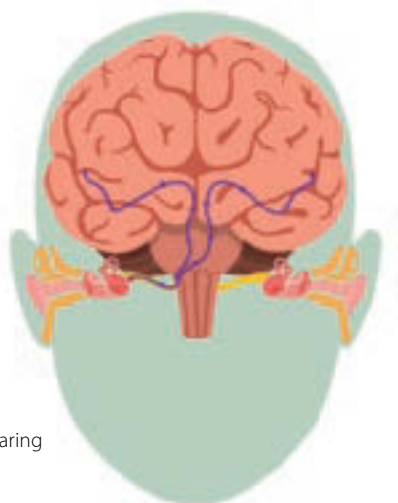


movement

Human Senses and Movement

Reader



hearing

helpful technology



vision



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Human Senses and Movement

Reader



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Human Senses and Movement

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Returning a Serve

Chapter

1

In the sport of table tennis, the action happens fast. Two people can hit the ball back and forth across the net in less than a second. If someone serves a table tennis ball and you hit it back, what happens in your body while you do that? First you sense the ball coming. Then you react quickly to return the ball.

Big Question

How does a human body return a table tennis serve?

You use your whole body to sense and react in a table tennis game. You use eyes and ears, hands and arms, and feet and legs. Parts that you can't see inside your body control the action.



Your eyes and ears detect the serve of a table tennis ball. Nerves carry the messages about what you sense to your brain. Then nerves carry messages from your brain to your muscles. Nerves make your muscles contract. The muscles move your skeleton, and you can contact the ball. It all happens in an instant!

Juggling is another example of how you sense something and react to it with movement. Body parts and systems work together to keep those three balls moving. In the chapters ahead, you will learn more about some body parts that enable you to sense and move.



Human Hearing

Chapter

2

A game of table tennis includes many sounds. The ball clicks when it hits the paddle. It clacks when it hits the table. The ball moves fast. It can be hard to see. But the sound of the ball helps players tell when it is coming. The sound helps players tell which direction the ball is coming from.

Your ability to detect sound is your sense of **hearing**. Hearing helps you detect objects that are in motion around you. For example, you hear footsteps moving toward or away from you. You hear the rustle of the clothes of a nearby person. You hear the engine of an approaching car or one that is moving away from you.

Hearing also helps you to communicate. You listen to others speak. You hear the words people say. You also can tell how they feel by the tone of their voices.

Big Question

How does human hearing work?

Vocabulary

hearing, n. the ability to sense vibration as sound



Hearing Is Detecting Vibration

Blow on the palm of your hand. Moving air particles contact your skin. Even though you cannot see the particles that make up air, you feel their contact. You can also sense the vibration of air particles inside your ears.

Vocabulary

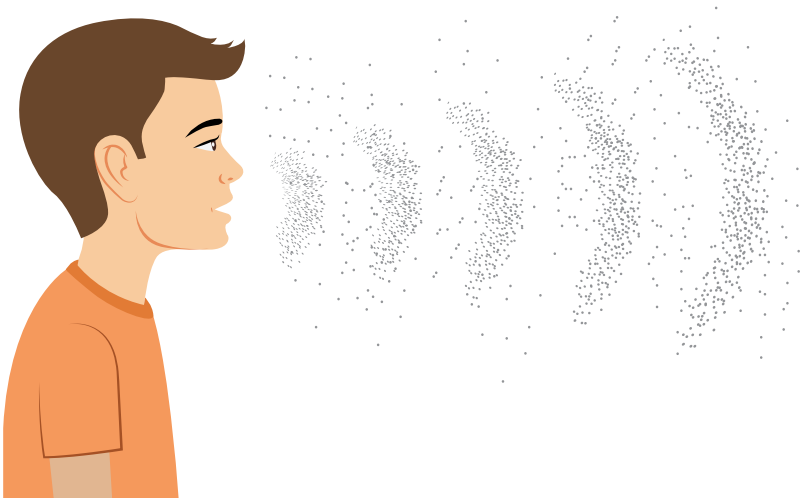
vibrate, v. to move back and forth very quickly

sound, n. vibration detected by the sense of hearing

When an object **vibrates**, it makes a **sound** wave, it. A vibrating object bumps into particles of air that surround it. Those particles bump into other particles. They pass the vibration from one air particle to another across a distance. The vibration of air particles, the sound wave, reaches the air touching your eardrums. You experience the vibrations as sound.

Think About Sound

Sound waves travel outward from a vibrating object. The sound you hear across a room has traveled through air. Air is a gas. Sound can also travel through liquid and solid matter.



