Science Ch. 4

Body systems

NASA Biography

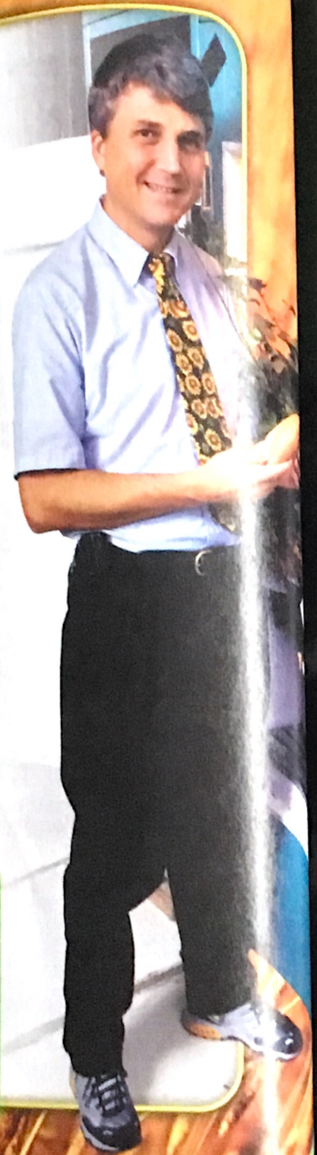
Daniel Barta

BOTANIST

Would you guess that a love for plants could lead a scientist to outer space? It did for Daniel J. Barta. Along with scientists from many different areas of study, he works every day to solve problems that people will face in space.

Barta earned his Ph.D. in Botany/Horticulture (the science of plant reproduction) in 1991 from the University of Wisconsin in Madison. He then went to work at the Wisconsin Center for Space Automation and Robotics. This may seem like an odd workplace for a man who works with plants. But it made perfect sense. The Center was trying to learn if plants could be grown in space. Dr. Barta was trying to find out if plants could reproduce in space.

NASA was interested in Dr. Barta's work because plants can be the solution to many problems in human space travel. For example, astronauts in space need a constant supply of food, water, and oxygen. Dr. Barta grew sweet potatoes in conditions identical to those in a spaceship. The experiment showed that growing plants on spacecraft can provide astronauts with food, clean water, and oxygen. When humans someday build stations on the Moon or travel to Mars, they will have people like Daniel Barta to thank.

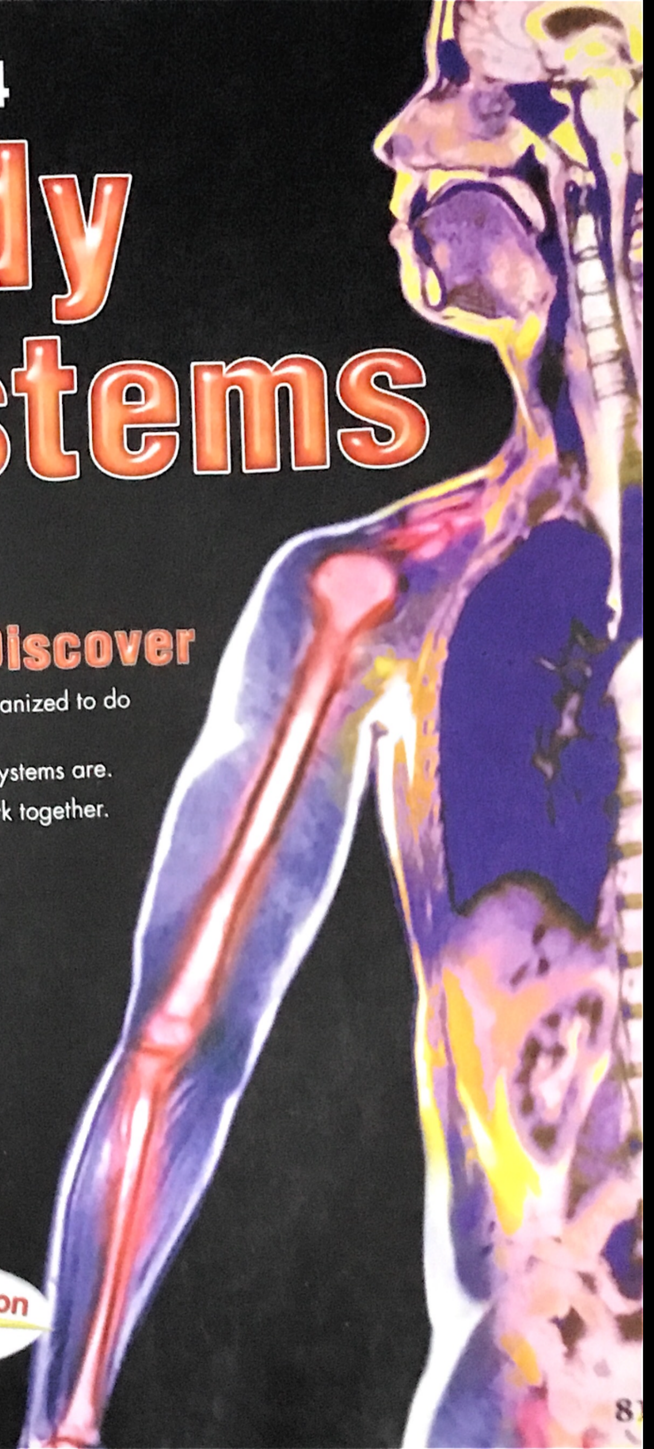


Lab zone Take-Home Activity

Write a short story about astronauts on a spaceship who depend on plants for food and oxygen. Think about what crises the astronauts might face if the plants begin to die. What steps would they have to take? How do they solve their problem?

Chapter 4

Body Systems



You Will Discover

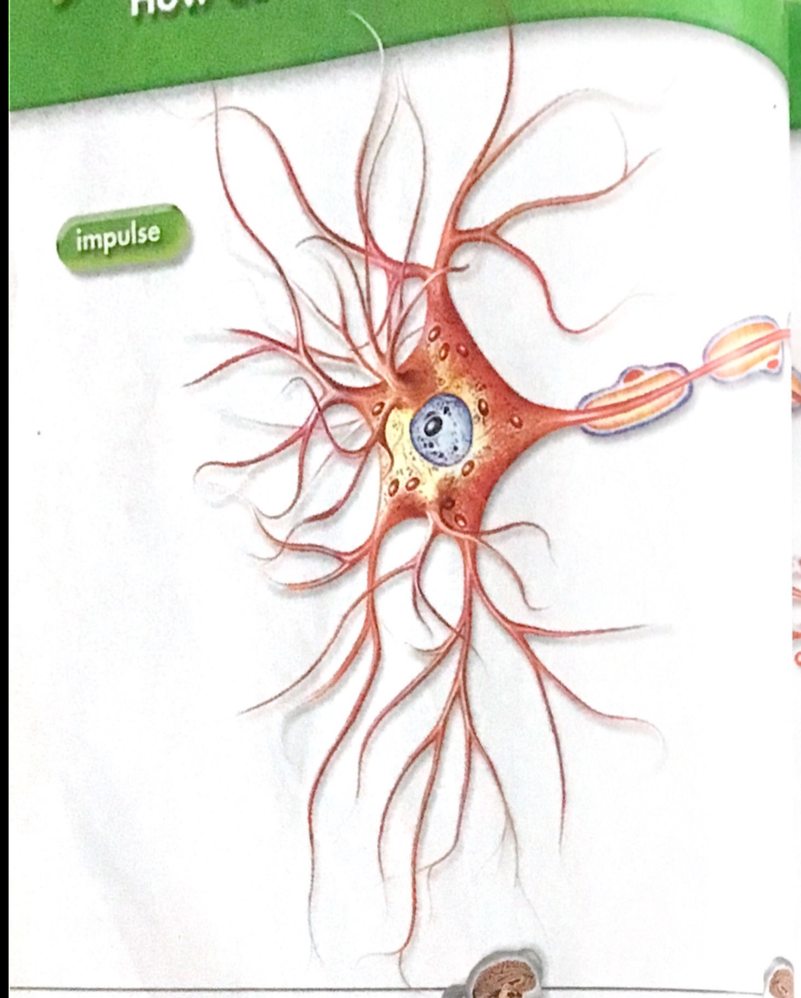
- how body cells are organized to do certain tasks.
- what the major body systems are.
- how body systems work together.

