV: Human Body

Products Available From National Geographic Society

To order the following products, call National Geographic Society at 1-800-368-2728:

Videos
Incredible Human Machine
Circulatory and Respiratory Systems (Human Body Series)

GLENCOE TECHNOLOGY

The following multimedia resources are available from Glencoe.

Biology: The Dynamics of Life

CD-ROM ELL
Animation: *The Mechanics of Breathing*
BioQuest: *Body Systems*
BioQuest: *Triathalon*
Video: *Lymphocytes*
Exploration: *Blood Types*
Video: *Capillaries*
Animation: *One Way Valves*

Videodisc Program
The Mechanics of Breathing
Capillaries
One Way Valves

Getting Started Demo

Have students take their pulse rates for one minute. Record the data needed to calculate the class average. Use the class average to introduce and discuss the meanings of average, high, and low pulse rates.

Theme Development

Homeostasis is the major theme of the chapter. Emphasis is placed on how the respiratory, circulatory, and urinary systems maintain balance in the body. **Systems and interactions** is shown by the interactions among the three systems discussed and how these systems work in conjunction with the nervous system.

0:00 Out of Time?

If time does not permit teaching the entire chapter, use the BioDigest at the end of the unit as an overview.

Chapter

37 Respiration, Circulation, and Excretion

What You'll Learn

- You will explain the mechanics of breathing.
- You will distinguish the types of blood cells and trace the pathway of blood circulation through the body.
- You will describe the structure and function of the urinary system.

Why It's Important

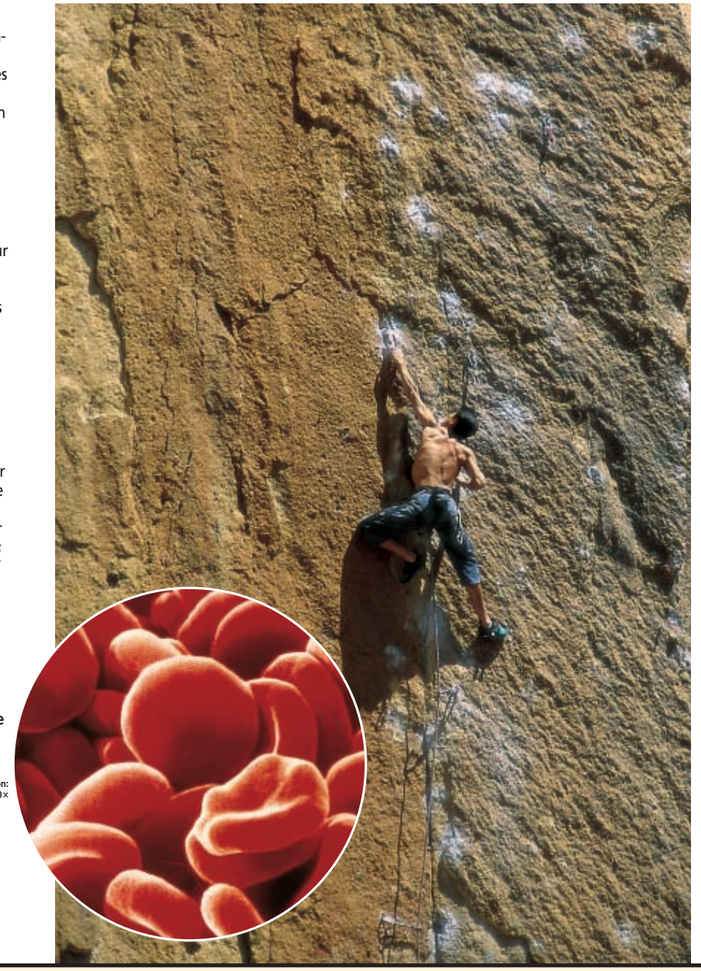
With a knowledge of how your circulatory, respiratory, and urinary systems function, you will understand how your cells receive, deliver, and remove materials to maintain your body's homeostasis.

Getting Started

Taking Your Pulse

Find your wrist pulse with your index and middle fingers. Take your pulse rate as you sit at your desk. *Can you lower your pulse rate by closing your eyes and thinking of a calm, restful place?*

interNET CONNECTION To find out more about respiration, circulation, and excretion, visit the Glencoe Science Web Site.
www.glencoe.com/sec/science



Magnification: 40 000×

These biconcave blood cells carry vital oxygen to the rock climber's muscles.

Multiple Learning Styles

Look for the following logos for strategies that emphasize different learning modalities.

- ***Kinesthetic*** Quick Demo, p. 1010
- ***Visual-Spatial*** Portfolio, pp. 1005, 1009, 1012, 1018; Meeting Individual Needs, pp. 1005, 1009; Microscope Activity, p. 1011
- ***Interpersonal*** Meeting Individual Needs, p. 1017
- ***Intrapersonal*** Project, p. 1004
- ***Linguistic*** Biology Journal, pp. 1004, 1013, 1017; Tech Prep, p. 1010; Project, p. 1011
- ***Logical-Mathematical*** Portfolio, p. 1010; Going Further, p. 1021

Section

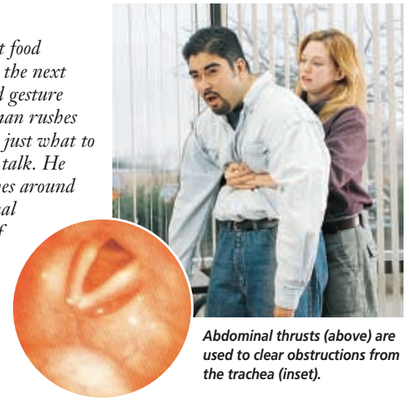
37.1 The Respiratory System

SECTION PREVIEW

Objectives
List the structures involved in external respiration.
Explain the mechanics of breathing.
Contrast external and cellular respiration.

Vocabulary
trachea
alveoli

Imagine yourself in a fast food restaurant. The man at the next table begins to choke and gesture wildly at his throat. A woman rushes across the room. She knows just what to do. First, she asks if he can talk. He can't answer her. She reaches around him and performs abdominal thrusts to dislodge a piece of burger stuck in his windpipe. Without her expert help, the man could have died due to the blockage of his respiratory system.



Abdominal thrusts (above) are used to clear obstructions from the trachea (inset).

Passageways and Lungs

Your respiratory system is made up of a pair of lungs, a series of passageways into your body, and a thin sheet of skeletal muscle called the diaphragm. When you hear the word respiration, you probably think of breathing. But breathing is just part of the process of respiration that an oxygen-dependent organism carries out. Respiration includes all the mechanisms involved in getting oxygen to the cells of your body and getting rid of carbon dioxide. Recall that respiration also involves the formation of ATP within cells.

The path air takes

The first step in the process of respiration involves taking air into your body through your nose or mouth. Air flows into the pharynx, passes the epiglottis, and moves through the larynx. It then travels down the windpipe, or **trachea** (TRAY kee uh), a tubelike passageway that leads to two bronchi (BRAHN ki) tubes, which lead into the lungs. When you swallow food, the epiglottis covers the entrance to the trachea. It prevents food and other large materials from getting into the air passages.

Cleaning dirty air

The air you breathe is far from clean. It is estimated that an individual living in an urban area breathes in 20 million particles of foreign matter each day. To prevent most of this material from reaching your lungs, the nasal cavity, trachea, and bronchi

Assessment Planner

Portfolio Assessment
Portfolio, TWE, pp. 1005, 1010, 1012, 1018, 1019

Performance Assessment
Assessment, TWE, pp. 1004, 1008
Alternative Lab, TWE, pp. 1014-1015
BioLab, SE, pp. 1020-1021
BioLab, TWE, p. 1021
MiniLab, SE, pp. 1013, 1019
MiniLab, TWE, pp. 1013, 1018

Knowledge Assessment
Assessment, TWE, p. 1016
Section Assessment, SE, pp. 1006, 1016, 1019
Chapter Assessment, SE, pp. 1023-1025

Skill Assessment
Assessment, TWE, p. 1006
Problem-Solving Lab, SE, pp. 1005, 1015

Prepare

Key Concepts

Students will learn about the mechanics of breathing and the exchange of gases. The control of the respiratory system by the nervous system is also discussed.

Planning

- Obtain a model of the respiratory system for the Quick Demo and the Meeting Individual Needs.
- Buy balloons, straws, and string for the BioLab.

1 Focus

Bellringer

Before presenting the lesson, display **Section Focus Transparency 90** on the overhead projector and have students answer the accompanying questions. L1 ELL

Resource Manager
Section Focus Transparency 90 and Master L1 ELL

2 Teach

Quick Demo

Use an anatomical model of the respiratory organs to point out the parts of the respiratory system as they are mentioned in the chapter.

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Animation: *The Mechanics of Breathing,* Disc 5

VIDEODISC
Biology: The Dynamics of Life
The Mechanics of Breathing
(Ch. 32), Disc 2, Side 1, 1 min.

Assessment

Performance Assessment in the Biology Classroom, p. 43, *Making a Model of Inhalation and Exhalation*. Have students carry out this activity to model the respiratory system. L2

Resource Manager

Reinforcement and Study Guide, p. 163 L2
Tech Prep Applications, p. 51 L2
Content Mastery, pp. 181-182 L1
BioLab and MiniLab Worksheets, pp. 163-164 L2

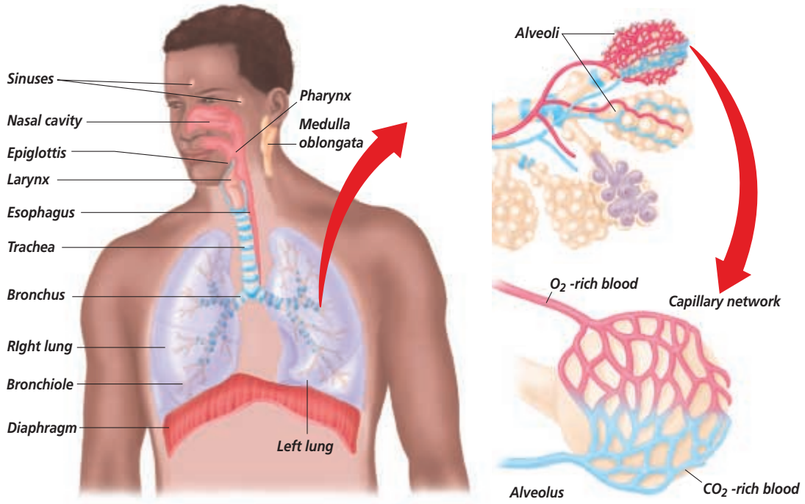


Figure 37.1
As air passes through the respiratory system, it travels through narrower and narrower passageways until it reaches the alveoli.

are lined with ciliated cells that secrete mucus. The cilia constantly beat upward in the direction of your throat, where foreign material can be swallowed or expelled by coughing or sneezing. Follow the passage of air through the lungs in ***Figure 37.1.***

Alveoli: The place of gas exchange

Like the branches of a tree, each bronchus branches into bronchioles, which in turn branch into numerous microscopic tubules that eventually expand into thousands of thin-walled sacs called alveoli. **Alveoli** (al VEE uh li) are the sacs of the lungs where oxygen and carbon dioxide are exchanged by diffusion between the air and blood. The clusters of alveoli are surrounded by networks of tiny blood vessels. Blood in these vessels has come from the cells of the body and contains wastes from cellular respiration. Diffusion of gases takes place easily because the wall of each alveolus, and the walls of each capillary, are only one cell thick. External respiration involves the exchange of oxygen or carbon dioxide between the air in the alveoli and the blood that circulates through the walls of the alveoli, and is shown in the inset portion of ***Figure 37.1.***

WORD Origin
alveoli
From the Latin word *alveolus,* meaning "a small hollow sac." The alveoli are small air sacs of the lung.