Parts of the Ear

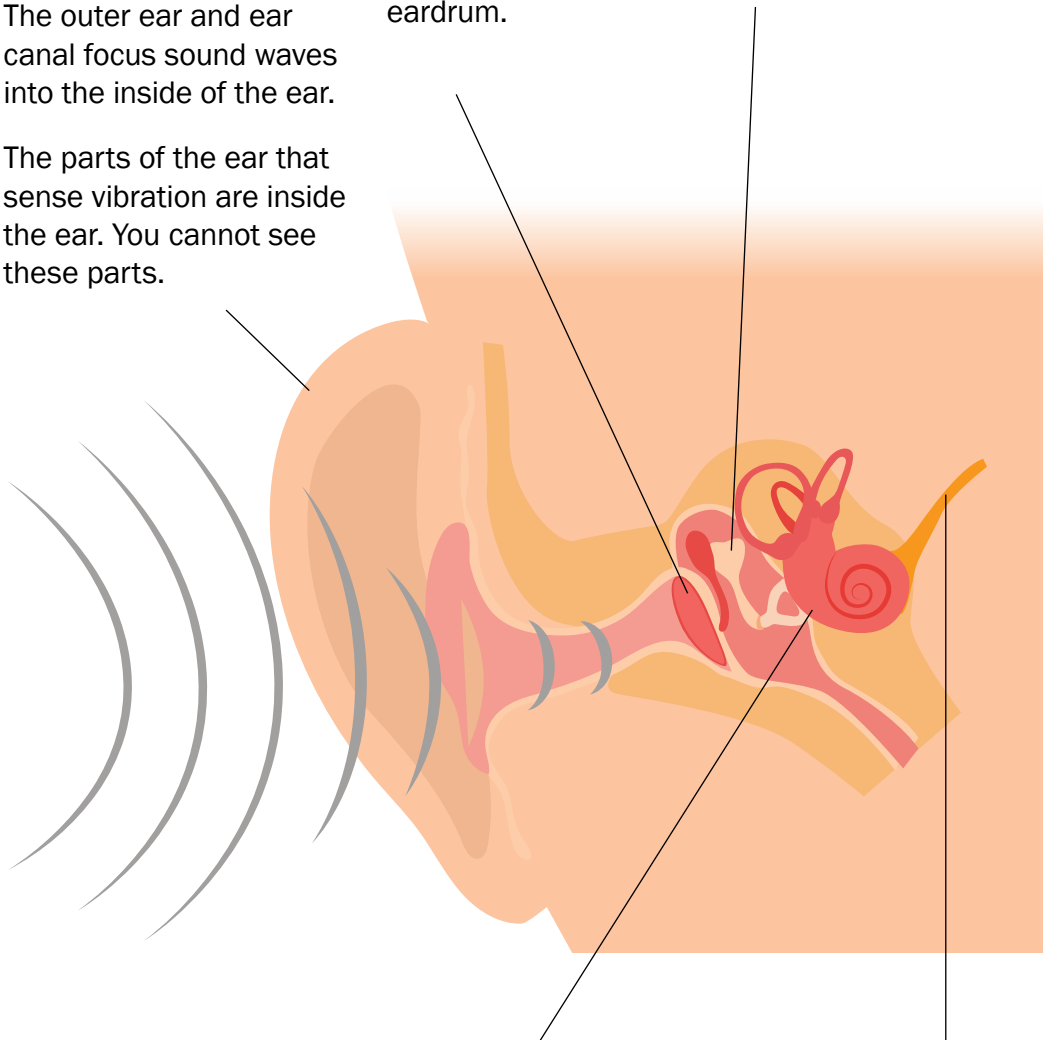
The human body part that enables hearing is the ear.

The part of the ear that you can see is shaped something like a funnel. The outer ear and ear canal focus sound waves into the inside of the ear.

The parts of the ear that sense vibration are inside the ear. You cannot see these parts.

Vibrating air pushes against a thin piece of tissue called the eardrum.

The eardrum vibrates an arrangement of three tiny bones.



Word to Know

Auditory refers to things related to hearing.

The tiny bones pass the vibrations through the cochlea to the auditory nerve.

Nerves deliver the message to the brain.

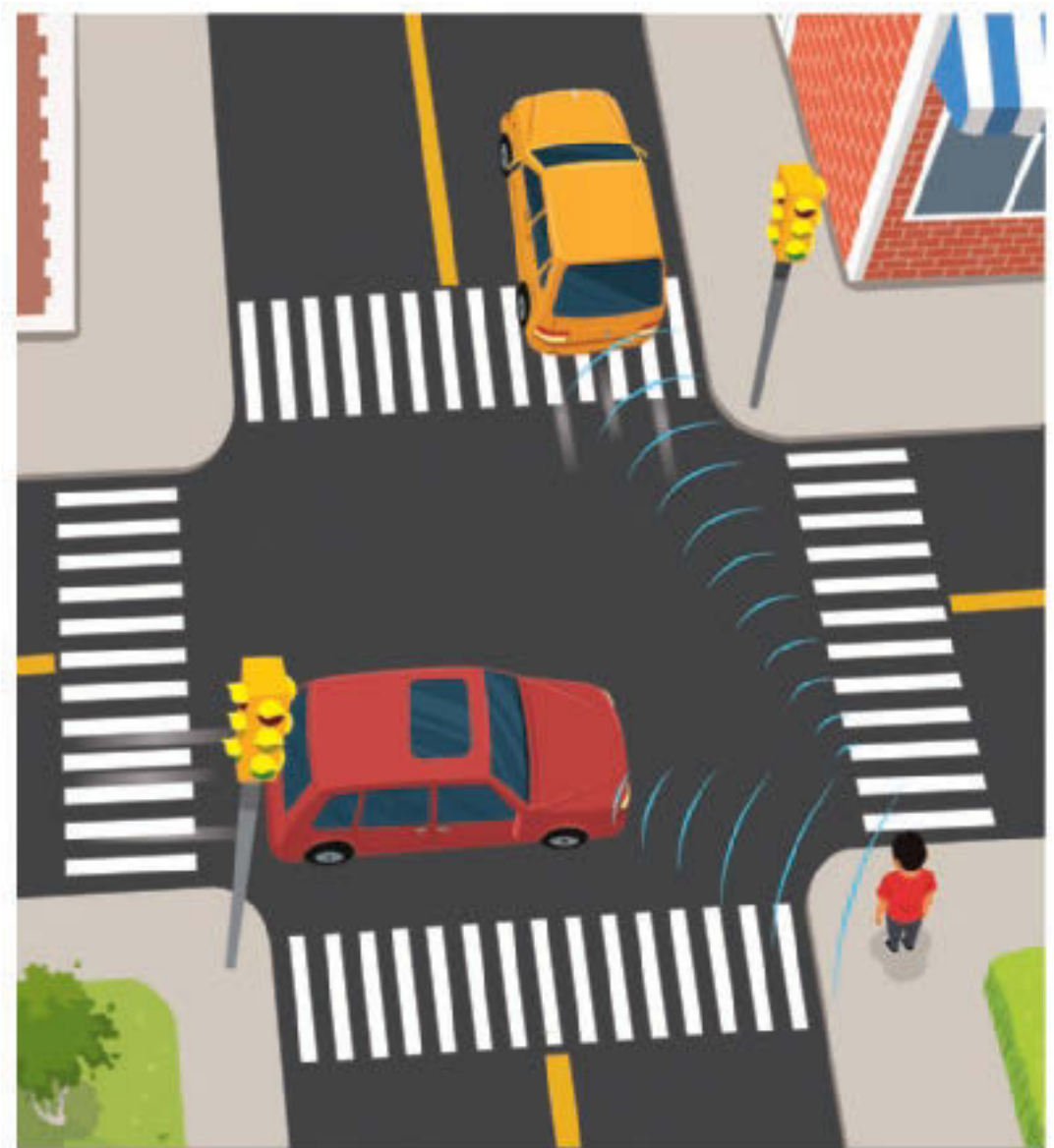
Two Ears Are Better than One

Your sense of hearing lets you perceive sound. It also enables you to tell different things about sounds. You can tell which direction sounds are coming from. You can tell if the thing making a sound is moving. You can tell if the source of sound is getting closer to you or farther away.