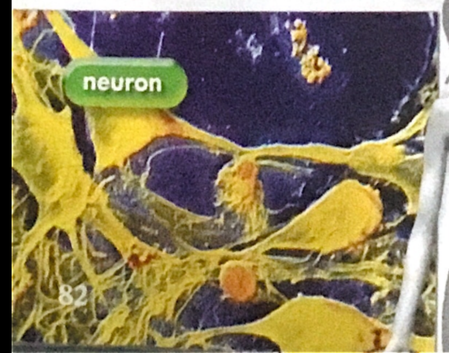
online Student Edition
pearsonsuccessnet.com

Build Background

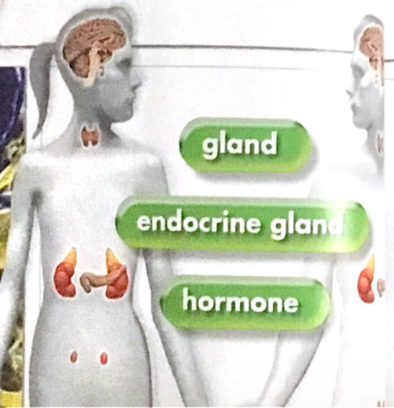
How do body parts work together?

impulse





neuron



gland

endocrine gland

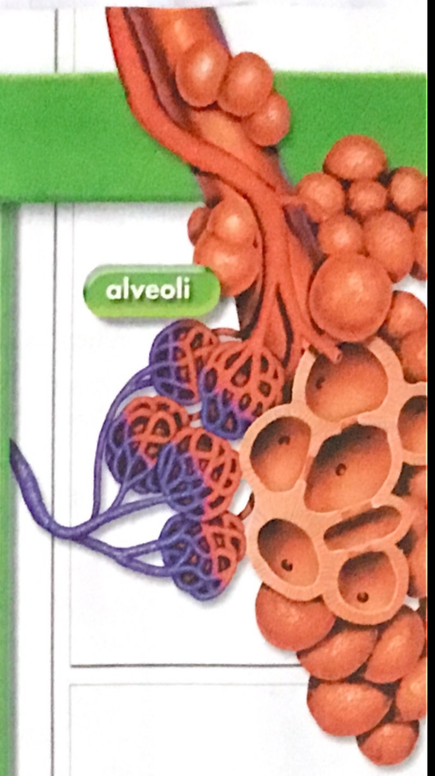
hormone

Chapter 4 Vocabulary

neuron page 95
impulse page 95
gland page 96
endocrine gland page 96
hormone page 96
enzyme page 98
alveoli page 101
pathogen page 102
antibody page 103

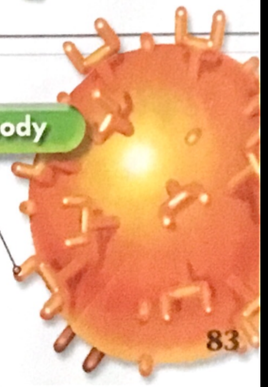
enzyme

chemicals that help break down food into nutrients

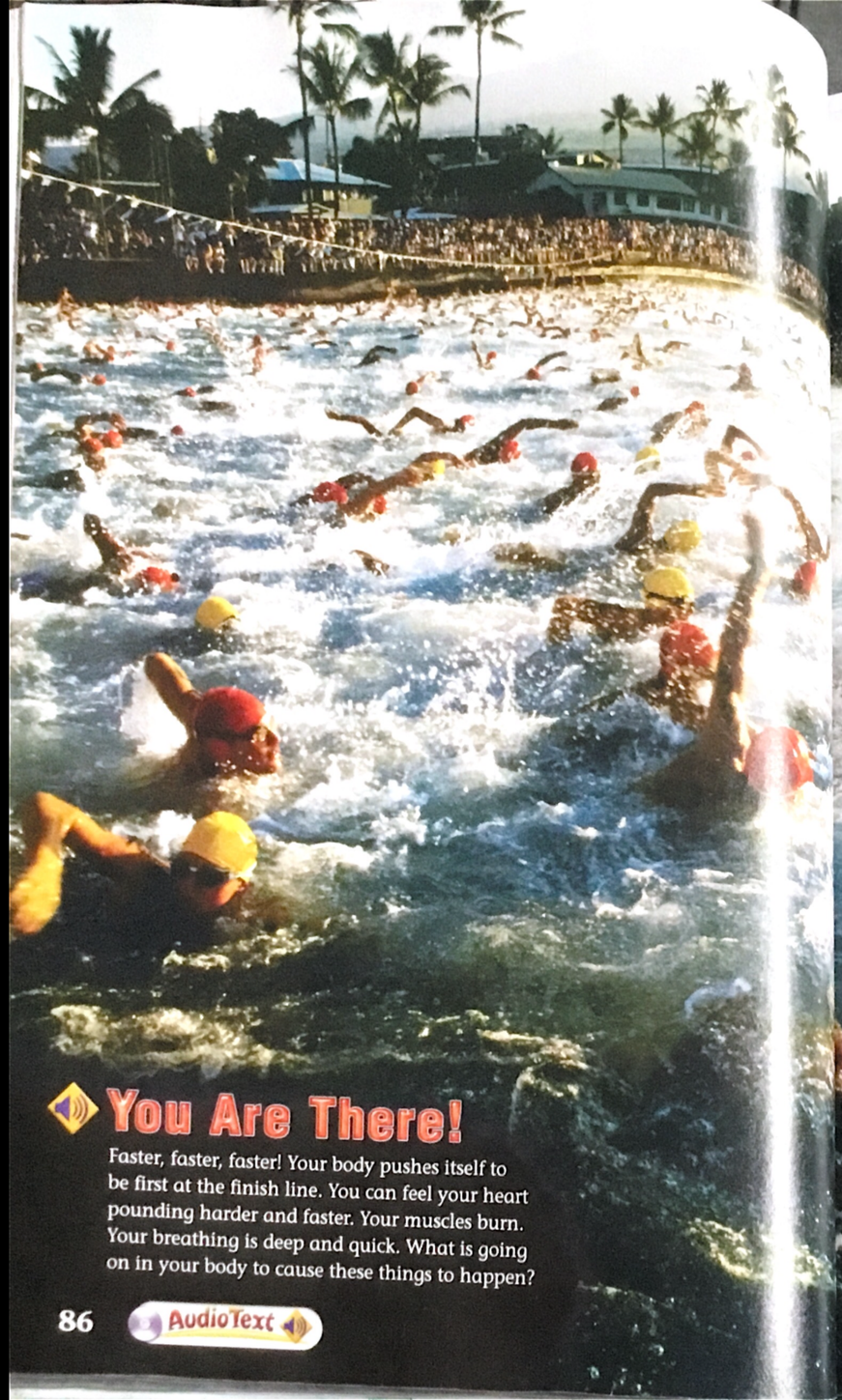


alveoli

pathogen



antibody



You Are There!

Faster, faster, faster! Your body pushes itself to be first at the finish line. You can feel your heart pounding harder and faster. Your muscles burn. Your breathing is deep and quick. What is going on in your body to cause these things to happen?

AudioText

Lesson 1

How is the body organized?

Cells are the building blocks of your body. Specialized cells make up different body parts, which work together to meet all of the needs of your body.

Cells Working Together

Your body is able to do some pretty amazing things. You can run and catch a ball. You can write and read. You can dance, play an instrument, or even create your own music. No one body part is responsible for any of these activities. Instead, each part involved contributes in its own way.

The human body is an amazing system made up of more than 75,000,000,000,000 cells. These cells are so small that a sheet of about 10,000 of them would only cover the head of a pin. Every one of those cells is a living unit. At the same time, each cell is part of a larger living unit—your body.

Millions of chemical processes go on in your body every minute. Those chemical processes take place in cells. Cells depend on each other to keep all the body's internal conditions in balance so that all cells can work properly. For example, the important processes that go on in your body cells can only happen within a particular temperature range—around 37°C (98.6° F). Cells in different parts of your body work together to make sure the body's temperature stays in that range. Your body depends on its cells to make it run smoothly.

The surprising thing about cells is that they do so many important tasks but they are so small. The largest cell, the human egg cell, is about the diameter of a human hair. Most human cells are much smaller. How can so many tiny, individual cells in the body work together so efficiently? The answer is in the way cells are organized.