Blood transport of gases

Once oxygen from the air diffuses into the blood vessels surrounding the alveoli, it is pumped by the heart to the body cells, where it is used for cellular respiration. In an earlier chapter, you learned that cellular respiration is the process by which cells use oxygen to break down glucose and release energy in the form of ATP. Carbon dioxide and water are waste products of this process. The water stays in the cell or diffuses into the blood. The carbon dioxide diffuses into the blood, which carries it back to the lungs.

As a result, the blood that comes to the alveoli from the body's cells is high in carbon dioxide and low in oxygen. Carbon dioxide from the body diffuses from the blood into the air spaces in the alveoli. During exhalation, this carbon dioxide is removed from your body. At the same time, oxygen diffuses from the air in the alveoli into the blood, making the blood rich in oxygen. Use the *Problem-Solving Lab* on this page to find out more about how the composition of air changes as it passes through the lungs.

The Mechanics of Breathing

The action of your diaphragm and the muscles between your ribs enable you to breathe in and breathe out. ***Figure 37.2*** shows how air is drawn in or forced out of the lungs as a result of the diaphragm's position.

When you inhale, the muscles between your ribs contract and your

Problem-Solving Lab 37.1 Interpreting Data

How do inhaled and exhaled air compare? Air is composed of a number of different gases. During respiration, the lungs absorb some of these gases, but not others.

Analysis

Study ***Table 37.1*** below. It compares the relative percentages of gases in inhaled and exhaled air.

Table 37.1 Comparison of gases in inhaled and exhaled air

Gas	Inhaled air	Exhaled air
Nitrogen	78.00 %	78.00 %
Oxygen	21.00 %	16.54 %
Carbon dioxide	0.03 %	4.49 %
Other gases	0.97 %	0.97 %

Thinking Critically

1. What information about respiration is conveyed by the data in the table?
2. Trace the pathway that a molecule of nitrogen follows when entering and leaving the lungs. Start with air in the bronchus. (Note: Normally, nitrogen does enter the blood stream.)
3. Explain why carbon dioxide levels are higher in exhaled air.

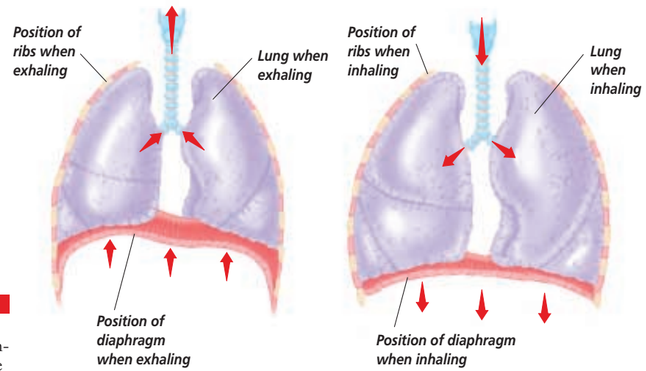


Figure 37.2
Air pressure in the lungs is varied by changes in the volume of the chest cavity.

CD-ROM
View an animation of the mechanics of breathing in the Presentation Builder of the Interactive CD-ROM.

A When relaxed, your diaphragm is positioned in a dome shape beneath your lungs.

B When contracting, the diaphragm flattens, enlarging the chest cavity and drawing air into the lungs.

Problem-Solving Lab 37.1

Purpose
Students use data to support the conclusion that the body uses oxygen and produces carbon dioxide.

Process Skills
analyze information, think critically, compare and contrast, draw a conclusion, sequence

Teaching Strategies
- Tell students that "other gases" include inert gases such as helium, neon, and argon.
- Make certain students understand that the respiratory system delivers oxygen to the circulatory system for distribution throughout the body.

Thinking Critically
1. The same volume of air is inhaled and exhaled, but its composition changes; the percentage of oxygen is higher in inhaled air, and the percentage of carbon dioxide is higher in exhaled air.
2. bronchus, bronchiole, alveoli, capillary network in alveoli, heart, circulatory system, heart, lung, capillary network, alveoli, bronchiole, bronchus, exhaled to air
3. Carbon dioxide is a waste produced by body cells that exits the body via the lungs.

Assessment

Skill Ask students to trace the pathway oxygen follows inside the body. Use the Performance Task Assessment List for Events Chain in **PASC,** p. 91. L2

3 Assess

Check for Understanding

Have students trace the pathway of a carbon dioxide molecule from a body cell to the nose.

PROJECT

Smoking and Lung Capacity

Intrapersonal Ask students to form a hypothesis about the lung capacity of smokers versus nonsmokers. Have students design an experiment to test their hypothesis. L2

BIOLOGY JOURNAL

Respiratory Diseases

Linguistic Have students compose letters to the American Lung Association and American Cancer Society asking for posters and information on the respiratory system and diseases that affect it. Have students include the letters in their journals. L2

MEETING INDIVIDUAL NEEDS

Visually/Hearing Impaired

Visual-Spatial Pair visually impaired or hearing impaired students with other students. Have them use a model of the respiratory system to explain the mechanics of breathing. Have students point to or touch the various anatomical parts as they are discussed. L1 ELL

Portfolio

Tracing the Path of Air

Visual-Spatial Ask students to make a circular flowchart describing the pathway and processes involved in respiration. One-half of the circle should show events that take place as the diaphragm contracts, the other half should show events that take place as the diaphragm relaxes. Have them include the charts in their portfolios. L2 P

Reteach

Have students label a diagram of the respiratory system. L1

Extension

Have interested students find out what causes nitrogen narcosis. L3

Assessment

Skill Ask students to make a flowchart that describes the pathway of air as it moves into and out of the respiratory system. L2

INVESTIGATE BioLab

The BioLab at the end of the chapter can be used at this point in the lesson.

Careers in Biology

TECH PREP

Career Path

Courses in high school: sciences, mathematics, psychology

College: two-year associate degree, two- or three-year diploma program, or four-year bachelor's degree

Career Issue

Ask students whether they think doctors should consult with the nursing staff responsible for a patient before making medical decisions about that patient.

For More Information

To learn more about becoming a nurse, students can contact:

American Nurses' Association
600 Maryland Ave. SW
Washington, DC 20024-2571

4 Close

Discussion

Discuss why a gas mixture of 95% oxygen and 5% carbon dioxide is used to revive someone who has fainted.

Careers in Biology

Registered Nurse

If you want a fast-paced, hands-on career that puts your "people skills" to work, consider becoming a registered nurse.

Skills for the Job

Nurses give care, support, and advice as they help their patients get well or stay well. They may work in medical or psychiatric hospitals, doctors' offices, schools, hospice programs, nursing homes, rehabilitation centers, public health agencies, and other settings. Registered nurses (RNs) must complete a two-year associate degree program, a two- or three-year diploma program, or a four-year bachelor's degree at a college or a hospital-based nursing school. To become licensed, they must also pass a national test. After earning a master's degree, RNs can become nurse practitioners or specialize in areas such as anesthesia or midwifery.

internet CONNECTION For more careers in related fields, be sure to check the Glencoe Science Web Site.
www.glencoe.com/sec/science

rib cage rises. At the same time, the diaphragm muscle contracts, becomes flattened, and moves lower in the chest cavity. These actions increase the space in the chest cavity, which creates a slight vacuum. Air rushes into your lungs because the air pressure outside your body is greater than the air pressure inside your lungs.

When you exhale, the muscles associated with the ribs relax, and your ribs drop down in the chest cavity. Your diaphragm relaxes, returning to its resting position. The relaxation of these muscles decreases the volume of the chest cavity and forces most of the air out of the alveoli.

The alveoli in healthy lungs are elastic, like balloons. They stretch as you inhale and return to their original size as you exhale. A balloon that has had the air let out of it does not go totally flat. Similarly, the alveoli still contain a small amount of air after you exhale. Measure your breathing rate in the *BioLab* at the end of this chapter.

Control of Respiration

Breathing is usually an involuntary process. It is controlled by the chemistry of your blood as it interacts with a part of your brain called the medulla oblongata. The medulla oblongata helps maintain homeostasis. It responds to higher levels of carbon dioxide in your blood by sending nerve signals to the rib muscles and diaphragm. The nerve signals cause these muscles to contract, and you inhale. When breathing becomes more rapid, as during exercise, a more rapid exchange of gases between air and blood occurs.

Section Assessment

Understanding Main Ideas

1. Describe the path an oxygen molecule takes as it travels from your nose to a body cell. List each structure of the respiratory system through which it passes.
2. Compare and contrast external respiration and cellular respiration.
3. Explain the process by which gases are exchanged in the lungs.
4. Describe how air in the respiratory tract is cleaned before it reaches the lungs.

Thinking Critically

5. During a temper tantrum, four-year-old Jamal tries to hold his breath. His parents are afraid that he will be harmed by this behavior. How will Jamal be affected by holding his breath?

Skill Review

6. **Sequencing** What is the sequence of muscle actions that takes place during inhalation and exhalation? For more help, refer to *Organizing Information* in the **Skill Handbook.**

Section Assessment

1. nose, pharynx, epiglottis, larynx, trachea, bronchi, alveoli, blood, cells
2. External respiration is the exchange of oxygen and carbon dioxide in the alveoli. Internal respiration uses oxygen to break down glucose inside the cells.
3. In the alveoli, oxygen from the air diffuses into, and carbon dioxide diffuses out of, the blood.
4. Particles are trapped in mucus. Cilia beat the mucus up the throat where it can be expelled or swallowed.
5. As carbon dioxide builds up in the blood, the child's medulla will stimulate his muscles to contract so that he inhales.
6. During inhalation, muscles between the ribs and the diaphragm contract. During exhalation, these muscles relax.

Section

37.2 The Circulatory System

Blood flowed freely from this injury until direct pressure was applied. Pressure limits bleeding until the blood's adaptive ability to clot takes over. Your blood has other life-supporting qualities. As it travels through your body, it carries oxygen from your lungs and nutrients from your digestive system to your cells, then hauls away cell wastes. Together, your blood, your heart, and a network of blood vessels make up your circulatory system.

Magnification: 5500×

A blood clot is composed of a network of fibers in which blood cells are trapped.

SECTION PREVIEW

Objectives

Distinguish among the various components of blood and among blood groups.

Trace the route blood takes through the body and heart.

Explain how heart rate is controlled.

Vocabulary

plasma
red blood cell
hemoglobin
white blood cell
platelet
antigen
antibody
artery
capillary
vein
atrium
ventricle
vena cava
aorta
pulse
blood pressure

Your Blood: Fluid Transport

Your blood is a tissue composed of fluid, cells, and fragments of cells. *Table 37.2* summarizes information about the components of human blood. The fluid portion of blood is called **plasma.** Plasma is straw colored and makes up about 55 percent of the total volume of blood. Blood cells—both red and white—and cell fragments are suspended in plasma.

Red blood cells: Oxygen carriers

The round, disk-shaped cells in blood are red blood cells. **Red blood cells** carry oxygen to body cells. They make up 44 percent of the total volume of your blood, and are produced in the red bone marrow of your ribs, humerus, femur, sternum, and other long bones.