Two ears on opposite sides of your head help you tell what direction sounds are coming from. If a noise sounds louder in your left ear than it sounds in your right ear, the sound is coming from your left. Your brain automatically figures this out using information from both ears.



As the source of a sound moves closer to you, the sound gets louder and clearer. As the source of a sound moves farther away, the sound gets fainter. Like the direction of a sound source, your brain also figures out the changing distance of sounds using information from both ears.



Taking Care of Your Hearing

The eardrum is a very delicate body part. It is very thin. It can be easily damaged. If the eardrum is injured, the sense of hearing is harmed. Never stick objects into your ear canals.

Very loud sounds can injure eardrums, too. Lawn mowers and other power tools can be loud enough to harm hearing. So can long exposure to loud vehicles or concerts. A baby needs special protection from loud sounds. Soft earplugs or ear covers can provide hearing protection around loud sounds.



Human Vision

Chapter

3

A table tennis ball moves fast. It speeds across the net. If players take their eyes off the ball for even a split second, they won't be able to move quickly enough to hit it back.

Your ability to see things is your sense of **vision**. *Vision* is another word for the sense of sight. Vision helps you locate and identify objects. It also allows you to determine motion. For example, you can see a table tennis ball. You can see when the ball is moving. You can see where you must swing your paddle to hit the ball back.

Vision enables you to communicate. You can see facial expressions when people talk to you, and they can see yours. You can see words on pages to read. You can see to write words.

Big Question

How does human vision work?

Vocabulary

vision, n. the ability to detect objects that reflect light; the sense of sight



Vision Is the Detection of Light

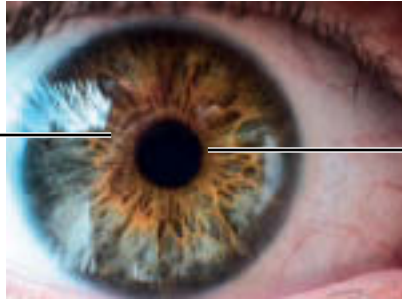
Light makes vision possible. Objects are visible to you when light rays bounce off them. The light then enters your eyes. You can tell a lot about objects that you see. You see their size and shape. You see their color. You know if they are rough or smooth. You see if they are shiny or dull. You see if they are near or far away. And you see if they are moving or still.



Parts of the Eye

The human body part that enables vision is the eye.

The colored part of the eye is the iris.



The pupil looks like a black circle in the center of the iris.

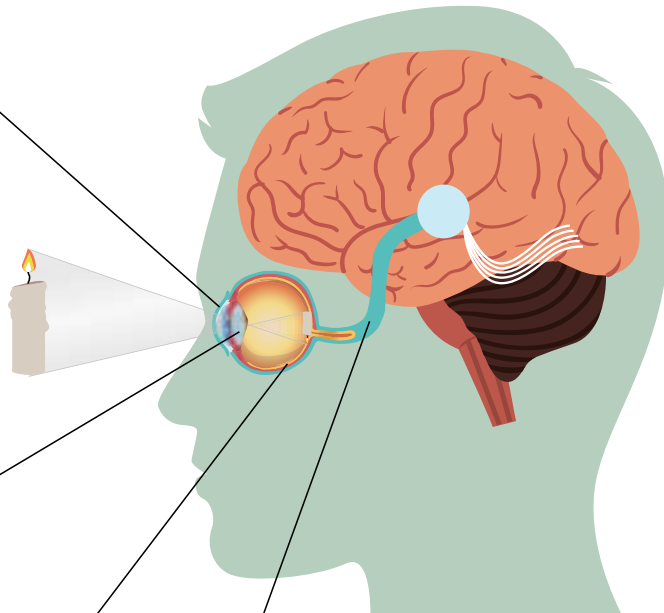
The pupil is an opening in the eye. Light passes through the pupil to the inside of the eye. The pupil can get larger or smaller. In bright light, the pupil closes to become smaller. In dim light, the pupil opens up. When the pupil is open larger, more light gets into the eye. When the pupil is closed smaller, less light gets into the eye.

The clear front surface of the eye is the cornea. Light passes through the cornea.

The lens is also transparent. It is located inside the pupil. The lens focuses light inside the eye.

The retina is a thin layer of tissue at the back of the eye. Light is focused onto the retina.

The optic nerve transfers information from the retina to the brain.



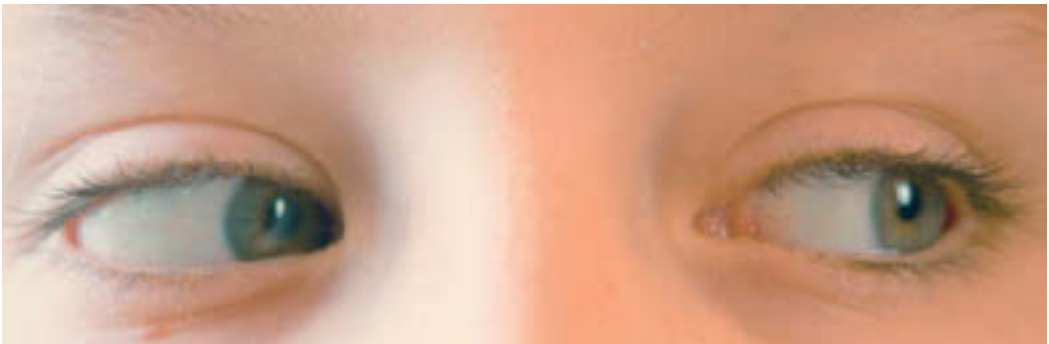
Word to Know

Optic refers to things related to the eyes.