1. **Checkpoint** Why is keeping the body in balance important?
2. **Health** in Science Use Internet resources to find out three things you can do each day to help your body perform at its best.

Levels of Organization

Although all cells are made of the same basic parts, each type of cell is adapted to perform certain activities or functions. Keeping the body in balance requires many different activities, but each cell does not have to do them all. Cells are organized by the activities they do.

Similar cells that work together to perform a particular function in the body make up tissues. Cells that can contract, or shorten, make up muscle tissue. When the cells that make up muscle tissue contract, some part of your body moves. You use muscle tissue when your eyes move to read this page or when you move in your chair.

Although muscle tissue contracts to move your body, nerve tissue tells the muscle tissue to do so. The cells that make up nerve tissue are alike in that they can carry messages from one cell to another. Your brain is made of mostly nerve tissue. Other types of tissue hold together body parts, support the body, cushion organs, or release substances.

When two or more tissues work together to do a job, they form an organ. The job of an organ is usually not as simple as the job of a tissue. For example, your heart must pump blood all over your body. To do so, it must have different kinds of tissues—muscle tissue that contracts, nerve tissue that directs its activities, and other tissues to hold it together and carry blood.

Each organ in your body is part of an organ system. Different organ systems work together and depend on each other. Read the chart on the next page to see the important jobs each body system does.

Cells
The heart must beat without stopping so that the body has a constant supply of blood. Heart muscle cells have many mitochondria (red) to provide energy for this task.

Tissues
The arrangement of muscle cells in this heart tissue allows the muscles to shorten and then relax, causing the heart to beat.

The Body's Major Systems

System	Function
Circulatory	Transports oxygen, nutrients, and cell wastes
Digestive	Breaks down foods into a form the body can use
Endocrine	Controls internal conditions, growth, development, and reproduction
Excretory	Removes wastes from the blood
Immune	Defends the body against pathogens
Muscular	Allows body movement and movement of substances within the body
Nervous	Controls body movement, thought, and behavior
Reproductive	Produces sex cells and offspring
Respiratory	Provides the body with oxygen and removes gas wastes from the blood
Skeletal	Provides body protection and support; interacts with muscles to allow movement

Organs
The heart itself is an organ. In addition to muscle tissue, the heart is made of tissues that provide support and protection and that form its blood vessels.

Blood Cells

These blood cells are only two of the many kinds of cells that make up your body. Red blood cells carry oxygen throughout the body so that all cells can carry out life functions. White blood cells help to fight off disease-causing invaders that attack the body.

Although each person is unique, the cells of everyone's body are similar in some ways. This similarity makes it possible for individuals to donate their blood to others. Other cell similarities enable people to donate entire organs.

Lesson Checkpoint

1. What is the basic unit of structure in the human body?
2. Identify and give an example of each level of organization in the human body.
3. **Health** in Science There are four basic types of blood. Usually, only individuals with the same type can exchange blood. Use reference sources to find out the four basic types of blood and which one can be donated to anyone.

Lesson 2

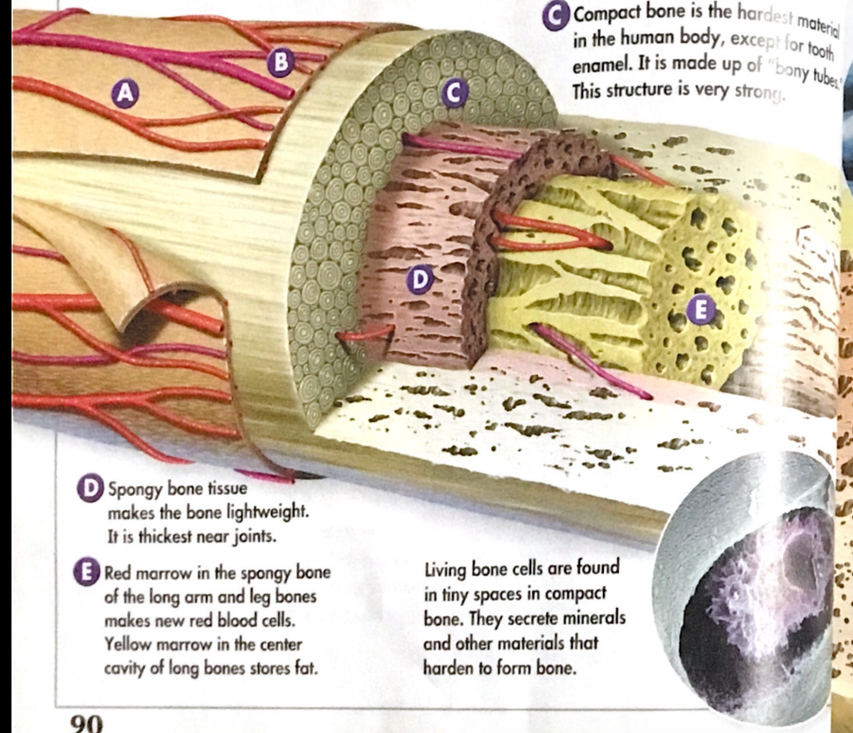
What systems help move body parts?

Your skeleton provides support, protects organs, makes new blood cells, and stores important minerals. Its 206 bones work with skeletal muscles to allow your body to move.

Skeletal System

When you look at a bone, like the one in the picture, you might think that it is dead. But the bones of your body are very alive. Bones are made of living tissues, as well as nonliving minerals that are deposited by bone cells. Blood flows through every part of a bone.

Parts of a Bone



A The thin, tough, outer covering on the surface of a bone is living tissue.

B Blood vessels in the bone carry blood, which supplies materials that bone cells need. Blood also removes wastes that bone cells produce.

C Compact bone is the hardest material in the human body, except for tooth enamel. It is made up of "bony tubes." This structure is very strong.

D Spongy bone tissue makes the bone lightweight. It is thickest near joints.

E Red marrow in the spongy bone of the long arm and leg bones makes new red blood cells. Yellow marrow in the center cavity of long bones stores fat.

Living bone cells are found in tiny spaces in compact bone. They secrete minerals and other materials that harden to form bone.

When you were a baby, some of your bones were made of a flexible material called cartilage. Much of the cartilage is replaced by hard bone as a person ages. But you still have cartilage. Move the tip of your nose or the tops of your ears. The flexible tissue in those places is cartilage. Bones and cartilage make up your skeletal system.

Bones have several functions. They support your body and give you height. Bones of the skull, rib cage, and back protect important organs. Some bones form new blood cells. Bones also store minerals, such as calcium and phosphorus. Small amounts of stored minerals are released when the body needs them. These same minerals make bones hard and strong.

Calcium in the bony material that makes up much of your body's long bones helps make the bones hard and heavy. The network of spaces in this normal bone below helps make the bone lighter.

As people grow older, they lose calcium in their bones. The result can be seen in the bone below. This is a bone of a person who has a disease called osteoporosis. Bones that are weakened like this can break easily.

1. **Checkpoint** What are three functions of bones?
2. **Cause and Effect** What is osteoporosis? What is its cause?

Joints

A joint is a place where two bones meet. Flexible cartilage covers and protects the ends of bones at joints. The shape of cartilage surfaces and the way they fit together determine the directions a joint can move. Strong cords of tissue called ligaments connect the bones in each joint.

Ball-and-Socket
The shoulder joint allows the arm to swing freely in a circle. This type of joint allows the most movement.

Hinge
The knee joint works like the hinges of a door. It allows the leg to bend and straighten.

Pivot
The joint at your elbow allows bones to rotate around one another. This allows your arm to twist.