Red blood cells in humans have nuclei only during an early stage in each cell's development. The nucleus is lost before the cell enters the bloodstream. Red blood cells remain active

Table 37.2 Blood components

Components	Characteristics
Red blood cells	Transport oxygen and some carbon dioxide; lack a nucleus; contain hemoglobin
White blood cells	Large; several different types; all contain nuclei; defend the body against disease
Platelets	Cell fragments needed for blood clotting
Plasma	Liquid; contains proteins; transports red and white blood cells, platelets, nutrients, enzymes, hormones, gases, and inorganic salts

Internet Address Book

internet CONNECTION Note Internet addresses that you find useful in the space below for quick reference.

Resource Manager

Section Focus Transparency 91 and Master L1 ELL
Reinforcement and Study Guide, pp. 164-165 L2

Prepare

Key Concepts

Students will examine the three major components of the circulatory system: the blood, the vessels, and the heart. They will examine the composition and functions of blood and learn the importance of blood groups. Students will trace the path of blood through the body and heart. They will examine how heart rate is controlled.

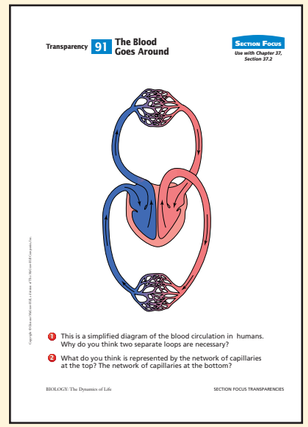
Planning

- Borrow a stethoscope and a heart model for the Inside Story.
- Obtain live *Daphnia* for the Microscope Activity.
- Purchase soda straws and gather other materials for the Alternative Lab.

1 Focus

Bellringer

Before presenting the lesson, display **Section Focus Transparency 91** on the overhead projector and have students answer the accompanying questions. L1 ELL



2 Teach

Tying to Previous Knowledge

Review diffusion from Chapter 6. Relate this process to how oxygen and carbon dioxide get into the blood.

Assessment

Performance Have each student write two questions about blood transport. Arrange students in pairs and have them quiz each other. L2

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Bioquest: *Body Systems*
Disc 1-5
BioQuest: *Triathalon*
Disc 5
Video: *Lymphocytes*
Disc 5

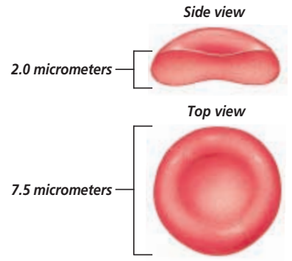
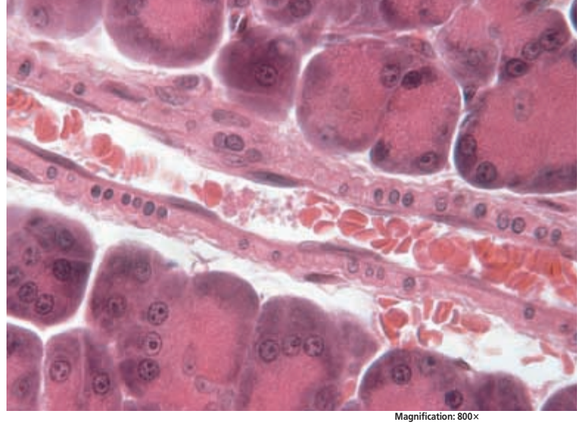


Figure 37.3
Red blood cells are donut-shaped cells that carry oxygen to tissue cells through thin-walled capillaries.

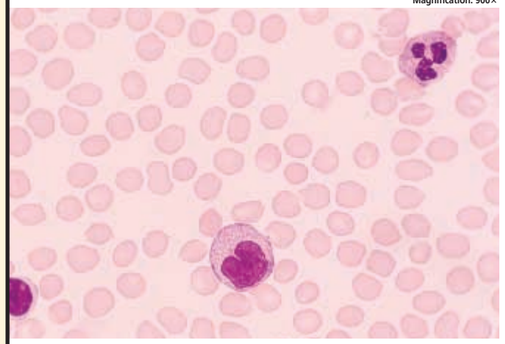

Magnification: 800×

in the bloodstream for about 120 days, then they break down and are removed as waste. Old red blood cells are destroyed in your spleen, an organ of the lymphatic system, and in your liver.

Oxygen in the blood

How is oxygen carried by the blood? Red blood cells like those shown in ***Figure 37.3*** are equipped with an iron-containing protein molecule called **hemoglobin** (HEE muh gloh bun). Oxygen becomes loosely bound to the hemoglobin in blood cells that have entered the lung. These oxygenated blood cells carry oxygen from the lungs to the body's cells. As blood passes through body tissues with low oxygen concentrations, oxygen is released from the hemoglobin and diffuses into the tissues.

Figure 37.4
Compared with red blood cells, white blood cells are larger in size and far fewer in number. White blood cells have a nucleus; mature red blood cells do not have a nucleus.


Magnification: 900×

Carbon dioxide in the blood

Hemoglobin carries some carbon dioxide as well as oxygen. You have already learned that, once biological work has been done in a cell, wastes in the form of carbon dioxide diffuse into the blood and are carried in the bloodstream to the lungs. About 70 percent of this carbon dioxide combines with water in the blood plasma to form bicarbonate. The remaining 30 percent travels back to the lungs dissolved in the plasma or attached to hemoglobin molecules that have already released their oxygen into the tissues.

White blood cells: Infection fighters

White blood cells shown in ***Figure 37.4,*** play a major role in protecting your body from foreign substances and from microscopic organisms that cause disease. They make up only one percent of the total volume of your blood.

Blood clotting

Think about what happens when you cut yourself. If the cut is slight, you usually bleed for a short while, until the blood clots. That's because, in addition to red and white blood cells, your blood also contains small cell fragments called **platelets,** which help blood clot after an injury, as shown in ***Figure 37.5.*** Platelets help link together a sticky network of protein fibers called fibrin, which forms a web over the wound that traps escaping blood cells. Eventually, a dry, leathery scab forms. Platelets are produced from cells in bone marrow. They have a short life span, remaining in the blood for only about one week.

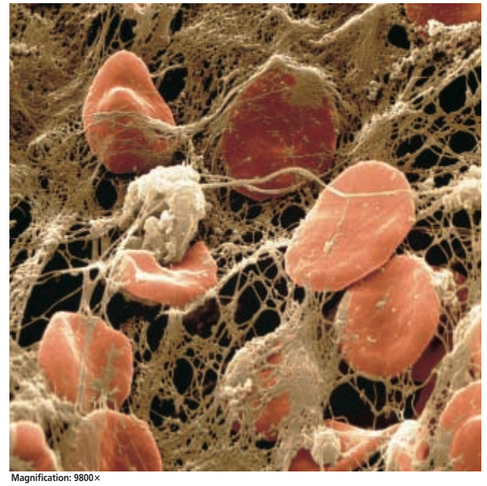

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Figure 37.5
Blood platelets—the whitish, globular structures shown adhering to red blood cells—help clot the blood by linking together a threadlike network of fibrin that traps escaping blood cells.

ABO Blood Groups

If a person is injured so severely that a massive amount of blood is lost, a transfusion of blood from a second person may be necessary. Whenever blood is transfused from one person to another, it is important to know to which blood group each person belongs. You have already learned about the four human blood groups—A, B, AB, and O. You inherited the characteristics of one of these blood groups from your parents. Sometimes, the term *blood type* is used to describe the blood group to which a person belongs. If your blood falls into group O, for example, you are said to have type O blood.

Blood surface antigens determine blood group

Differences in blood groups are due to the presence or absence of proteins, called antigens, on the membranes of red blood cells. **Antigens** are substances that stimulate an immune response in the body. As you'll learn in a later chapter, an immune response defends the body against foreign proteins. The letters A and B stand for the types of blood surface antigens found on human red blood cells.

Blood plasma contains proteins, called **antibodies** (ANT ih bahd eez), that are shaped to correspond with the different blood surface antigens. The antibody in the blood plasma reacts with its matching antigen on red blood cells if they are brought into contact with one another. This reaction results in clumped blood cells that can no longer function. Each blood group contains antibodies for the blood surface antigens found only in the other blood groups—not for antigens found on its own red blood cells.

For example, if you have type A blood, you have the A antigen on your red blood cells and the anti-B antibody in your plasma. If you had anti-A antibodies, they would react with your own type A red blood cells. However, if you have type A blood and anti-A is added to it by way of a

Concept Development

Karl Landsteiner (1868–1943), Austrian-born pathologist of the United States, was awarded a Nobel prize in 1930 for discovering the major blood groups and developing the ABO system of blood typing. He was the first to reveal specific differences between the cells of one individual and another. Have students research and write a report about Landsteiner.

Enrichment

Have a representative of the American Red Cross speak to students on blood donation, blood transfusions, blood tests, and AIDS.

GLENCOE TECHNOLOGY

VIDEODISC
VIDEOTAPE
The Secret of Life
In the Land of Milk and Money: Biotechnology

CD-ROM
Biology: The Dynamics of Life
Exploration: *Blood Types*
Disc 5

Resource Manager

Basic Concepts Transparency 71 and Master L2 ELL

Cultural Diversity

Carlos Monge and High-Altitude Physiology

Much of what is known about high-altitude or environmental physiology is the result of research by Peruvian scientist Carlos Monge (1884–1970), the first to describe high-altitude sickness, or hypoxia, and the founder of the Institute of Andean Biology and Pathology. Introduce students to Monge's research and major findings. Discuss with students the physiological adaptations of people who live at high altitudes, such as the Aymara and Quechua Indians of South America. Have students relate these adaptations to the proper functioning of the respiratory system.

Meeting Individual Needs

Gifted

Visual-Spatial Have students conduct research to find information about the different types of white blood cells. Ask them to create a visual display that includes sketches of each type of cell with its name and function. L3

Portfolio

Summarizing Circulation

Visual-Spatial Have students make a chart that lists the substances that blood carries to and from the heart. Have students identify how each substance is used by the body or the process that releases the substance as a waste product. L2 P

Reinforcement

A for *artery* and *A* for *away* is a mnemonic device that helps students remember that arteries carry blood away from the heart.

Quick Demo

Kinesthetic Have pairs of students take each other's resting pulse. Then have each student drink a glass of water while his or her pulse is taken again. Ask students to compare the two measurements. Explain that pulse rate increases slightly while drinking because swallowing puts pressure on the vagus nerve, which normally slows the heart rate. This pressure decreases the number of nerve impulses that reach the heart, so the heart rate increases. L2

TechPrep

American Red Cross

Linguistic Have students interested in a health career interview an American Red Cross representative and find out about the work of the American Red Cross in the United States as well as internationally. Have them place a copy of their interview questions and answers in their portfolios. L2

GLENCOE TECHNOLOGY

VIDEODISC
The Secret of Life
Pregnancy and Rh Disease

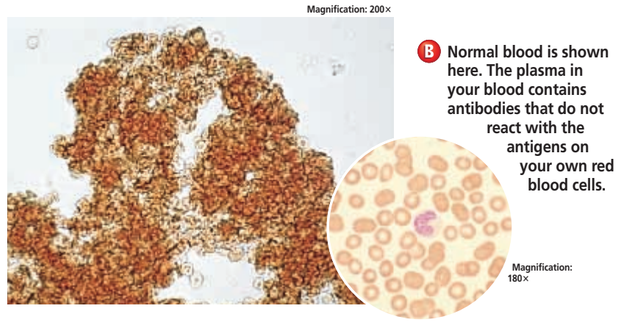
transfusion of type B blood, an antigen-antibody reaction will occur, resulting in clumped blood cells like those shown in ***Figure 37.6A.*** Clumped blood cells cannot carry oxygen or nutrients to body cells. Similarly, if you have type B blood, you have the B antigen on your red blood cells and the anti-A antibody in your blood plasma. ***Figure 37.6*** illustrates the antigens and antibodies present in each blood group.