Looking Around

Hold your head still, and look from side to side. Then look up and down. You can move your eyes to direct your vision without moving your head. Muscles rotate the eyes in their sockets. These muscles allow you to look up, down, or sideways while holding your head still.

Tear ducts keep your eyes wet. When you blink, your eyelids spread liquid from tear ducts to cover the surface of the eye. The moisture helps your eyes move around smoothly in your eye sockets. Eyelashes help keep dust out of your eyes.



The focus of your vision can change. Your eyes can adjust to see objects at different distances. You can see things up close and farther away. You can tell how distant objects are in relation to each other.

This ability is called depth perception.

You can also see things around the edges of the space you are directly facing. This is called peripheral vision.



Out of Focus

Eyes don't always focus clearly. Sometimes vision is blurry. To a nearsighted person, objects too far from the eyes appear blurry. Nearsighted people can see objects clearly only if the objects are close enough to the eyes.

To a farsighted person, objects too close to the eyes appear blurry. Farsighted people can see objects clearly only if the objects are not too close to the eyes.



Lenses in eyeglasses can correct blurry vision. Eyeglass lenses focus light properly on the retina so vision is clear.



Taking Care of Your Vision

It is important to take care of the eyes to protect vision.

- Eat a nutritious diet. Dark, leafy greens contain vitamins that eyes need. Examples include spinach, kale, and collard greens.
- Wear sunglasses outside on bright, sunny days. The sun gives off a type of light called ultraviolet, or UV, light. UV light is harmful to eyes. Sunglasses that block UV light provide protection.
- Don't touch or rub eyes with unwashed hands. Germs from hands can infect eyes. Germs can also travel through the eyes to make the entire body sick.
- Wear safety glasses or goggles when using tools. Wear protective eyewear for sports.



The Muscular System

Chapter

4

The action begins in a table tennis game. The server lifts the ball and swings the paddle. Both players' heads and eyes turn quickly to track the ball. Players shift on their feet from side to side. Their arms are extended for balance. Their hands push their paddles forward and swing them back.

These and all other body movements happen because of muscles. **Muscle** is soft body tissue. Muscles connect to bones and to other muscles. They produce motion by contracting and relaxing. To contract means to become shorter. When muscle tissue relaxes from a contraction, it becomes longer.

Big Question

How do muscles work in the human body?

Vocabulary

muscle, n. soft body tissue that contracts



Voluntary Muscles

If you hit a table tennis ball, you make a decision to perform the movements. You see where the ball is and decide to reach in that direction. You lift and swing the paddle using muscles in your arm. You stand and step into place using muscles in your legs. You twist and bend using muscles in your abdomen and back.

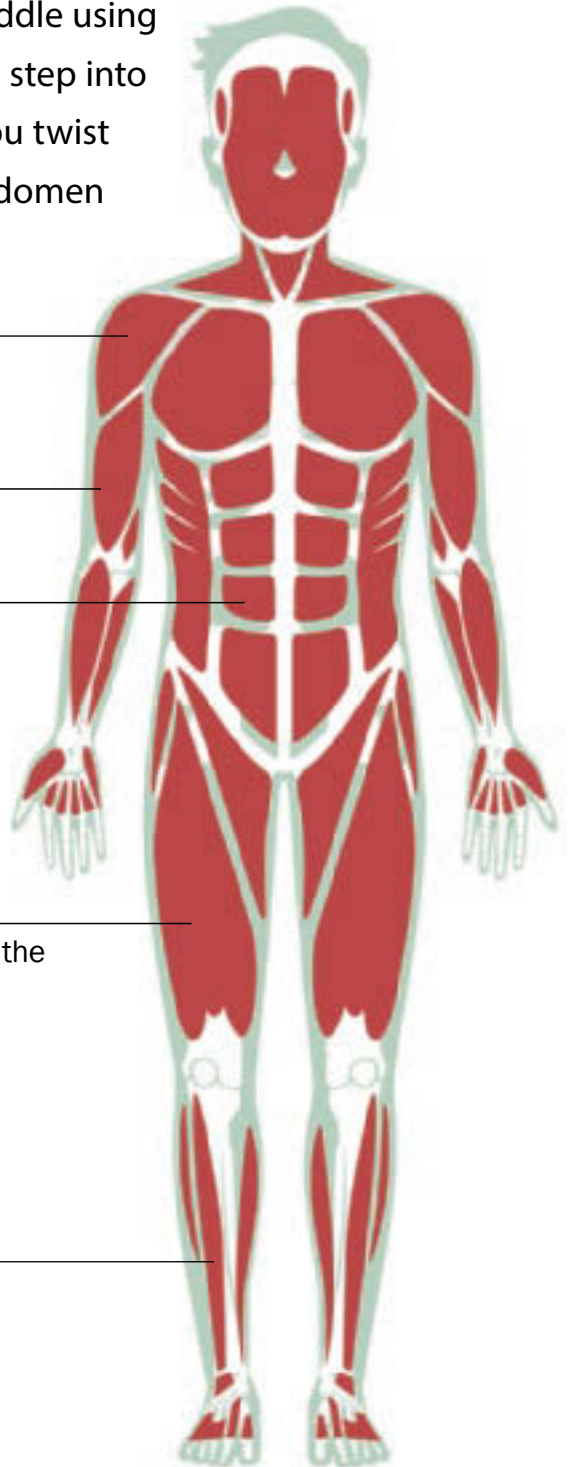
Shoulder muscles raise and rotate the arm.

Biceps bend the arm.