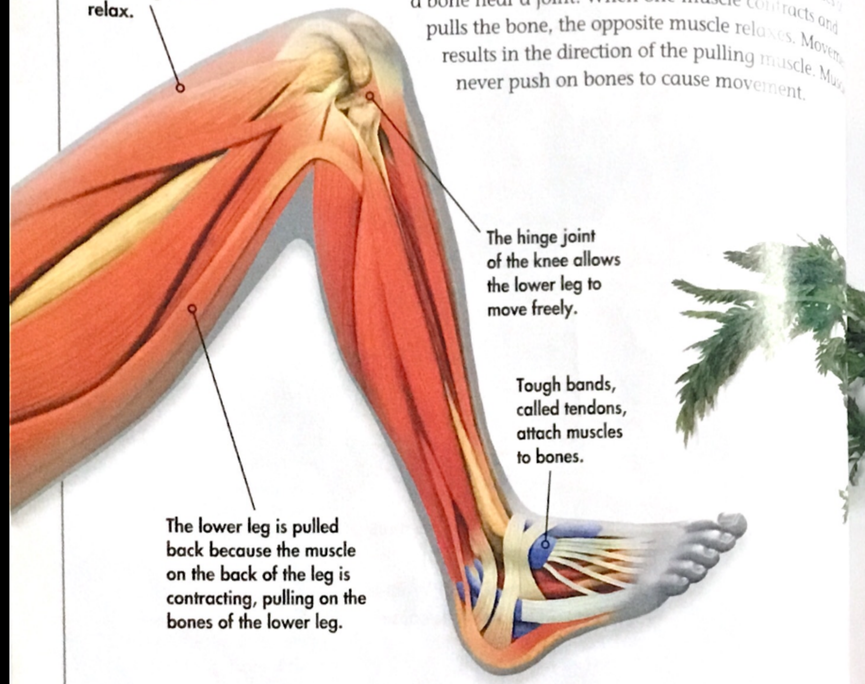
Muscular System

Your bones support your body, but without your muscles you would not be able to move. In fact, you wouldn't be able to stand, breathe, or swallow food. The more than 600 muscles of your body make up 40 to 50 percent of your body weight. The muscles and the tissues that attach them to bones make up the muscular system.

Your body has three types of muscle tissue. The muscle tissue in the heart, called cardiac muscle, is found nowhere else in the body. This kind of muscle tissue can contract time after time without getting tired. Another kind of muscle, called smooth muscle, can be found in organs of the digestive system and blood vessels. Cardiac and smooth muscles are involuntary muscles—they work automatically to control movements inside your body. For example, the smooth muscles lining your stomach cause it to twist and turn to mix food with digestive juices.

The third kind of muscle—skeletal muscle—is voluntary muscle. You can control voluntary muscles. The muscles that move your arms and legs are voluntary muscles.

All muscles can contract, but only skeletal muscles are responsible for the body's movement. Your bones and skeletal muscles work together to make your body move. Pairs of muscles attach to opposite sides of a bone near a joint. When one muscle contracts and pulls the bone, the opposite muscle relaxes. Movement results in the direction of the pulling muscle. Muscles never push on bones to cause movement.



Keeping Muscles and Bones Healthy

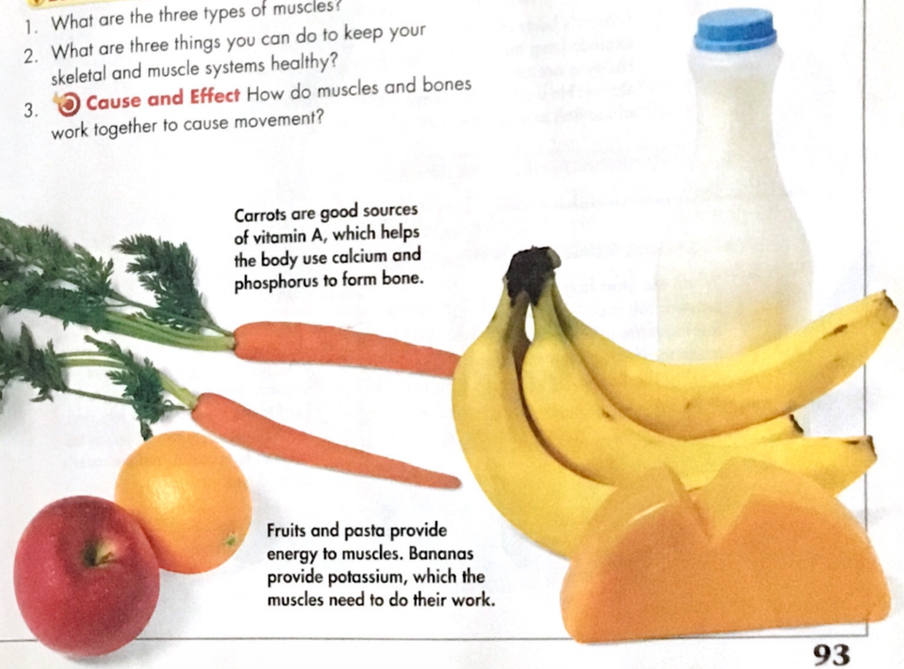
Although your muscles are very strong, they can become injured or develop other problems. Overworking or stretching your muscles too far may result in a muscle strain or an irritation of the tendons, the tough tissue that connects muscle to bone. Muscular dystrophy is a condition in which the muscles become weaker and weaker as the muscles are slowly destroyed. It is an inherited condition, and the most common form occurs mostly in males.

Disorders of the skeletal system include arthritis and osteoporosis. Arthritis is a condition in which the joints become painful and swollen. It is the most common disease in the United States not caused by germs. Arthritis can affect children or adults. Osteoporosis is a condition in which bones become weak and break easily. Although symptoms of osteoporosis do not show up until people become older, getting enough calcium during childhood and adolescence and being physically active can help prevent this condition.

You can keep your skeletal and muscular systems strong and healthy by eating healthful foods. Get plenty of rest and exercise. Some people warm up before beginning exercise. Warming up loosens muscles, tendons, and ligaments.

Lesson Checkpoint

1. What are the three types of muscles?
2. What are three things you can do to keep your skeletal and muscle systems healthy?
3. **Cause and Effect** How do muscles and bones work together to cause movement?



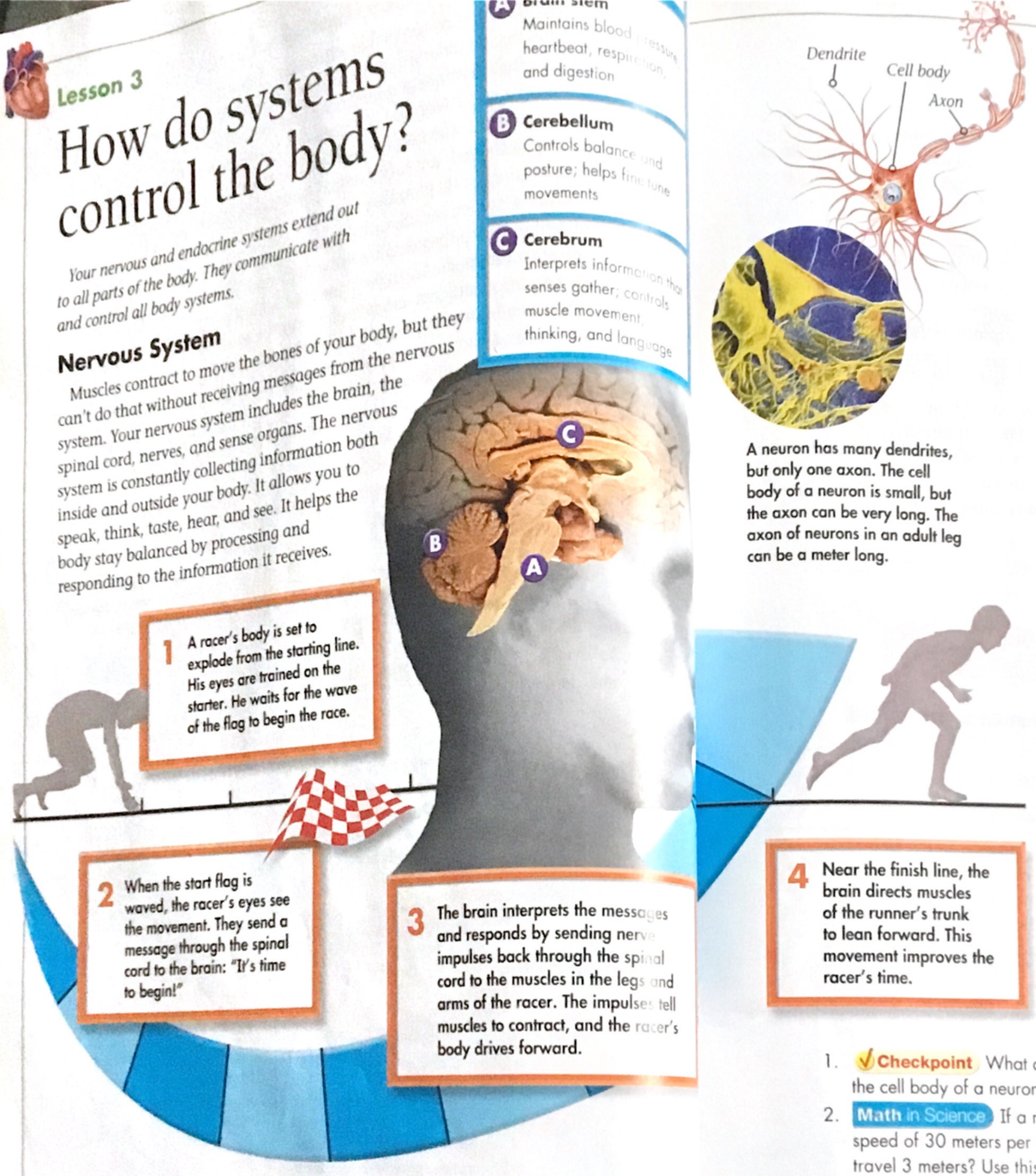
Lesson 3

How do systems control the body?