Rh factor

Another characteristic of red blood cells involves the presence or absence of an antigen called Rh, or Rhesus factor. Rh factor is an inherited characteristic. People are Rh positive (Rh^+) if they have the Rh antigen factor on their red blood cells. They are Rh negative (Rh^-) if they don't.

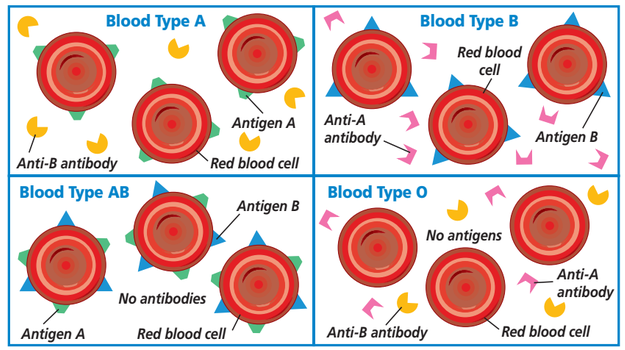
Rh factor can cause complications in some pregnancies. Problems occur only if an Rh^- mother becomes pregnant with an Rh^+ baby. At birth, the Rh^+ baby's blood mixes with the Rh^- blood of the mother, as ***Figure 37.7A*** illustrates. Upon exposure to the baby's Rh^+ antigen factor, the mother will make anti-Rh^+ antibodies like those shown in ***Figure 37.7B.*** Should the mother become pregnant again, these antibodies will cross the placenta. If the new fetus is Rh^+, the anti-Rh^+ antibodies from the mother will destroy red blood cells in the fetus, as shown in ***Figure 37.7 C.***

Figure 37.6
Blood contains both antigens and antibodies.



A The clumped blood illustrates an antibody-antigen reaction that could occur with an incorrect transfusion.

B Normal blood is shown here. The plasma in your blood contains antibodies that do not react with the antigens on your own red blood cells.



C The four types of blood groups have different antigens and antibodies.

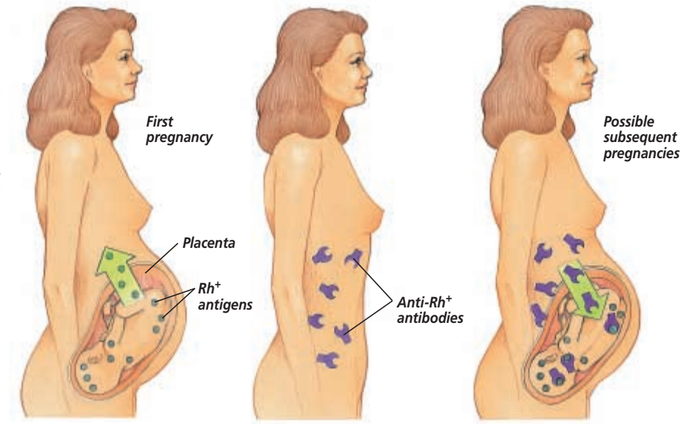


Figure 37.7
If a baby inherits Rh^+ blood from the father and the mother is Rh^-, problems can develop if the blood cells of mother and baby mix during birth.

A Mother is exposed to Rh antigens at the birth of her Rh^+ baby.

B Mother makes anti-Rh^+ antibodies.

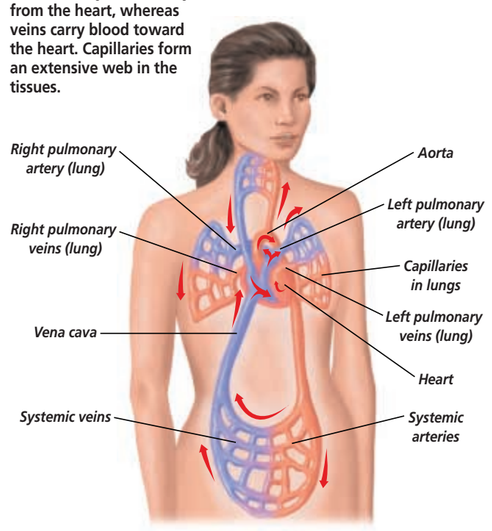
C During the mother's next pregnancy, Rh antibodies can cross the placenta and endanger the fetus.

Your Blood Vessels: Pathways of Circulation

Because blood is fluid, it must be channeled through blood vessels like those shown in ***Figure 37.8.*** The three main types of blood vessels are arteries, capillaries, and veins. Each is different in structure and function.

Arteries are large, thick-walled, muscular, elastic vessels that carry oxygenated blood away from the heart. The blood that they carry is

Figure 37.8
Arteries carry blood away from the heart, whereas veins carry blood toward the heart. Capillaries form an extensive web in the tissues.



Visual Learning

Figure 37.8 How are arteries different from veins? *Arteries are much more muscular than veins. Veins contain valves to prevent blood from flowing backwards.*

Misconception

A common misconception is that arteries carry only oxygenated blood and veins carry only unoxygenated blood. Point out that in the case of the pulmonary artery and pulmonary vein, this generalization does not hold true.

Microscope Activity

Visual-Spatial Have students place a *Daphnia* on a depression slide and observe its heart beating. Remind students to be gentle when handling live animals and to use care when working with depression slides and coverslips. L1 ELL

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Video: *Capillaries*
Disc 5

VIDEODISC
Biology: The Dynamics of Life
Capillaries (Ch. 33)
Disc 2, Side 1, 12 sec.

Portfolio

Daily Heart Output

Logical-Mathematical Have students calculate the daily heart output of a person whose pulse rate is 72 beats per minute and blood volume is 70 mL per beat. They should show and label the steps in their calculations. L3

PROJECT

Heart Health Survey

Linguistic Have students do research to determine what foods are healthy and unhealthy for the heart. Have them use this information to develop a survey that can be given to other students in the school. Ask students to conduct their surveys and evaluate the diets of high school students. Have them use the results to answer the following questions. What foods do students eat that are high in saturated fats or cholesterol? How could students improve their diets? Are the school lunches served by your school good for your heart? L2

Concept Development

A heart murmur occurs when heart valves do not prevent backward blood flow. Rheumatic fever from a streptococcal infection can produce valve defects. Reassure students that many people are born with murmurs. Most do not affect activity but should be checked regularly.

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Animation: *One-Way Valves*
Disc 5

VIDEODISC
Biology: The Dynamics of Life
One-Way Valves (Ch. 34)
Disc 2, Side 1, 19 sec.

Resource Manager

Basic Concepts Transparency 72 and Master L2 ELL
Concept Mapping, p. 37 L3 ELL
Reteaching Skills Transparency 54 and Master L1 ELL

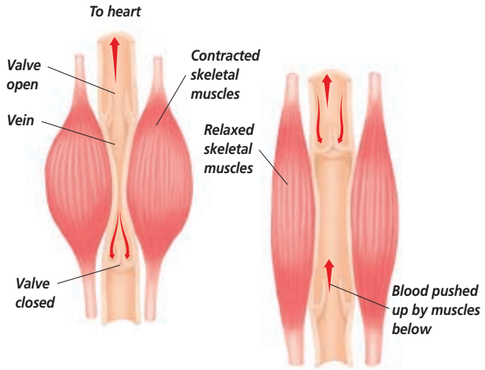


Figure 37.9
Veins contain one-way valves that work in conjunction with skeletal muscles.

CD-ROM
View an animation of the veins' one-way valves in the Presentation Builder of the Interactive CD-ROM.

WORD Origin
vena cava
From the Latin words *vena*, meaning "vein," and *cava*, meaning "empty." Each vena cava empties blood into the heart.

under great pressure. As the heart contracts, it pushes blood through the arteries. Each artery's elastic walls expand slightly. As the heart relaxes, the artery shrinks a bit, which also helps push the blood forward. As a result, blood surges through the arteries in pulses that correspond with the rhythm of the heartbeat.

After the arteries branch off from the heart, they divide into smaller arteries that, in turn, divide into even smaller vessels called arterioles. Arterioles enter tissues, where they branch into the smallest blood vessels, the capillaries. **Capillaries** (KAP ul ler eez) are microscopic blood vessels with walls that are only one cell thick. These vessels are so tiny that red blood cells must move through them in single file. Capillaries form a dense network that reaches virtually every cell in the body. Thin capillary walls enable nutrients and gases to diffuse easily between blood cells and surrounding tissue cells.

As blood leaves the tissues, the capillaries join to form slightly larger vessels called venules. The venules merge to form **veins,** the large blood vessels that carry blood from the tissues back toward the heart. Blood in veins is not under pressure as great as that in the arteries. In some veins, especially those in your arms and legs, blood travels uphill against gravity. These veins are equipped with valves that prevent blood from flowing backward. ***Figure 37.9*** shows how these valves function. When your skeletal muscles contract, the valves open, and blood is forced toward the heart. When the skeletal muscles relax, the valves close to prevent blood from flowing backward, away from the heart. If you remain inactive for too long, blood may pool in your feet and lower legs, which can sometimes result in swollen feet or ankles.

Your Heart: The Vital Pump

The thousands of blood vessels in your body would be of little use if there were not a way to move blood through them. The main function of the heart is to keep blood moving constantly throughout the body. Well adapted for its job, the heart is a large organ made of cardiac muscle cells that are rich in energy-producing mitochondria.

All mammalian hearts, including yours, have four chambers. The two upper chambers of the heart are the **atria.** The two lower chambers are the **ventricles.** The walls of each atrium are thinner and less muscular than those of each ventricle. As you will see, the ventricles perform more work than the atria, a factor that helps explain the thickness of their muscles. The left ventricle pumps blood to the entire body, so its muscles are thicker than those of the right ventricle, which pumps blood to the lungs. As a result, your heart is somewhat lopsided.

Blood's path through the heart

Blood enters the heart through the atria and leaves it through the ventricles. Both atria fill up with blood at the same time. The right atrium receives oxygen-poor blood from the head and body through two large veins called the **venae cavae** (vee nee KAY vee). The left atrium receives oxygen-rich blood from the lungs through four pulmonary veins. These veins are the only veins that carry blood rich in oxygen. After they have filled with blood, the two atria then contract, pushing the blood down into the two ventricles.

After the ventricles have filled with blood, they contract simultaneously. When the right ventricle contracts, it pushes the oxygen-poor blood from the right ventricle against gravity out of the heart and toward the lungs through the pulmonary arteries. These arteries are the only arteries that carry blood poor in oxygen. At the same time, the left ventricle forcefully pushes oxygen-rich blood from the left ventricle out of the heart through the **aorta** to the arteries. The aorta is the largest blood vessel in the body. How does a drop of blood move through the heart? To find out, read the *Inside Story* on the next page.

Heartbeat regulation

Each time the heart beats, a surge of blood flows from the left ventricle into the aorta and then into the arteries. Because the radial artery in the arm and carotid arteries near the jaw are fairly close to the surface of the body, the surge of blood can be felt as it moves through them. This surge of blood through an artery is called a **pulse.** Find out more about how the pulse is used to measure heart rate by conducting the *MiniLab* on this page.

MiniLab 37-1 Experimenting

Checking Your Pulse The heart speeds up when the blood volume reaching your right atrium increases. It also speeds up when the level of carbon dioxide in the blood rises. The number of heartbeats per minute is your heart rate, which can be measured by taking your pulse.