Abdominal muscles bend and twist the torso.

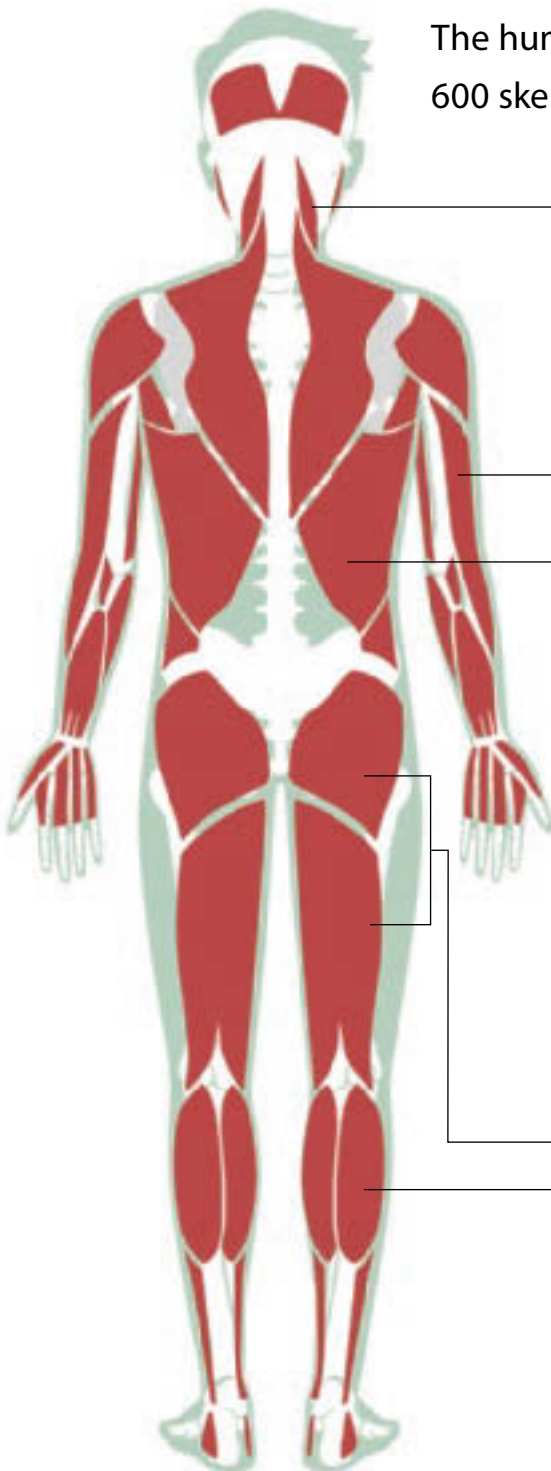
Thigh muscles lift the leg to bend at the hip and straighten the knee.

Muscles in the lower leg move the foot.



These are all movements that you choose to make. They are voluntary actions. The muscles that perform the movements are **voluntary muscles**. Skeletal muscles, the muscles that attach to the frame of your skeleton, are voluntary muscles.

The human body has more than 600 skeletal muscles.



Vocabulary

voluntary muscle,
n. a muscle that
moves as a result of
conscious thought

Word to Know

Voluntary means
done by choice.

Neck muscles control all
movement of the head.

Triceps straighten
the arm.

Back muscles curve
and twist the torso.

The gluteus and back
thigh muscles lower
the leg and bend
the knee.

The calf moves the foot.

Involuntary Muscle

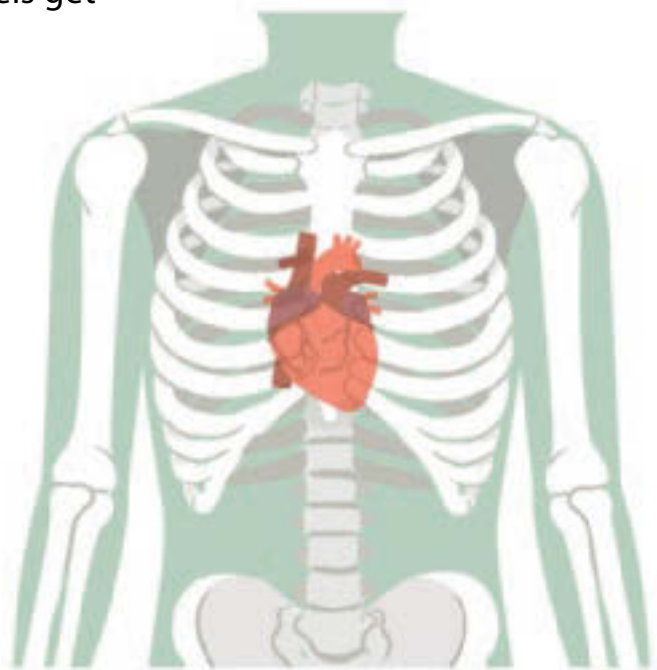
You use your body's voluntary muscles to hit a table tennis ball. At the same time, other muscle tissues inside your body are contracting and relaxing to perform different functions. Some muscle tissue operates without you thinking about it. This muscle is **involuntary muscle**.

Your heart is an involuntary muscle. It operates without your conscious control. Each heartbeat is a contraction and relaxation of the heart muscle. Every time your heart contracts, it squeezes blood out through blood vessels. Your heart beats all the time. It beats without you thinking about it.

Blood vessels are lined with involuntary smooth muscle tissue. Blood vessels get wider or narrower. They contract and relax to adjust how your blood flows. The changes depend on your activity, but you are not aware of them.