Your nervous and endocrine systems extend out to all parts of the body. They communicate with and control all body systems.

Nervous System

Muscles contract to move the bones of your body, but they can't do that without receiving messages from the nervous system. Your nervous system includes the brain, the spinal cord, nerves, and sense organs. The nervous system is constantly collecting information both inside and outside your body. It allows you to speak, think, taste, hear, and see. It helps the body stay balanced by processing and responding to the information it receives.



A neuron has many dendrites, but only one axon. The cell body of a neuron is small, but the axon can be very long. The axon of neurons in an adult leg can be a meter long.

Nerve cells, called **neurons,** pass messages throughout your body. Each neuron has a cell body with many thin branches. Short branches, called dendrites, carry messages from other neurons to the cell body. A long branch, the axon, carries messages away from the cell body to other nerve cells.

When the dendrite of a neuron receives a message, the chemical makeup of the neuron changes. This chemical change causes an **impulse,** or message, to travel along the neuron and from one neuron to the next. These impulses can travel in only one direction—from the axon of one neuron to the dendrite of another neuron.

Most impulses travel along neurons to the brain, which controls almost everything you experience and do. Much of the information that your nervous system collects is processed by the brain. The brain interprets the information and responds by sending messages to different parts of the body telling them to act.

Impulses received and sent by the brain pass through the spinal cord. This long bundle of nerves runs down your back and is protected by your backbone. Some neurons in the spinal cord carry messages to the brain. Others carry them away.

Reflexes

Some messages that the body receives do not pass to the brain. One example is the response of your body when you touch your hand to a hot surface. The response to that action is a reflex, a response that happens automatically without the brain "thinking" about it. Reflexes happen very fast. They help protect the body from dangerous situations.

Without the nervous system, the many parts of your body would not be able to work together. You can help protect your nervous system by avoiding alcohol and other illegal drugs. Wear protective gear when playing sports or doing any activity in which the brain may be injured. Wear seat belts when riding in a car. Never dive into a shallow pool.

1. **Checkpoint** What are the two kinds of branches that extend from the cell body of a neuron? What does each do?
2. **Math in Science** If a nerve signal travels to and from the brain at a speed of 30 meters per second, how long would it take the signal to travel 3 meters? Use this equation: time = distance/speed.

Endocrine System

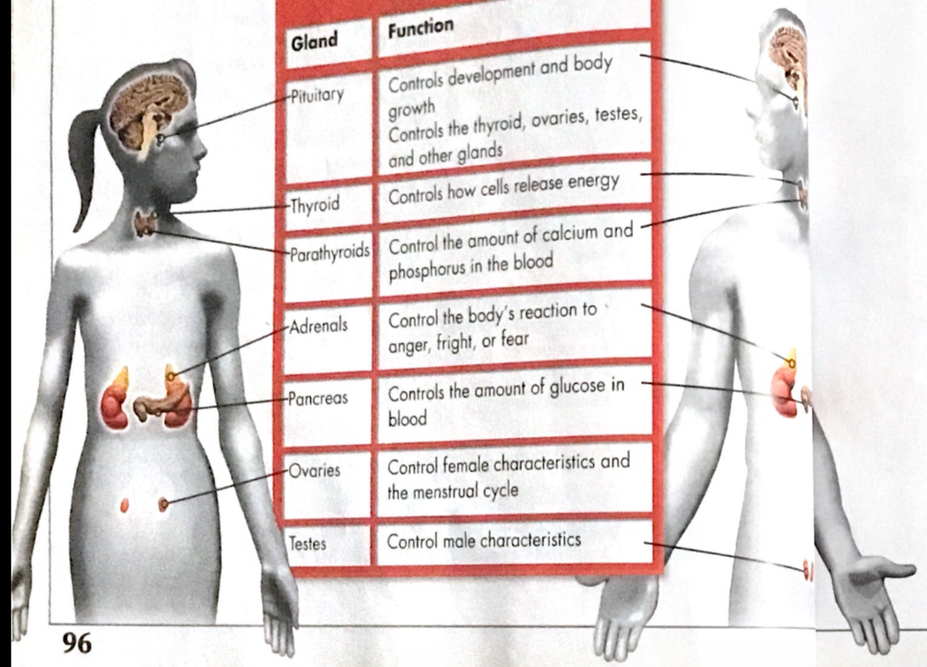
Your nervous system helps maintain balance in the body's processes by interpreting information about the environment and then telling parts of the body to act. Your endocrine system also helps balance your body's processes. But it controls slower processes, such as growth and sugar levels in the blood.

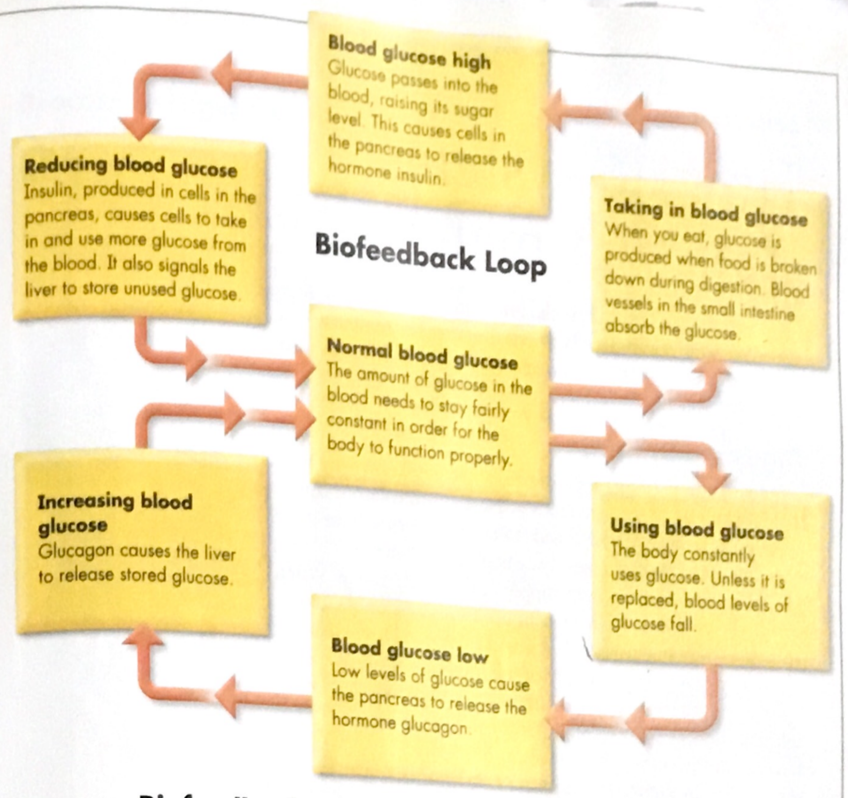
The endocrine system is made up of glands. A **gland** is an organ that produces a chemical. Some glands release their chemicals into tiny tubes called ducts. The endocrine glands do not release chemicals into ducts. Each **endocrine gland** is an organ that releases chemical substances directly into the blood. The substances they release are called **hormones.** Hormones control many of your body's functions.

The endocrine system continually checks your body's condition. It releases hormones when needed to maintain your body's internal balance. Each kind of hormone travels in the blood to particular target cells throughout the body. Each hormone causes target cells to perform certain tasks. For example, a hormone may cause bones to grow or muscles to store sugar.