Procedure

1. Copy the data table.
2. Have a classmate take your resting pulse for 60 seconds while you are sitting at your lab table or desk. Use the photo above as a guide to finding your radial pulse.
3. Record your pulse in the table.
4. Repeat steps 2 and 3 four more times, then calculate your average resting pulse rate. Switch roles and take your classmate's resting pulse.
5. Exercise by doing "jumping jacks" for one minute.
6. Have your classmate take your pulse for 60 seconds immediately after exercising and record the value in the data table.
7. Repeat steps 5 and 6 four more times. Switch roles again with your classmate.

Data Table
Heart rate (beats per minute)

Trial	Resting	After exercise
1		
2		
3		
4		
5		
Total		
Average		

Analysis

1. Explain why your pulse is a means of indirectly measuring heart rate.
2. Use actual values from your data table to describe the changes that occur to your heart rate when exercising.
3. Suppose the amount of blood pumped by your left ventricle each time it contracts is 70 mL. Calculate your cardiac output (70 mL × heart rate per minute) while at rest and just after exercise.

MiniLab 37-1

Purpose
Students will measure their resting pulse and compare it with their pulse after exercise.

Process Skills
compare and contrast, hypothesize, experiment, analyze information, apply concepts, collect data, use numbers, recognize cause and effect

Teaching Strategies
- Excuse students with health or physical impairments from the exercise portion of this activity.
- Help students find their radial pulse. If difficulty continues, have them locate their carotid or neck pulse. Advise students not to use their thumb when taking a pulse.
- Pulse recording should begin immediately after exercising is finished. Each exercise trial must be preceded by a full minute of exercise.

Expected Results
Resting pulses will be around 80-90 beats per minute. After exercise, beats will be close to 120 per minute.

Analysis
1. A surge of blood through arteries corresponds with each ejection of blood from the heart.
2. Answers will vary. Average pulse after exercise is higher than resting pulse.
3. 70 mL × average resting pulse per minute = resting cardiac output in mL per minute
   70 mL × average exercising pulse per minute = exercising cardiac output in mL per minute

Assessment
Performance Have students design and carry out an experiment that determines the time needed after exercise for heart rate to return to its resting rate. This period of time is called the heart's recovery time. Use the Performance Task Assessment List for Designing an Experiment in **PASC,** p. 23. L2

Portfolio

Diagramming the Heart
Visual-Spatial Have students draw, color, and label a diagram of the heart and lungs. Have them use a blue pencil to draw with arrows the pathway of deoxygenated blood and a red pencil to draw the pathway of oxygenated blood. L1 ELL P

BIOLOGY JOURNAL

Aspirin and the Circulatory System
Linguistic Have students research the use of aspirin as a means of preventing heart attack. Have them write reports to include in their journals. L3

Resource Manager

BioLab and MiniLab Worksheets, pp. 165-166 L2
Content Mastery, pp. 183-184 L1
Laboratory Manual, pp. 269-276 L2

INSIDE STORY

Purpose
Students will examine heart structure and function.

Teaching Strategies
- Heart valves close due to blood pressure changes in the chambers, creating the characteristic lubb-dupp sounds that can be heard with a stethoscope. As the atria contract, they force blood against the valves, causing them to open. As the ventricles contract, blood flows back against the heart valves, causing them to close.
- Allow students to listen to their heartbeats with stethoscopes. The earpiece should be cleaned with alcohol before each use.

Visual Learning
- Use a heart model to trace the pathway of blood as it flows through the heart.
- A fetal heart has an opening between the two atria. Contrast how fetal heart circulation is different from adult heart circulation. Have students research blue babies. L2

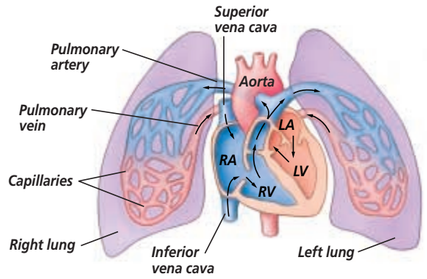
Critical Thinking
Evaluate students' concept maps. The maps should show an understanding of the pathway of blood through the body.

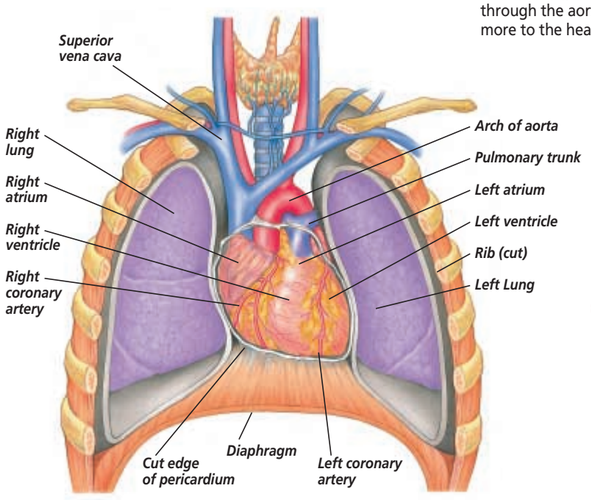
INSIDE STORY

Your Heart

Your heart is about 12 cm by 8 cm—roughly the size of your fist. It lies in your chest cavity, just behind the breastbone and between the lungs, and is essentially a large muscle completely under involuntary control.

Critical Thinking ***Construct a concept map for the pathway of blood through the body described on this page.***





1 Pericardium The heart is enclosed in a protective, flexible membrane called the pericardium.

2 The passage of blood If you were to trace the path of a drop of blood through the heart, you could begin with blood coming back from the body through a vena cava. The drop travels first into the right atrium, then into the right ventricle, and then through a pulmonary artery to one of the lungs. In the lungs, the blood drops off its carbon dioxide and picks up oxygen. Then it moves through a pulmonary vein to the left atrium, into the left ventricle, and finally out to the body through the aorta, eventually returning once more to the heart.

3 Heart valves Between the atria and ventricles are one-way valves that keep blood from flowing back into the atria. Sets of valves also lie between the ventricles and the arteries leaving the heart.

The heart rate is set by the pacemaker, a bundle of nerve cells located at the top of the right atrium. This pacemaker generates an electrical impulse that spreads over both atria. The impulse signals the two atria to contract at almost the same time. The impulse also triggers a second set of cells at the base of the right atrium to send the same electrical impulse over the ventricles, causing them to contract. These electrical signals can be measured and recorded by a machine called an electrocardiograph. This recording, shown in ***Figure 37.10,*** is called an electrocardiogram (ECG).

The ECG is an important tool used in diagnosing abnormal heart rhythms or patterns. Each peak or valley in the ECG tracing represents a particular electrical activity that takes place during a heartbeat. You can learn how ECG tracings are analyzed by carrying out the *Problem-Solving Lab* on this page.

Problem-Solving Lab 37-2

Analyzing Information

How are electrocardiograms analyzed? The heart muscle follows a rhythmic pattern of contraction and relaxation. The electrical signals that regulate this pattern can be measured and recorded on an electrocardiograph.

Electrocardiograph

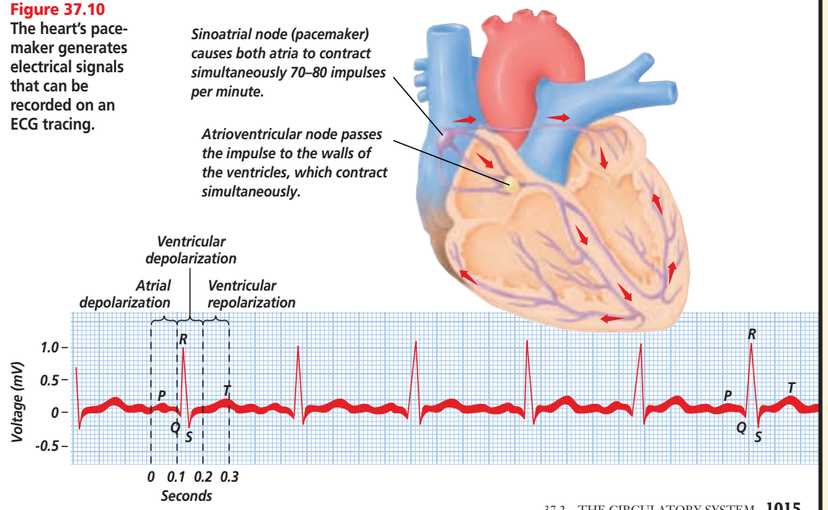
Analysis

The electrocardiogram (ECG) in ***Figure 37.10*** is a tracing from a normal heart. The red, inked line is marked with letters that can be used to identify electrical impulses that occur during the heartbeat, such as P-Q and QRS. Segment P-Q represents the electrical charge that causes the atria to contract. Segment Q-T records the electrical charge that causes the ventricles to contract. The blue, vertical lines of the graph paper represent units of time. The distance between heavy graph lines is equal to 0.1 seconds. The distance between light lines is equal to 0.02 seconds.

Thinking Critically

How long is the atrial contraction? The ventricular contraction? How would a physician interpret an ECG if the distances between T and P were much closer together?

Figure 37.10
The heart's pacemaker generates electrical signals that can be recorded on an ECG tracing.



Problem-Solving Lab 37-2

Purpose
Students will determine the length of specific heart beat events by analyzing an ECG.

Process Skills
interpret data, interpret scientific illustrations, use numbers

Teaching Strategies
- Students may be familiar with the older terminology of referring to the tracing as an EKG.
- Review with students the procedure for calculating percent.
- Remind students that the values being calculated from this ECG are average times.

Expected Results
Students will determine that atria are stimulated to contract first, for a short time, followed by ventricular contractions, which last slightly longer.

Analysis
Atria contract for 0.12 seconds; ventricles for 0.32 seconds. The ECG would indicate that the heart is being stimulated to contract more rapidly.

Assessment

Skill Have students calculate pulse rate from the ECG by determining the total time that elapses between two atrial contractions, then dividing this number into 60. (60 sec/min ÷ 0.84 sec = 71 beats/min). Use the Performance Task Assessment List for Using Math in Science in **PASC,** p. 29. L3

Alternative Lab

Exercise and CO_2

Purpose
Students will determine how exercise affects the amount of carbon dioxide exhaled.

Materials
distilled water, 250 mL flask, plastic straw, dropper bottle of phenolphthalein indicator, dropper bottle of 0.04% NaOH. For preparation instructions for NaOH solution, see page 40T of the Teacher Guide.