Vocabulary

involuntary muscle, n. muscle tissue that contracts without conscious thought

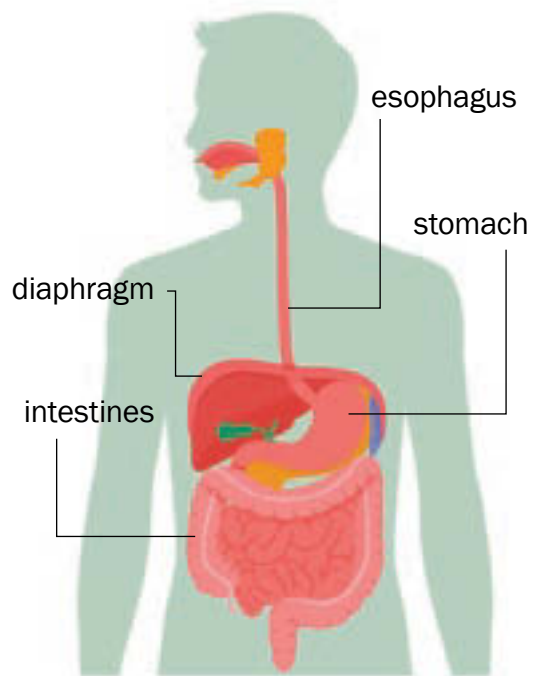


Involuntary muscle tissue also lines your esophagus, stomach, and intestines. Muscles contract to move food and waste material through the digestive tract. You do not need to think about these processes for the muscles to function.

The eye contains involuntary muscles, too. Muscles in the iris control the opening and closing of the pupil. The pupil automatically opens wider in dim light. It automatically closes smaller in bright light.



The diaphragm is the main muscle that controls breathing. When the diaphragm contracts, the chest cavity gets bigger. The lungs expand and fill with air. When the diaphragm relaxes, it takes up space in the chest cavity. Air is pushed out of the lungs. Most of the time, breathing is involuntary. But you can control the diaphragm voluntarily, too.



Taking Care of Your Muscles

Exercise helps keep muscles healthy. If muscles are not used enough, they become smaller and weaker. Regular fitness activities keep muscles flexible. Exercising muscles makes them stronger. You should be physically active for an hour every day. Muscles also need rest between periods of exercise. It is important to get enough sleep for muscle health.



A nutritious diet also supports healthy muscles. Muscles need nutrients from fruits and vegetables, grains, and healthful proteins. Healthy muscles also require that you drink plenty of water. Foods that are too high in fats, salt, or added sugar are not good for muscles or for the body in general.



The Skeletal System

Chapter

5

A player's hand grips a table tennis paddle. The shoulder, elbow, and wrist all bend and straighten in a coordinated movement. The arm swings the paddle into the place where it hits the ball.

The places at which the body bends and straightens are called joints. A joint is the place where two **bones** meet. Bones themselves are hard. They do not bend. Bones do not cause movement, either. Contracting muscles bend and straighten the skeleton at joints. The body's bones, the skeletal system, enable movement by giving contracting muscles something to pull against.

Big Question

How does the skeleton work in the human body?

Vocabulary

bone, n. rigid body material that provides structure and protection

Word to Know

Coordinated means working together effectively.