Endocrine Glands

Gland	Function
Pituitary	Controls development and body growth Controls the thyroid, ovaries, testes, and other glands
Thyroid	Controls how cells release energy
Parathyroids	Control the amount of calcium and phosphorus in the blood
Adrenals	Control the body's reaction to anger, fright, or fear
Pancreas	Controls the amount of glucose in blood
Ovaries	Control female characteristics and the menstrual cycle
Testes	Control male characteristics





Biofeedback Loop

Endocrine glands keep important body substances in balance. They do this by releasing fewer or more hormones. This allows glands to turn on, turn off, speed up, or slow down the activities of organs and tissues.

An example of the way the endocrine glands help maintain balance in the body is the way hormones control blood sugar, or glucose, in the blood. All the body's cells need glucose to carry on life functions. The process is summarized in the diagram of a biofeedback loop. A biofeedback loop is a circular pathway that sends information back and forth from one part of the body to another. If the biofeedback loop doesn't work properly, problems including diabetes, can result.

Lesson Checkpoint

1. How do impulses travel throughout the nervous system? Use the terms *axon* and *dendrite* in your answer.
2. Both the nervous system and the endocrine system control the body's processes. How do their functions differ?
3. **Cause and Effect** What causes the pancreas to release insulin?

Lesson 4

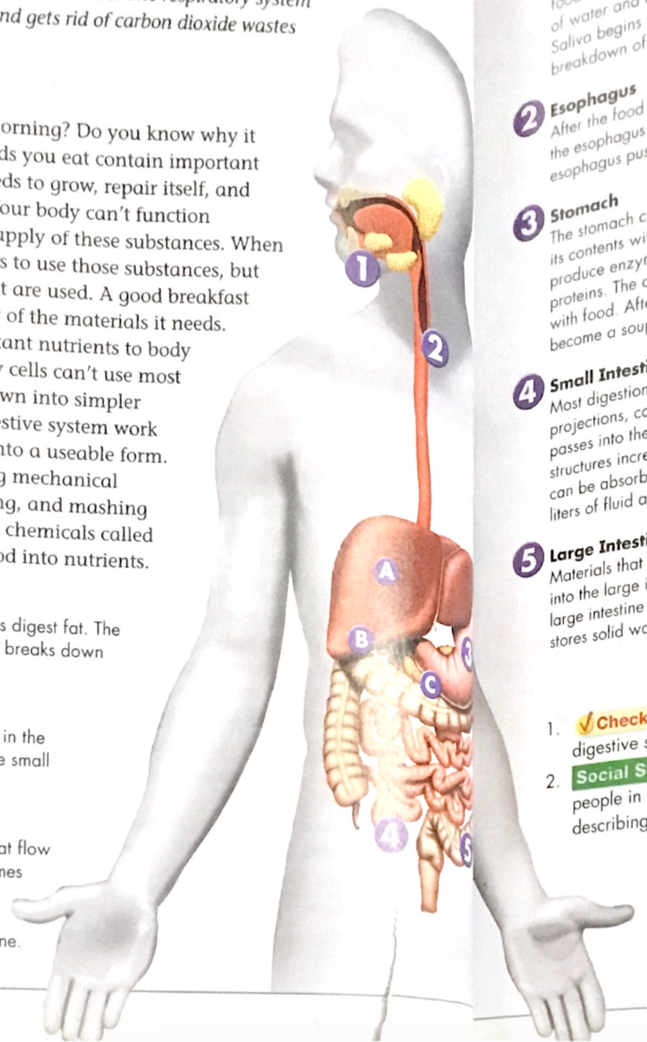
How do systems transport materials?

The digestive system takes in materials needed by the body. It breaks them down into a form that body cells can use. The respiratory system takes in oxygen that cells need and gets rid of carbon dioxide wastes that cells produce.

Digestive System

Did you eat breakfast this morning? Do you know why it is important to do so? The foods you eat contain important substances that your body needs to grow, repair itself, and carry on other life processes. Your body can't function properly without a constant supply of these substances. When you sleep, your body continues to use those substances, but you aren't replacing those that are used. A good breakfast can restore your body's supply of the materials it needs.

After you eat, getting important nutrients to body cells can take some time. Body cells can't use most foods until they are broken down into simpler substances. Organs of the digestive system work together to break down food into a useable form. Some foods break down during mechanical digestion—the tearing, crushing, and mashing of food. In chemical digestion, chemicals called **enzymes** help break down food into nutrients.



A Liver
The liver produces bile, which helps digest fat. The liver also stores some nutrients and breaks down harmful substances in the blood.

B Gallbladder
Bile produced by the liver is stored in the gallbladder until it is released to the small intestine when it is needed.

C Pancreas
The pancreas produces enzymes that flow into the small intestine. These enzymes and other substances neutralize stomach acid that is mixed with the food that enters the small intestine.

Process of Digestion

1 Mouth
Mechanical digestion begins in the mouth where teeth shred food. The tongue mixes the food with saliva, which is a mixture of water and enzymes produced by the salivary glands. Saliva begins the process of chemical digestion. It starts the breakdown of starch into simple sugars.

2 Esophagus
After the food becomes soft and moist, the tongue pushes it to the esophagus. Rhythmic contractions of the smooth muscles in the esophagus push the food toward the opening to the stomach.

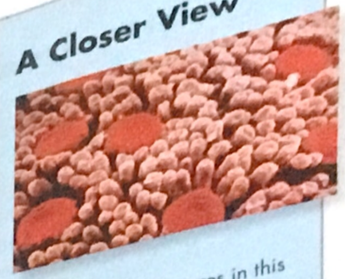
3 Stomach
The stomach continues the mechanical digestion by squeezing its contents with muscular contractions. Glands in the stomach produce enzymes and acid that begin the breakdown of proteins. The acid also kills bacteria that have been swallowed with food. After several hours in the stomach the food has become a soupy mixture.

4 Small Intestine
Most digestion takes place in the small intestine. Tiny fingerlike projections, called villi, line the small intestine. Digested food passes into the blood through the walls of the villi. These structures increase the surface area, where digested materials can be absorbed into the blood. The villi absorb about 7.5 liters of fluid a day.

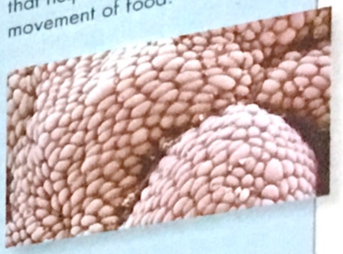
5 Large Intestine
Materials that cannot be absorbed into the bloodstream pass into the large intestine. Little digestion takes place here. The large intestine absorbs water from the undigested material and stores solid wastes until they leave the body.

1. **Checkpoint** How does each part of the digestive system contribute to digestion?
2. **Social Studies in Science** Find out what people in another country eat. Write a paragraph describing the foods they eat.

A Closer View



Tongue
The large, red structures in this electron microscope image of the surface of the tongue are small taste buds. The smaller fingerlike projections form a rough surface on the tongue that helps in the chewing and movement of food.



Stomach
The oval cells in this electron microscope image of the stomach lining produce mucus that protects the stomach from digestive substances. Pits in the lining contain glands that produce digestive juices.

Small Intestine
As many as 40 villi per square millimeter cover the surface of the small intestine. There are more at the beginning of the intestine than toward the end.