Procedure
Give students the following directions.
CAUTION: ***Put on goggles. NaOH can cause burns. Always place the dropper back in the bottle. Flush all spills with excess water. If NaOH spills on skin or clothing, rinse off immediately and notify your teacher.***

1. Place 200 mL of distilled water in a 250 mL flask and add 5 drops of phenolphthalein indicator. This indicator is clear in the presence of an acid and pink in the presence of a base.
2. Add NaOH drop by drop to the flask while gently swirling until a faint pink color remains in the solution for one minute.
3. Exhale through the straw into the flask for 5 seconds, then remove your mouth from the straw and inhale for 5 seconds. Repeat until one minute has elapsed. **CAUTION:** ***Do not inhale through the straw.***
4. Again add NaOH drop by drop, while swirling the flask, until the solution again remains pink for one minute.
5. Record the number of drops of NaOH needed to produce the pink color.
6. Rinse the flask. Repeat steps 2 through 5 after jogging in place for 1 minute. Record the number of drops of NaOH needed after jogging. **CAUTION:** ***Wash hands with soap and water at the end of the lab.***

Analysis
1. Did the number of drops of NaOH needed increase or decrease after exercise? *increase*
2. NaOH neutralizes the carbonic acid formed by carbon dioxide and water. Why is more carbon dioxide produced during exercise? *As more energy is used, more carbon dioxide is produced.*

Assessment

Performance Have students write a summary of the lab for their journal, including answers to the Analysis questions. Use the Performance Task Assessment List for Lab Report in **PASC,** p. 47. L2

3 Assess

Check for Understanding

Have students trace the pathway of blood on a diagram of the heart. L1

Reteach

Play "Wheel of Circulation" using a cardboard wheel. You can be Pat Pacemaker or Vanna Valve. Have students make up questions. L2

Extension

Have students find out more about heart transplants, high blood pressure, and the use of blood typing in criminal investigations. L3

Assessment

Knowledge Ask students to summarize the role of the three components of the circulatory system and explain how each structure is related to its function. L2

4 Close

Debate

Divide the class into two groups. Have each group take a stand on the question: Does death occur when the heart stops beating? L2

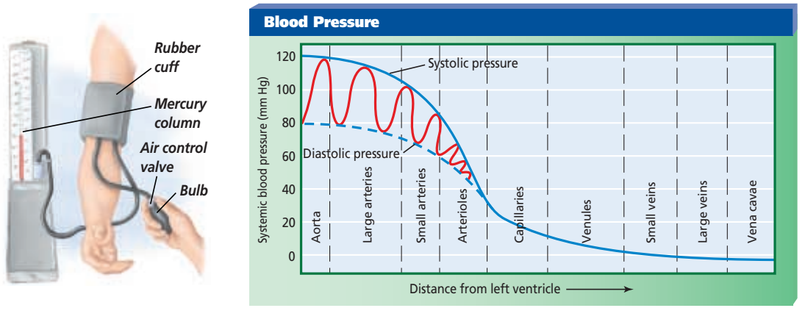


Figure 37.11 **Blood pressure rises and falls with each heart beat. Pressure is exerted on all vessels throughout the body. However, blood vessels near the left ventricle are subjected to higher pressure than vessels that are farther away. Blood pressure is measured in the artery of the upper arm.**

Blood pressure

A pulse beat represents the pressure that blood exerts as it pushes against the walls of an artery. **Blood pressure** is the force that the blood exerts on the blood vessels. As ***Figure 37.11*** shows, blood pressure rises and falls as the heart contracts and then relaxes.

Blood pressure rises sharply when the ventricles contract, pushing blood through the arteries. The high pressure is called systolic pressure. Blood pressure then drops dramatically as the ventricles relax. The lowest pressure occurs just before the ventricles contract again and is called diastolic pressure.

Control of the heart

Whereas the pacemaker controls the heartbeat, a portion of the brain called the medulla oblongata regulates the rate of the pacemaker, speeding or slowing its nerve impulses. If the heart beats too fast, sensory cells in arteries near the heart become stretched. Via the nervous system, these cells send a signal to the medulla oblongata, which in turn sends signals that slow the pacemaker. If the heart slows down too much, blood pressure in the arteries drops, signalling the medulla oblongata to speed up the pacemaker and increase the heart rate.

Section Assessment

Understanding Main Ideas

1. Summarize the distinguishing features and role of each of the four components of blood: plasma, platelets, and red and white blood cells.
2. Distinguish between an artery and a vein.
3. Outline the path taken by a red blood cell as it passes from the left atrium to the right ventricle of the heart.
4. Describe the location and function of the two pacemakers in the heart.

Thinking Critically

5. The level of carbon dioxide in the blood affects breathing rate. It also affects the heart rate. How would you expect high levels of carbon dioxide to affect the heart rate?

Skill Review

6. **Making and Using Graphs** Make a circle graph showing the relative proportions of the components of blood. For more help, refer to *Organizing Information* in the **Skill Handbook.**

Section Assessment

1. Plasma is a fluid that contains proteins and carries blood cells, platelets, enzymes, hormones, gases, and inorganic salts. Red blood cells lack a nucleus, contain hemoglobin, and transport oxygen. White blood cells contain nuclei and defend against disease. Platelets are cell fragments needed for blood clotting.
2. An artery is a vessel that carries blood away from the heart. A vein is a vessel that carries blood toward the heart.
3. left atrium to left ventricle to arteries to arterioles to capillaries to venules to veins to right atrium to right ventricle
4. The main pacemaker is located at the top of the right atrium. A second pacemaker is located at the base of the right atrium. These cells send impulses to signal the chambers of the heart to contract.
5. High levels of carbon dioxide increase the heart rate.
6. The circle graph should show the following proportions: red blood cells—44%; white blood cells—1%; plasma—55%.

Section

37.3 The Urinary System

SECTION PREVIEW

Objectives

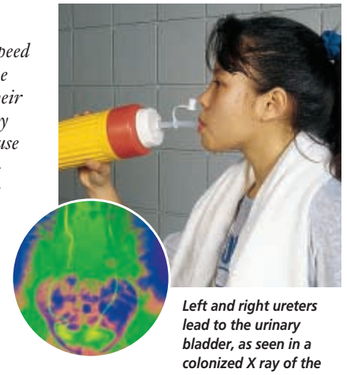
Describe the structures and functions of the urinary system.

Explain the kidneys' role in maintaining homeostasis.

Vocabulary

kidney
ureter
urinary bladder
nephron
urine
urethra

Water consumption helps speed the filtering process of the kidneys and maintain their efficiency. Any disruption in kidney function is potentially serious because these organs are essential to maintaining the balance of fluids in the body. The kidneys are the most important organs of the human urinary system. They perform a major cleanup job for the body.

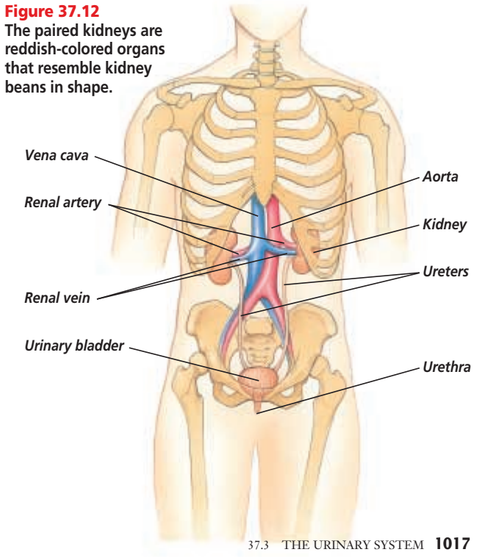


Left and right ureters lead to the urinary bladder, as seen in a colonized X ray of the human urinary system.

Kidneys: The Body's Janitors

The urinary system is made up of two kidneys, a pair of ureters, the urinary bladder, and the urethra, which you can see in ***Figure 37.12.*** The **kidneys** filter the blood to remove wastes from it, thus maintaining the homeostasis of body fluids. Your kidneys are located just above the waist, behind the stomach. One kidney lies on each side of the spine, partially surrounded by ribs. Each kidney is connected to a tube called a **ureter,** which leads to the urinary bladder. The **urinary bladder** is a smooth muscle bag that stores a solution of wastes called urine.

Figure 37.12 **The paired kidneys are reddish-colored organs that resemble kidney beans in shape.**



Nephron: The unit of the kidney

Have you ever seen an air filter on a car or a water filter in an aquarium?

Meeting Individual Needs

English Language Learners

Interpersonal Have students in teams play Hangman or Password with the terms found in this section. Once a team gets the word, they must properly define the term to get the point. This will also help students who are having difficulty with the terms. L1 ELL

Biology Journal

Using an Analogy

Linguistic Ask students to write an essay in which they compare a kidney to a recycling center. Have them consider substances that can be reused and those that cannot be recycled. L2

Prepare

Key Concepts

Students will survey the structure and function of the urinary system and learn about the kidneys' role in maintaining homeostasis.

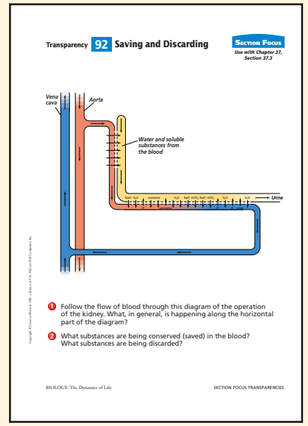
Planning

- Obtain whole kidney for Quick Demo.
- Acquire materials for MiniLab 37-2.

1 Focus

Bellringer

Before presenting the lesson, display **Section Focus Transparency 92** on the overhead projector and have students answer the accompanying questions. L1 ELL



Resource Manager

Section Focus Transparency 92 and Master L1 ELL
Reinforcement and Study Guide, p. 166 L2
Basic Concepts Transparency 73 and Master L2 ELL

2 Teach

MiniLab 37-2

Purpose
Students will use commercial glucose testing paper to detect glucose in simulated urine.

Process Skills
collect data, compare and contrast, draw a conclusion, experiment, interpret data, observe and infer, predict

Safety Precautions
Remind students to use care when handling glass slides and to wash their hands at the end of the lab.

Teaching Strategies
- Glucose test paper is available from drug stores or biological supply houses.
- To prepare abnormal urine, add 2 tsp. glucose and 2-3 drops of yellow food coloring to 500 mL water. To prepare normal urine, add 2-3 drops yellow food coloring to 500 mL water.
- Prepare unknowns—some containing glucose and some without—and place in Barnes dropping bottles. Use a letter or number code to keep track of the contents of each bottle.

Expected Results
Test paper turns green in the presence of glucose. Water causes no color change.

Analysis
1. Any unknown that tests positive for glucose could indicate diabetes. High sugar intake may also result in glucose elimination in urine.
2. testing of normal and abnormal urine before testing of unknowns
3. Possible answers: error in labeling, contamination of samples, normal urine was mixed with abnormal urine by accident, not using clean droppers

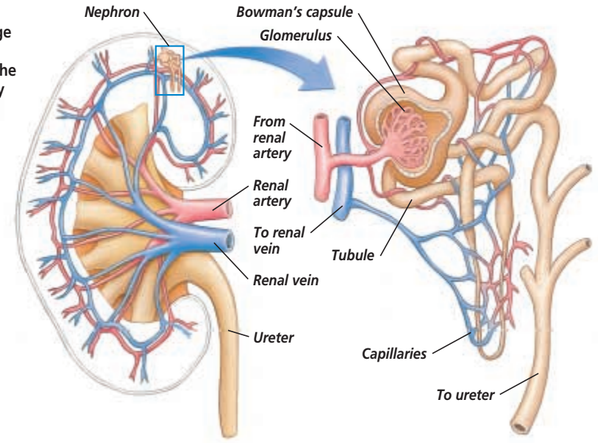


Figure 37.13
Each kidney receives a large blood supply through the renal artery for filtering. The blood leaves the kidney by the renal vein.

CD-ROM
View an animation of kidney function in the Presentation Builder of the Interactive CD-ROM.

WORD Origin
nephron
From the Greek word *nephros*, meaning "kidney." A nephron is a functional unit of a kidney.

A filter is a device that removes impurities from a solution. Within your body, each kidney is made up of about 1 million tiny filters. Each filtering unit in the kidney is called a **nephron.** ***Figure 37.13*** shows the parts of a typical nephron.

Blood entering a nephron carries wastes produced by body cells. As blood enters the nephron, it is under high pressure and immediately flows into a bed of capillaries called the glomerulus. Because of the pressure, water, glucose, vitamins, amino acids, protein waste products, salts, and ions from the blood pass out of the capillaries into a part of the nephron called the Bowman's capsule. Blood cells and most proteins are too large to pass through the walls of a capillary, so these components stay within the blood vessels.