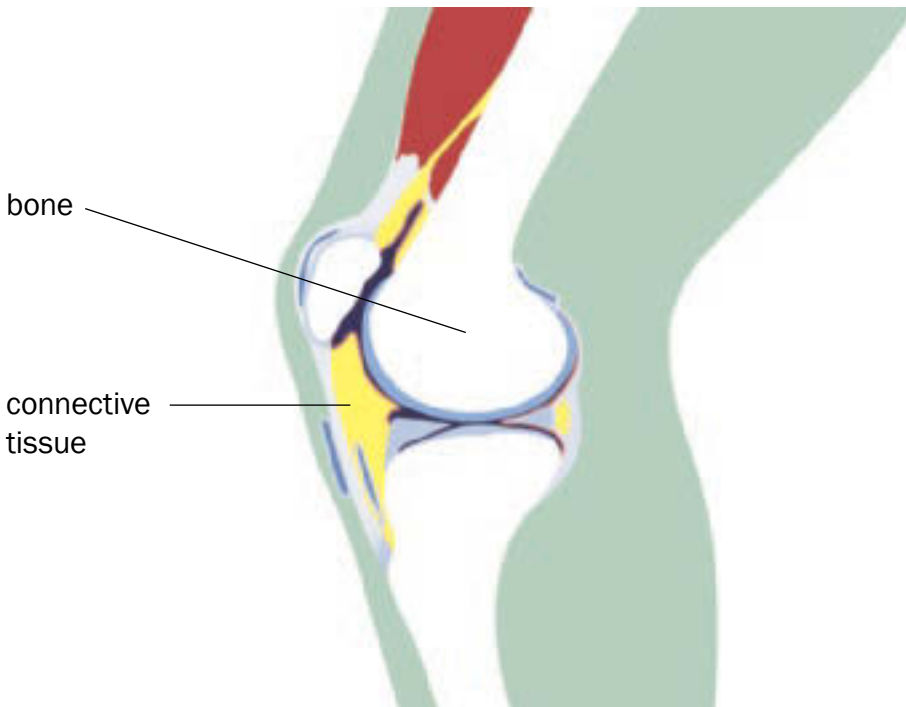
Connected Bones

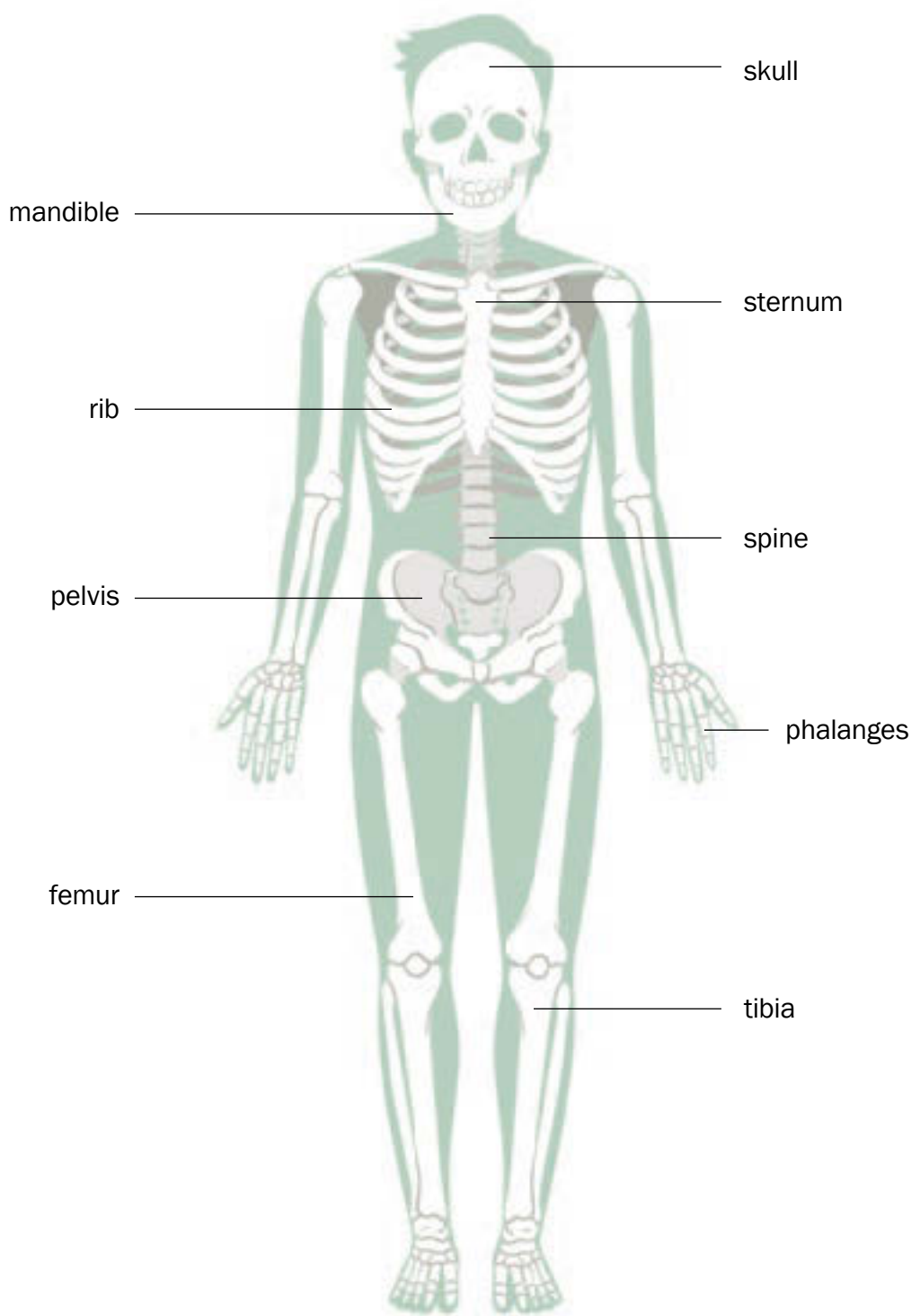
A human body contains over 200 bones. The bones make up the skeletal system. The skeleton gives the body its structure—head at the top, spine through the torso, and arms and legs on both sides. If you draw a line down the center of the skeleton, it makes a mirror image of itself. It has the same parts on both sides.

Vocabulary

connective tissue,
n. tissue that joins
bones to muscles or
other bones

The skeletal system is held together by **connective tissue**. Tendons are strong cords of tissue that connect muscles to bones. Ligaments are cords of tissue that connect bones to other bones. Tendons and ligaments are flexible but not stretchy. Another type of tissue called cartilage makes a cushion between bones at a joint. Cartilage is softer than bone but harder than muscle.