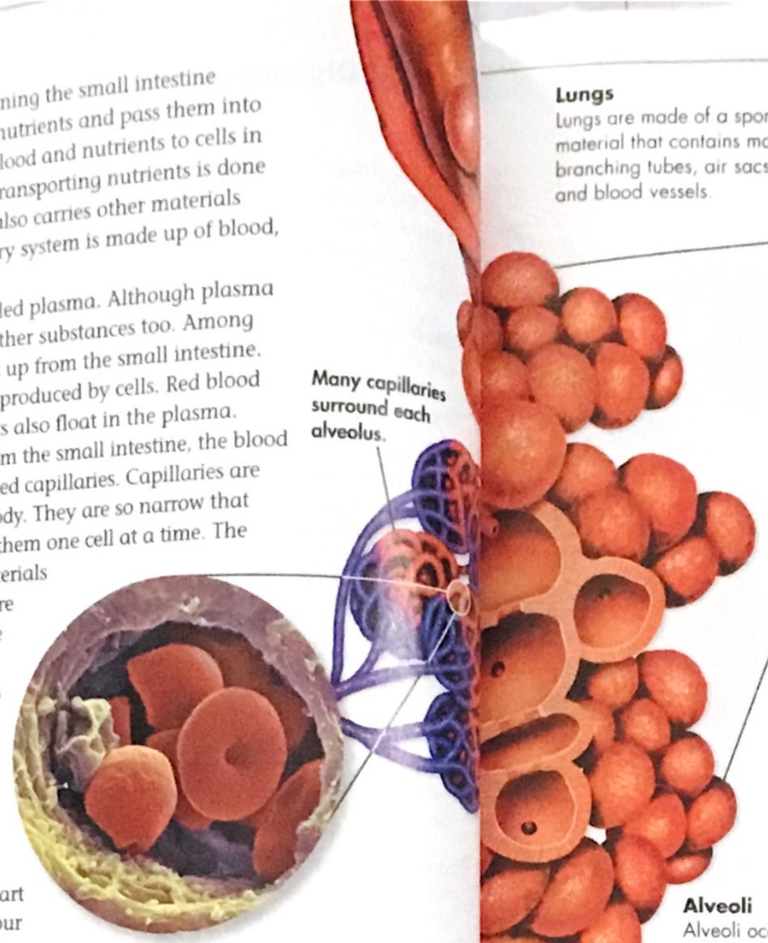
Circulatory System

As you just read, the many villi lining the small intestine contain blood vessels that pick up nutrients and pass them into the blood. These vessels carry the blood and nutrients to cells in all parts of your body. The task of transporting nutrients is done by your circulatory system, which also carries other materials throughout the body. The circulatory system is made up of blood, the heart, and blood vessels.

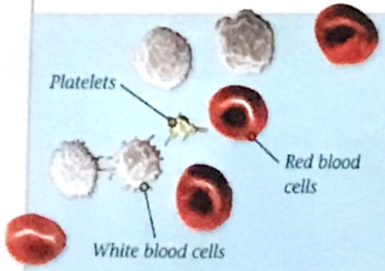
The liquid part of the blood is called plasma. Although plasma is mostly water, it contains many other substances too. Among them are nutrients that blood picks up from the small intestine. Plasma also carries waste products produced by cells. Red blood cells, white blood cells, and platelets also float in the plasma.

When blood picks up nutrients from the small intestine, the blood is traveling in tiny blood vessels called capillaries. Capillaries are the smallest blood vessels in your body. They are so narrow that red blood cells must travel through them one cell at a time. The capillary walls are very thin, so materials can pass through them. Materials are exchanged between the blood in the capillaries and the cells they pass among. Blood flows from capillaries into larger vessels called veins. Veins carry blood to the heart.

Your heart is a muscular organ that is about the size of your fist. It beats about 70 times a minute in adults, a little faster in children and teens. The pumping of your heart moves blood through all parts of your body. Blood travels away from the heart in thick, muscular tubes called arteries. As arteries move farther from your heart, they branch and become smaller and smaller until they form capillaries.

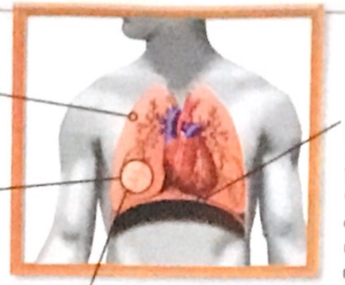


Oxygen in an alveolus moves across the alveolus and capillary walls. There red blood cells pick up the oxygen and carry it throughout the body. Carbon dioxide moves from capillaries to the alveolus.



Blood Cells

Red blood cells carry oxygen to your cells. White blood cells attack and destroy bacteria, viruses, and other disease-causing particles. Platelets are pieces of cells formed in bone marrow. When you are cut or bleeding, platelets cause tiny fibers to form in the blood. These fibers cause the blood to clot, which helps stop bleeding.



Lungs
Lungs are made of a spongy material that contains many branching tubes, air sacs, and blood vessels.

Diaphragm
Lungs do not contain muscle tissue. Air enters your lungs when the muscular diaphragm contracts, pulling your ribs up and out. The diaphragm relaxes when you exhale.

Alveoli
Alveoli occur in bunches. Each alveolus has its own tiny bronchiole that supplies it with oxygen.

Respiratory System

As cells in your body receive nutrients from the blood, they also need oxygen. Cells use oxygen to release energy from nutrients. In the process, carbon dioxide is produced. This gas is a waste that must be removed from cells. Blood is the substance that delivers the oxygen and removes the carbon dioxide. Blood picks up oxygen and releases carbon dioxide as it travels through your lungs.

Your lungs are part of the respiratory system. The respiratory system also includes your nose, trachea, and bronchial tubes. The function of the respiratory system is to take in oxygen from the air and release carbon dioxide from the body.

When you breathe in, air enters your nose. From your nose, air moves to the lungs through the trachea. The trachea branches into bronchial tubes, which continue to branch into smaller and smaller tubes. The smallest of these tubes are called bronchioles. In the lungs bronchioles end at tiny sacs, called **alveoli.** Capillaries cover the alveoli. It is in the alveoli that oxygen enters the blood and carbon dioxide is removed. This gas exchange occurs quickly and at all times. When you breathe out, the carbon dioxide leaves the lungs and exits the body.

Lesson Checkpoint

1. How does the exchange of carbon dioxide and oxygen take place?
2. How do the digestive and circulatory systems work together to provide body cells with the materials they need?
3. Writing in Science **Expository** Find out what simple steps everyone can take to keep his or her respiratory system healthy. Then write a two-minute radio announcement that informs the public of what you found.

Lesson 5

How do systems keep the body healthy?

Fighting off disease is the job of the immune system, but other systems contribute to the task. In fact, everything the body does requires the work of several systems.

Immune System

You may not know it, but a war is going on in your body every day. Your body must constantly defend itself against pathogens that are trying to attack it. **Pathogens** are organisms such as bacteria, viruses, and fungi that cause disease.

Pathogens can be found everywhere, but most never get a chance to make you sick. A healthy body is able to defend itself against pathogens. Your body has several ways to defend itself from pathogen invaders.

Many pathogens enter the body through its openings. Your body's first line of defense is to prevent pathogens from entering. It does this in several ways. Your skin is an effective barrier that stops many pathogens. The tears that your eyes produce wash pathogens away. Tears also contain chemicals that kill bacteria. The linings of your nose, mouth, and throat secrete mucus that traps pathogens. Your saliva and the juices produced in your stomach contain pathogen-killing chemicals.

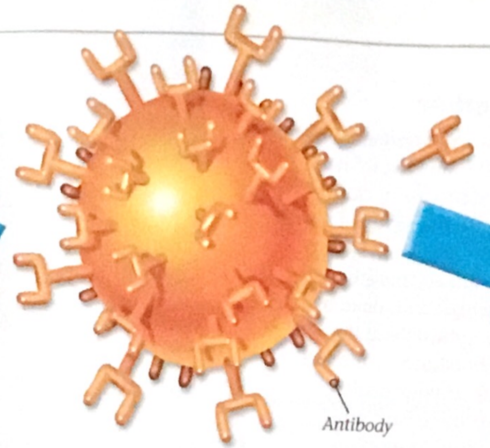
Your body's reflexes also help fight pathogens. Sneezing and coughing rid your lungs and throat of pathogens. Your stomach may expel food that contains pathogens.

How Pathogens Are Spread

- Direct contact with an infected person, such as kissing or touching
- Breathing in tiny droplets of moisture from an infected person who sneezes or coughs
- Using eating utensils that an infected person has used
- Contact with an organism, such as an insect, that carries the pathogen
- Eating or drinking contaminated food or water

After a pathogen enters the body, a white blood cell recognizes it. The white blood cell reproduces many times, producing many more white blood cells.

Other white blood cells attack body cells that contain the pathogens. They kill the infected cells and the pathogens.



Some white blood cells alert another kind of white blood cell to produce antibodies.

The antibodies cause the pathogens to clump together. These clumps of pathogens are destroyed by the body.

Fighting Pathogens

Even with these defenses, pathogens sometimes enter your body. When that happens, your immune system springs into action to fight the invaders. First, it increases blood flow to the area of the pathogens. That's why an infected cut becomes red and swollen. The increased blood supply signals one type of white blood cell to attack and kill pathogens. This type of white blood cell will attack any kind of invader.