The liquid forced into the Bowman's capsule passes through a narrow, U-shaped tubule. As the liquid moves along the tubule, most of the ions and water, and all of the glucose and amino acids, are reabsorbed into the bloodstream. This reabsorption of substances is the process by which the body's water is conserved and homeostasis is maintained. Small molecules, including water, move back into the capillaries by diffusion. Other molecules and ions move back into the capillaries by active transport.

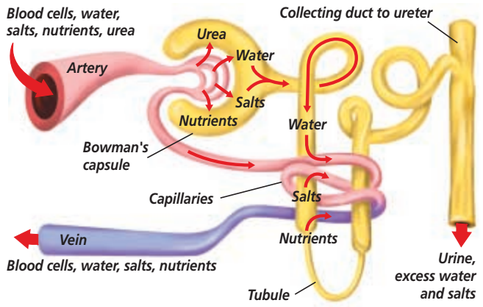


Figure 37.14
Filtration and reabsorption take place in the nephron.

The formation of urine

The liquid that remains in the tubules—composed of excess water, waste molecules, and excess ions—is **urine.** The production of urine is shown in ***Figure 37.14.*** You produce about 2 L of urine a day. This waste fluid flows out of the kidneys, through the ureter, and into the urinary bladder, where it may be stored. Urine passes from the urinary bladder out of the body through a tube called the **urethra** (yoo REE thruh).

The Urinary System and Homeostasis

The major waste products of cells are nitrogenous wastes, which come from the breakdown of proteins. These wastes include ammonia and urea. Both compounds are toxic to your body and, therefore, must be removed from the blood regularly.

In addition to removing these wastes, the kidneys control the level of sodium in blood by removing and reabsorbing sodium ions. This helps control the osmotic pressure of the blood. The kidneys also regulate the pH of blood by filtering out hydrogen ions and allowing bicarbonate to be reabsorbed back into the blood. Glucose is a sugar that is not usually filtered out of the blood by the kidneys. Individuals who have the disease known as diabetes have excess levels of glucose in their blood. The *MiniLab* on this page shows how urine is used to test for diabetes.

MiniLab 37-2 Experimenting

Testing Urine for Glucose Glucose is a sugar that is needed by the body and is normally not present in the urine. When the concentration of glucose becomes too high in the blood, as happens with diabetes, glucose is filtered out by the kidneys.

Procedure
1. Copy the data table.
2. Using a grease pencil, draw two circles on a glass slide. Mark one circle N, the other A.
3. Use a clean dropper to add two drops of "normal urine" to the circle marked N.
4. Use a clean dropper to add two drops of "abnormal urine" to the circle marked A.
5. Hold a small strip of glucose test paper in a forceps and touch it to the liquid in the drop labeled N. Remove it, wait 30 seconds, and record the color. A green color means glucose is present.
6. Use a new strip of glucose test paper to test drop A and record the color.
7. Test several unknown "urine" samples for the presence of glucose. Use a clean slide for each test.

Data Table

Urine sample	Color of test paper	Glucose present?
Normal (N)		
Abnormal (A)		
Unknown X		
Unknown Y		
Unknown Z		

Analysis
1. Which of the "unknown" samples could be from a person who has diabetes?
2. Which part of the test procedure could be considered your control? Explain your answer.
3. How could you explain your results if a test of normal urine indicated the presence of glucose?

Section Assessment

Understanding Main Ideas
1. Identify the organs that make up the urinary system and describe the function of each.
2. What is the function of a nephron in the kidney? Describe what happens in the glomerulus, Bowman's capsule, and U-shaped tubule.
3. Identify the major components of urine, and explain why it is considered a waste fluid.
4. What is the kidney's role in maintaining homeostasis in the body?

Thinking Critically
5. During a routine physical, a urine test indicates the presence of proteins in the patient's urine. Explain what this could indicate about the patient's health.

SKILL REVIEW
6. **Sequencing** Trace the sequence of urinary waste from a cell to the outside of the body. For more help, refer to *Organizing Information* in the **Skill Handbook.**

Assessment
Performance Have students design an experiment to test the lowest glucose concentration that can be detected using glucose test paper. Use the Performance Task Assessment List for Designing an Experiment in **PASC,** p. 23. L3

Portfolio
Diagramming the Urinary System
Visual-Spatial Have students make a labeled drawing of the urinary system. Have them place arrows on the diagram to show the flow of fluids through the nephron to the bladder and then out of the body. L1 P

Section Assessment
1. two kidneys, two ureters, urinary bladder, urethra. Kidneys filter blood to remove waste. Waste moves into the ureters and is collected in the bladder. When the bladder contracts, urine flows out of the body through the urethra.
2. to filter wastes from the blood plasma
3. urea, water, nitrogenous wastes, excess salt; contains toxic products from the metabolic breakdown of proteins
4. removes urinary waste; maintains blood pH, sodium levels, and osmotic balance
5. High blood pressure could force proteins into Bowman's capsule.
6. cell to blood to nephron to ureter to urinary bladder to urethra

Quick Demo
Slice a sheep kidney in half longitudinally. Identify the cortex and medulla. The cortex contains the nephrons. The medulla is a network of tubules and ducts that merge to form the ureter.

3 Assess

Check for Understanding
Have students trace the pathway of glucose, water, etc. through the kidney. L1

Reteach
Have students discuss the effect on the amount and concentration of urine of a meal rich in proteins, drinking large amounts of water, or high blood pressure. L2 COOP LEARN

Extension
Have interested students research how renin and angiotensin affect the kidneys. L3

Assessment
Portfolio Have students make a chart comparing the composition of blood plasma, the fluid inside the Bowman's capsule, and urine. Ask them to write a paragraph explaining the differences. L2 P

4 Close

Discussion
Have students orally summarize the role of the kidneys in maintaining homeostasis. L2

Resource Manager
BioLab and MiniLab Worksheets, pp. 165-166 L2
Content Mastery, p. 182 L1
Critical Thinking/Problem Solving, p. 37 L3

INVESTIGATE BioLab

Time Allotment
One class period

Process Skills
communicate, measure in SI, use numbers, interpret data, experiment, formulate a model

Safety Precautions
Provide plenty of balloons; students should not share balloons.

Preparation

- Ask students to bring calculators to lab for use in making calculations.
- Use large-capacity balloons.

Alternative Materials
- To decrease the number of balloons needed, cut a straw in half and use a rubber band to attach the balloon to the straw. Blow up the balloon through the straw, then replace only the straw for the next student.

Resource Manager

BioLab and MiniLab Worksheets, pp. 167-168 L2

INVESTIGATE BioLab

Measuring Respiration

The exchange of oxygen and carbon dioxide between the body and the atmosphere is external respiration. It should not be confused with the processes of cellular respiration, which are the chemical reactions that take place within cells to provide energy. The amount of air exchanged between the atmosphere and the blood during external respiration can be measured using a clinical machine called a spirometer. It also can be measured, although less accurately, using a balloon.

Preparation

Problem
How can you measure respiratory rate and estimate tidal volume?

Objectives
In this BioLab, you will:
- **Measure** resting breathing rate.
- **Estimate** tidal volume by exhaling into a balloon.
- **Calculate** the amount of air inhaled per minute.

Materials
round balloon
string (1 m)
metric ruler
clock or watch with second hand

Skill Handbook
Use the **Skill Handbook** if you need additional help with this lab.

Procedure

Data Table 1

Resting breathing rate	
Trial	**Inhalations in 30 s**
1	
2	
3	
Average number breaths	
Breaths per minute	

Part A: Breathing Rate at Rest
1. Copy Data Table 1.
2. Have your partner count the number of times you inhale in 30s.
3. Repeat step 2 two more times.
4. Calculate the average number of breaths.
5. Multiply the average number of breaths by two to get the average resting breathing rate in breaths per minute.

Part B: Estimating Tidal Volume
1. Copy Data Table 2.
2. Take a regular breath and exhale normally into the balloon. Pinch the balloon closed.
3. Have a partner fit the string around the balloon at the widest part.
4. Measure the length of the string, in centimeters, around the circumference of the balloon. Record this measurement.
5. Repeat steps 2-4 four more times.
6. Calculate the average circumference of the five measurements.
7. Calculate the average radius of the balloon by dividing the average circumference by 6.28 (which is approximately equal to 2 π).
8. Tidal volume is the amount of air expelled during a normal breath. Tidal volume can be determined using the balloon radius and the formula for determining the volume of a sphere.

$$\text{Volume} = \frac{4\pi r^3}{3}$$

where r = radius and $\pi = 3.14$. Calculate the average tidal volume using the average balloon radius.
9. Your calculated volume will be in cubic centimeters: 1 cm^3 = 1 mL.

Data Table 2

Tidal volume	
Trial	**String measurement**
1	
2	
3	
4	
5	
Average circumference	
Average radius	
Average tidal volume	

Part C: Amount of Air Inhaled
1. Copy Data Table 3.
2. Multiply the average tidal volume by the average number of breaths per minute to calculate the amount of air you inhale per minute.
3. Divide the number of milliliters of air by 1000 to get the number of liters of air you inhale per minute.

Data Table 3

Amount of air inhaled	
mL/min	
L/min	

Analyze and Conclude

1. **Making Comparisons** Compare your average number of breaths per minute and tidal volume per minute with those of other students.
2. **Thinking Critically** An average adult inhales 6000 mL of air per minute. Compare your estimated average volume of air with this figure. What factors could account for any differences?
3. **Making Predictions** Predict what would happen to your resting breathing rate after exercise.

Going Further

Applying Concepts The largest amount of air that can be exhaled is called vital capacity. Determine your estimated average vital capacity by following a procedure similar to the one you used to determine average tidal volume.

interNET CONNECTION To find out more about respiratory volumes, visit the Glencoe Science Web Site.
www.glencoe.com/sec/science

INVESTIGATE BioLab

Analyze and Conclude

1. Average breaths per minute and tidal volume per minute will differ among students.
2. Answers may vary from the average due to age, sex, size, and athletic condition.
3. After exercising, the breathing rate will be higher.

Assessment

Performance Have students write a summary of the lab, including the three tables and the answers to the Analyze and Conclude. Use the Performance Task Assessments List for Lab Report in **PASC,** p. 47. L2

Going Further

Logical-Mathematical
Students can calculate their tidal volume after exercising and compare this with their tidal volume during rest. L3

Procedure

Teaching Strategies
- Explain that there are about 300 million alveoli in a human lung with a surface area of more than 50 m^2. Have students measure the classroom, calculate the number of square meters, and compare this figure with that of a human lung.
- Have students work in pairs and, if time allows, reverse roles.

Data and Observations
Answers among students could vary greatly. Average breathing rate is 11 to 12 breaths per minute. Tidal volume should be approximately 280 mL. The amount of air inhaled should be 5 to 6 L per minute.

Biology & SOCIETY

Purpose

Students explore the connection between medical and social issues and learn about the need for organ donors

Background

There are two types of donors. Cadaveric donors are patients who have suffered brain death and will not survive. Living donors are healthy individuals willing to donate a kidney or a portion of their bone marrow. Humans can thrive with only a single kidney. Bone marrow is easily replaced by a healthy body.

Teaching Strategies

- Explain to students that most donor organs come from individuals who have suffered massive injuries from which they can never recover. The body may continue to function for a time, but only if it is kept on artificial life support. A patient is never taken off life support if there is any hope of recovery, even if it means that his or her organs would become useless for transplanting.

Investigating the Issue

Students may encounter a variety of opinions and beliefs. People who have received a donated organ, or know someone who has, are likely to encourage others to become donors. Some people may be uncomfortable talking about the subject. Students may discover that organ donation is one of the important decisions a family must make when one of its members has suffered brain death and is being kept alive by life support.

Biology & SOCIETY

Finding Transplant Donors

The ability to replace a diseased heart, liver, kidney, pancreas, or other organ with a healthy organ from a human donor is one of the most important of medical science's recent advances. Organs suitable for transplanting are scarce, and there are thousands of transplant patients waiting for them.

Transplant recipients include children born with malformed hearts or digestive systems, patients suffering from severe liver or heart disease, burn victims in desperate need of skin grafts, or people whose kidneys have stopped functioning.

The waiting list A patient who is a good candidate for a transplant is placed on a waiting list. A national computer database keeps track of each patient's blood and tissue type, organ size, and other medical factors. When an organ becomes available, the computer produces a list of all the patients for whom the organ is medically suitable. Patients are ranked according to the severity of their illness, the length of time they have been waiting, and the distance between the donor and the transplant hospital.

Recovering transplant patient

Different Viewpoints

A donor organ must be transplanted within hours. Deciding who should receive an organ involves questions of medical urgency and logistics. In most cases, organs are offered first to patients who are located closest to the donor. This sometimes means that patients who have been waiting longer or are more seriously ill are passed over because they live farther away.

Should the most seriously ill be first? One of the problems with selecting organ recipients by geography is that more donor organs become available in the most densely populated regions of the country. A seriously ill patient who lives far from a large population center might have to wait longer than a patient who lives in a big city. In 1998, the Department of Health and Human Services asked the national organization that coordinates the matching of organs with patients to revise their policies and make organs available to patients regardless of location. If the most seriously ill patient is so far away that the transplant cannot be completed within the time limit, then another patient must be selected. Final decisions are always left to medical professionals who are experts in transplant surgery.

Investigating the Issue

Analyzing the Issue Interview friends and family about the reasons why they would or would not consider becoming an organ donor. Organize a class discussion to share what you learned.

internet CONNECTION To find out more about organ transplants, visit the Glencoe Science Web Site.
www.glencoe.com/sec/science

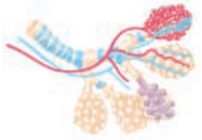
Going Further

Invite interested students to develop an education program to increase awareness in their community about the need for organ and tissue donors. L3

Chapter 37 Assessment

Summary

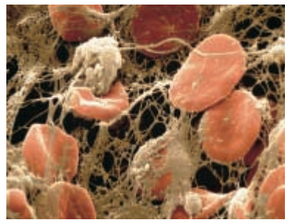
Section 37.1
The Respiratory System



Main Ideas
- External respiration involves taking in air through the passageways of the respiratory system and exchanging gases in the alveoli of the lungs.
- Breathing involves contraction of the diaphragm, the rush of air into the lungs, relaxation of the diaphragm, and air being pushed out of the lungs.
- Breathing is controlled by the chemistry of the blood.

Vocabulary
alveoli (p. 1004)
trachea (p. 1003)

Section 37.2
The Circulatory System



Main Ideas
- Blood is composed of red and white blood cells, platelets, and plasma. Blood carries oxygen, carbon dioxide, and other substances through the body.
- Blood cell antigens determine blood group and are important in blood transfusions.
- Blood is carried by arteries, veins, and capillaries.
- Blood is pushed through the vessels by the heart.

Vocabulary
antibody (p. 1009)
antigen (p. 1009)
aorta (p. 1013)
artery (p. 1011)
atrium (p. 1012)
blood pressure (p. 1016)
capillary (p. 1012)
hemoglobin (p. 1008)
plasma (p. 1007)
platelet (p. 1009)
pulse (p. 1013)
red blood cell (p. 1007)
vein (p. 1012)
vena cava (p. 1013)
ventricle (p. 1012)
white blood cell (p. 1008)

Section 37.3
The Urinary System

Main Ideas
- The nephrons of the kidneys filter wastes from the blood.
- The urinary system helps maintain the homeostasis of body fluids.

Vocabulary
kidney (p. 1017)
nephron (p. 1018)
ureter (p. 1017)
urethra (p. 1019)
urinary bladder (p. 1017)
urine (p. 1018)

Understanding Main Ideas

1. If you have type O blood, what blood group could be used if you needed a transfusion?
   a. type O
   b. type A
   c. type B
   d. type AB

2. The primary function of the kidneys is to rid the body of _____.
   a. carbon dioxide wastes
   b. undigested food
   c. wastes in the blood
   d. excess enzymes

GLENCOE TECHNOLOGY

VIDEOTAPE
MindJogger Videoquizzes
Chapter 37: *Respiration, Circulation, and Excretion*
Have students work in groups as they play the videoquiz game to review key chapter concepts.

Resource Manager

Chapter Assessment, pp. 217-222
MindJogger Videoquizzes
Computer Test Bank
BDOL Interactive CD-ROM, Chapter 37 quiz

Main Ideas

Summary statements can be used by students to review the major concepts of the chapter.

Using the Vocabulary

To reinforce chapter vocabulary, use the Content Mastery Booklet and the activities in the Interactive Tutor for Biology: The Dynamics of Life on the Glencoe Science Web Site.
www.glencoe.com/sec/science

THE PRINCETON REVIEW *All Chapter Assessment questions and answers have been validated for accuracy and suitability by the Princeton Review.*

Understanding Main Ideas

1. a
2. c

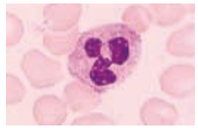
3. nuclei
4. c
5. d
6. b
7. b
8. medulla oblongata
9. a
10. b
11. trachea
12. alveoli, blood
13. carbon dioxide
14. lack a nucleus
15. antigens
16. arteries, blood
17. aorta
18. alveoli, lungs
19. blood, plasma
20. arterioles, capillaries

Applying Main Ideas

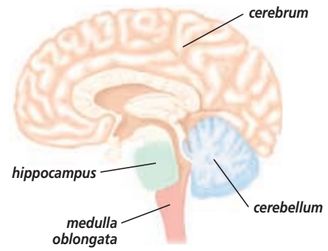
21. Pulmonary arteries carry oxygen-poor blood from the heart to the lungs, where excess carbon dioxide is released.
22. High blood pressure can damage the capsule by forcing fluids too rapidly through the capsule tissue.

Chapter 37 Assessment

3. White blood cells differ from red blood cells in that white blood cells have _____.



4. Blood cells receive oxygen in the _____.
   a. bronchi **c.** alveoli
   b. trachea **d.** pharynx
5. Which cell parts are involved in blood clotting?
   a. ribosomes **c.** nucleus
   b. mitochondria **d.** platelets
6. Oxygen travels in the blood attached to _____.
   a. white blood cells **c.** platelets
   b. hemoglobin **d.** wastes
7. The basic filtering unit of the kidney is the _____.
   a. Bowman's capsule **c.** bladder
   b. nephron **d.** glomerulus
8. Breathing is an involuntary process that is controlled by the _____.



The Princeton Review — Test-Taking Tip

Don't Use Outside Knowledge
When answering questions for a reading passage, do not use anything you know about the subject of the passage, or any opinions you have about it. Always return to the passage to reread and get the details from there.

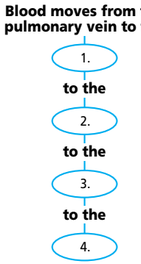
9. Which of the following molecules would NOT be found in normal urine?
   a. glucose **c.** salt
   b. water **d.** urea
10. The renal artery branches and sends a knot of capillaries into the _____.
    a. glomerulus **c.** nephron
    b. Bowman's capsule **d.** tubules
11. The _____ divides into narrower tubes called bronchi.
12. External respiration involves an exchange of gases between air in the _____ and the _____.
13. Blood that comes to the alveoli from body cells is high in _____.
14. Red blood cells are different from other body cells because they _____.
15. Differences in blood groups are due to the presence or absence of proteins called _____ on red blood cell membranes.
16. _____ are large, elastic blood vessels that carry _____ away from the heart.
17. The _____ is the largest blood vessel in the body.
18. The _____ are small sacs in the _____ where oxygen and carbon dioxide are exchanged.
19. The liquid portion of the _____ is called _____ and it carries blood cells around the body.
20. Arteries branch into _____, which in turn branch into _____.

Applying Main Ideas

21. Explain why all blood in all arteries is not oxygen-rich. Where in the circulatory system do arteries carry oxygen-poor blood?
22. Think about the structure of a nephron, and suggest a reason why high blood pressure could damage the kidneys.
23. A diet low in saturated fats and cholesterol helps maintain elasticity and prevent clogging of the blood vessels. Why is this type of diet considered healthy for your heart?
24. In some large cities, citizens are advised to avoid heavy outdoor exercise when air pollution levels are high. Explain why it would be wise to heed such a warning.

Thinking Critically

25. **Recognizing Cause and Effect** What activities besides exercise could affect breathing rate?
26. **Designing an Experiment** Design an experiment that would test the effect of various types of music on heartbeat rate.
27. **Formulating Hypotheses** The evolution of the mammalian kidney has allowed mammals to live efficiently on land and lose little water. Explain how the mammalian kidney conserves water.
28. **Concept Mapping** Complete the concept map using the following vocabulary terms: aorta, arteries, left atrium, left ventricle.

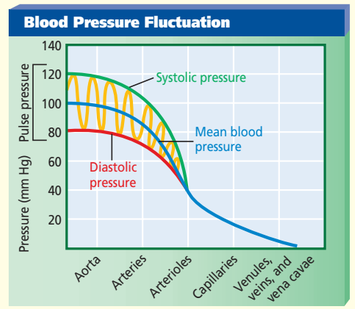


CD-ROM

For additional review, use the assessment options for this chapter found on the ***Biology: The Dynamics of Life Interactive CD-ROM*** and on the Glencoe Science Web Site.
www.glencoe.com/sec/science

Assessing Knowledge & Skills

The following graph shows blood pressure fluctuation in blood vessels.



Interpreting Data Use the graph to answer the following questions.

1. Which of the variables shown on the graph is the dependent variable?
   a. type of blood vessel
   b. systolic pressure
   c. diastolic pressure
   d. blood pressure
2. In which blood vessel is blood pressure greatest?
   a. the aorta **c.** the capillaries
   b. the arteries **d.** the veins
3. What is the mean blood pressure in the arteries?
   a. 120 mm Hg **c.** 80 mm Hg
   b. 90 mm Hg **d.** 70 mm Hg
4. **Observing and Inferring** Explain why the blood pressure changes periodically in the aorta and the small arteries, but not in the capillaries and veins.

Chapter 37 Assessment

23. Diets high in saturated fats and cholesterol are associated with increased risk of atherosclerosis.
24. Most air pollution contains high levels of carbon monoxide and other toxic substances. Exercise would increase the amount of these toxic gases drawn into the lungs.

Thinking Critically

25. sleeping, eating, watching an exciting movie, use of stimulants or depressants
26. Experiments might include playing various types of music while taking pulse rate and comparing with pulse rate without music.
27. In the tubules of the nephron, much of the water present in the filtrate is reabsorbed.
28. 1. Left atrium; 2. Left ventricle; 3. Aorta; 4. Arteries

Assessing Knowledge & Skills

1. d
2. a
3. b
4. The muscular aorta and arteries expand when the left ventricle forces blood into them. The muscles of these vessels recoil in between heartbeats, helping to push the blood along.