Other types of white blood cells are more specialized. They can tell the difference between various pathogens. These white blood cells produce **antibodies,** chemicals that kill specific pathogens. This response also allows the body to recognize and fight the same pathogen if it enters the body again. Study the diagram to see how white blood cells target and fight specific pathogens.

Your body responds in the same way to vaccinations. A vaccine is made of dead or weakened pathogens that can no longer cause the disease. The vaccine triggers your immune system to produce white blood cells that continue to fight pathogens when they enter the body.

1. **Checkpoint** What are four barriers to pathogens entering the body? Why are they important?
2. **Writing in Science** **Narrative** Write a story about a war between pathogens and white blood cells in a person's body.

Systems Working Together

Look at the people in the picture. What is going on in their bodies as they ride their bikes? Many systems are working hard to enable them to be successful at their tasks. Read the information on these pages to see how some of those systems are contributing.

Your amazing body sometimes runs so smoothly that you may forget that, like any machine, you need to take care of it on a daily basis. Everything you do—running, reading a book, eating, brushing your teeth, or getting upset with a friend—affects your health.

You might think that at your age there isn't much you can or need to do to stay healthy. Developing good health habits now can help you stay healthy now and for many years in the future. Many adult health problems start when a person is young. You just don't notice them until later. It's never too soon to take responsibility for your own health. Read the list on the next page to learn about some simple habits you can develop to stay healthy.

Respiratory and Circulatory Systems
These systems begin to work harder with activity. Breathing rate increases. This provides more oxygen to the working muscles. It helps get rid of their carbon dioxide waste. The heart pumps faster. This delivers more nutrients and oxygen to muscles.

Endocrine System
Endocrine glands check the body's condition. Their hormones make sure the muscles have enough energy. They maintain stability.

Digestive System
The digestive system has already begun its work before activity begins. Its role is to prepare the body for activity. Some nutrients are in the blood, ready to supply energy. Some nutrients are stored in tissue to be used as needed.

Nervous System
Nerves in the eyes, ears, nose, and skin gather information about the environment. This information is sent to the brain as impulses, which travel to the brain through the spinal cord. The brain interprets and tells different parts of the body what to do.

Muscular and Skeletal Systems
Muscles in the legs receive messages from the brain telling them to contract. As they contract, the muscles pull on the leg bones. This results in movement. To continue the activity, the contracting muscles relax. Muscles opposite them then contract. This moves the bones in the opposite direction.

Staying-Healthy Habits

- Eat well-balanced meals.
- Get regular physical activity.
- Sleep at least eight hours every night.
- Avoid using alcohol, drugs, or tobacco.
- Keep your body clean. Wash your hands often.
- Wear protective gear when participating in sports that require it.
- Wear a safety belt when riding in an automobile.
- Drink plenty of water.

Lesson Checkpoint

1. What is a pathogen?
2. Explain how your body systems work together when you are reading a book.
3. **Cause and Effect** What causes the body to produce antibodies?

The Amazing Machine

Your body isn't working hard only when you are very active. Here's what happens each day.

Brain cells
You use about 7,000,000 brain cells.

Heart tissue
Your heart beats 100,000 times.

Hair cells
Your hair grows almost a half millimeter.

Red blood cells
Each red blood cell, the most common type of cell in your body, will pass through the heart 14,000 times.

EQUATIONS and HEART RATES

A person's heart rate (or pulse) is usually expressed in beats per minute. An easy way to find your heart rate is to count the beats for 10 seconds and then multiply by 6. This will give an accurate heart rate, because there are 60 seconds in a minute, and 10 × 6 = 60.

If your doctor told you that your heart rate was 72 beats per minute, how many heartbeats did the doctor count in 10 seconds?

Let b equal the number of beats in 10 seconds.

$6b = 72$ Write a multiplication equation.

$\frac{6b}{6} = \frac{72}{6}$ Multiplication and division are inverses, so divide both sides by 6.

$b = 12$

The doctor counted 12 beats in 10 seconds.

If you are healthy, it is a good idea to increase your heart rate by exercising, but there are limits to how high it should go. One guideline is that an adult's maximum heart rate plus age should equal 220. What is the safe maximum heart rate for a healthy 30-year-old?

Let R equal an adult's maximum heart rate.

$R + 30 = 220$ Write an addition equation.

$R + 30 - 30 = 220 - 30$ Addition and subtraction are inverses, so subtract 30 from both sides.

$R = 190$

The safe maximum heart rate for a healthy 30-year-old is 190 beats per minute.

Write and solve an equation to answer the questions.

1. If you count 28 heartbeats in 10 seconds after exercising, what is your heart rate in beats per minute?
2. If the doctor tells you that your heart rate is 84 beats per minute, how many beats did the doctor count in 10 seconds?

For Questions 3 and 4, use the information about maximum safe heart rates on page 108.

3. Find the safe maximum heart rate for a person who is 25 years old.
4. At what age would a person's maximum heart rate be 180 beats per minute?

Lab zone Take-Home Activity

Count the beats of your heart for 10 seconds. Then multiply by 6 to find your heart rate in beats per minute. Do it first after sitting still for 10 minutes. Then do it again immediately after exercising, 1 minute later, and 5 minutes later. Compare the results.

Chapter 4 Review and Test Prep

Use Vocabulary

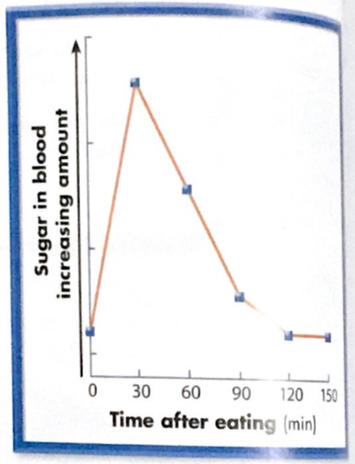
alveoli (p. 101)	**gland** (p. 96)
antibody (p. 103)	**hormone** (p. 96)
endocrine gland (p. 96)	**impulse** (p. 95)
enzyme (p. 98)	**neuron** (p. 95)
	pathogen (p. 102)

Use the vocabulary word from the list above that best completes each sentence.

1. A nerve cell is also called a(n) ____.
2. A chemical released by endocrine glands is called a(n) ____.
3. A(n) ____ is an organ that produces a chemical.
4. A message in a nerve cell is a(n) ____.
5. Oxygen enters the blood in tiny sacs called ____.
6. A(n) ____ is a chemical that breaks down food.
7. A chemical that destroys a specific kind of pathogen is a(n) ____.
8. An organism that causes disease is called a(n) ____.
9. A tissue or organ that releases a chemical into the bloodstream is a(n) ____.

Explain Concepts

10. Explain how muscles and bones work together to cause movement.
11. The body's systems work together to keep all its life processes balanced. Why do you think balance is important?
12. The graph shows the level of glucose in a person's body before and after she drank some juice. Use the information in the graph to explain how the body systems work together to keep the body processes balanced.



Process Skills

13. **Infer** Suppose the small intestine did not have villi. What could you infer about the body's ability to supply nutrients to its cells.
14. **Model** Draw a diagram to show how oxygen and carbon dioxide are exchanged in the alveoli of the lungs.

Cause and Effect

15. Make a graphic organizer like the one below. Fill in the correct cause and effect.

Cause	Effect
High glucose level in blood	
	Glucagon is released.

Test Prep

Choose the letter that best completes the statement or answers the question.

16. Which describes two or more tissues working together to perform a function?
    - Ⓐ organelles
    - Ⓑ cells
    - Ⓒ system
    - Ⓓ organ
17. Which system takes in oxygen from the air and delivers it to the blood?
    - Ⓕ circulatory system
    - Ⓖ digestive system
    - Ⓗ respiratory system
    - Ⓘ endocrine system
18. Which is the most common disease in the United States that is not caused by a pathogen?
    - Ⓐ arthritis
    - Ⓑ osteoporosis
    - Ⓒ muscular dystrophy
    - Ⓓ virus
19. Explain why the answer you chose for Question 17 is best. For each of the answers you did not choose, give a reason why it is not the best choice.
20. Writing in Science **Descriptive** Explain how your body's systems work together when you use a computer.