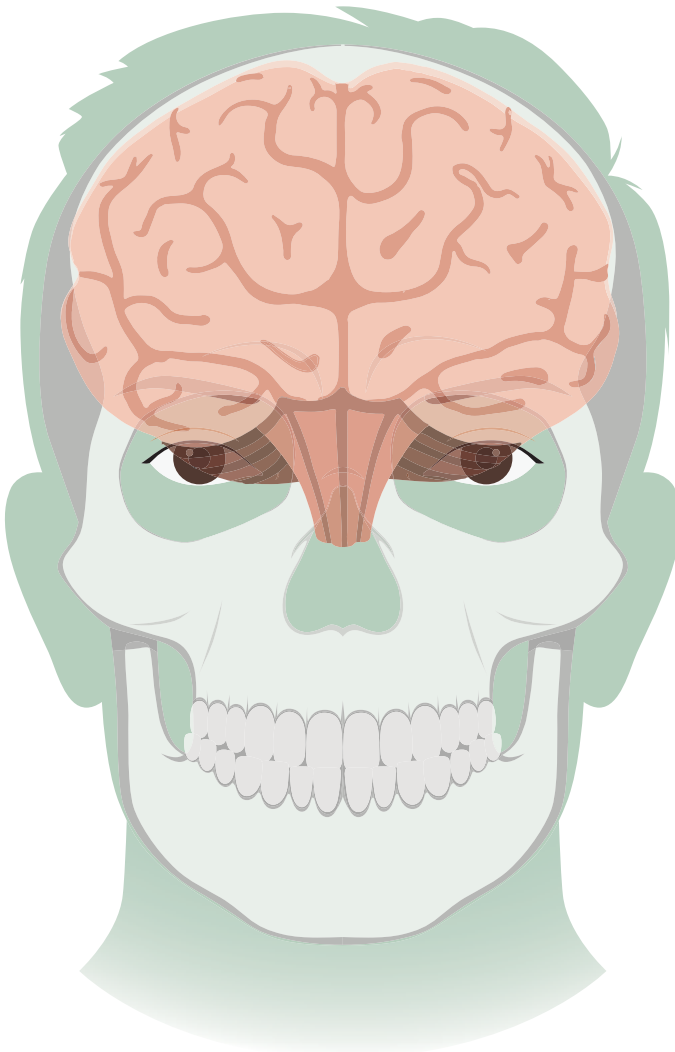




Protective Bones

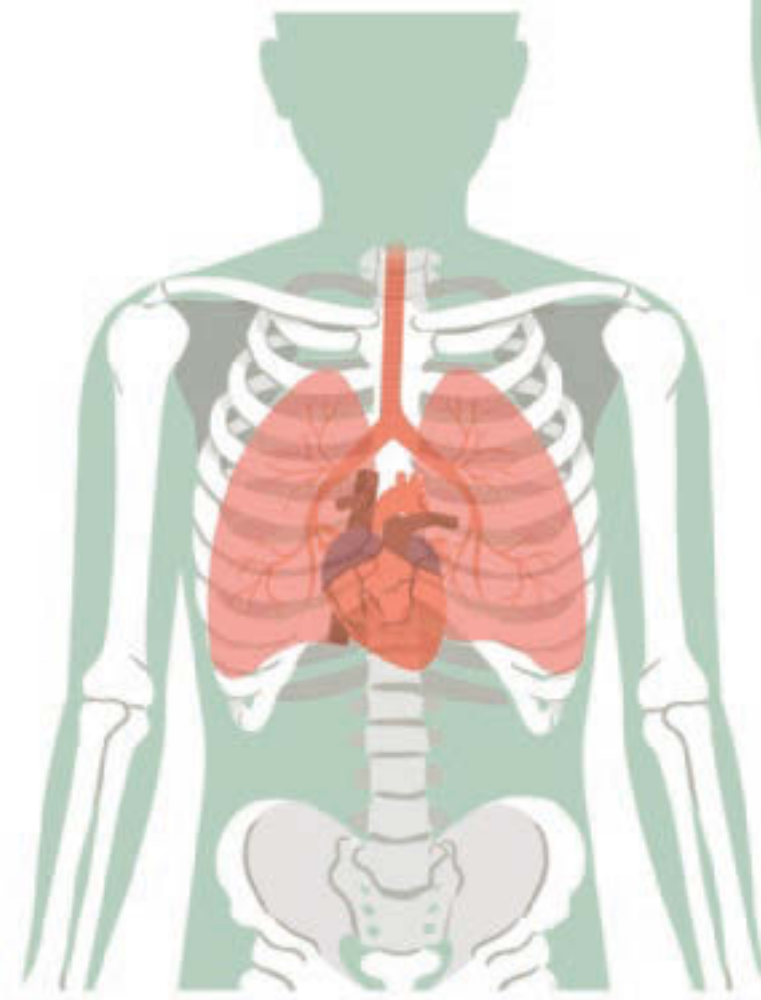
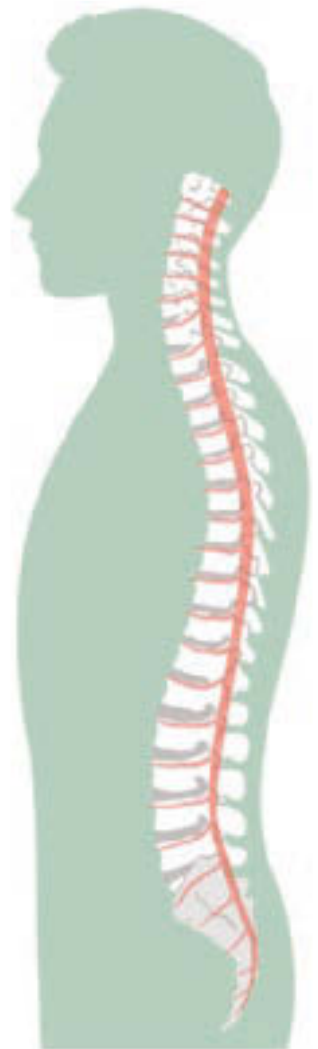
Some parts of the skeleton provide protection for soft internal organs. The skull provides protection for the brain. The brain is fully surrounded by the bones of the head. When babies are born, the skull is not fully hardened. Bones of the skull can move at long joints. When the brain has reached its full adult size, the soft bones harden, and the joints no longer allow bones to move.

The skull also protects soft eye tissue. Most of the eye is positioned inside the skull. Only one side of each eye is exposed through the skull's eye sockets.



The bones that make up the neck and backbone protect the spinal cord. Each separate bone is called a vertebra. Together they form the spine.

Ribs protect the heart, lungs, and other soft organs in the torso. The ribs form a hard cage surrounding the body parts in the top half of the torso.



Taking Care of Your Bones

Like all body parts, bones require nutrients from a healthful diet. The nutrient calcium is particularly important for growing bones. Many foods contain calcium, but dairy foods tend to contain the most per serving. Vitamin D is also important for healthy bones. Milk often has vitamin D added to it.



Like muscles, bones can also be strengthened by exercise. Lifting weights can make bones stronger over time.

Shoes that fit correctly play a part in bone health. Shoes with toe areas that are too pointed or too snug can cause painful problems for the bones in the feet. Shoes with high heels or poor arch support can also cause problems with posture. Over time, this can harm the spine.



The Nervous System

Chapter

6

Nerves play a part in both senses and movement. Nerves support the senses that detect the motion of a table tennis ball. They enable the body's movement to return the ball.



All the body's systems rely on nerves. Nerves transfer electrical impulses. The impulses are signals of information to and from the brain.

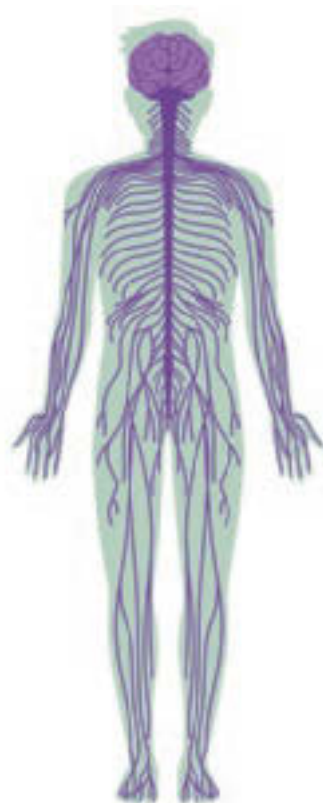
The nervous system includes the brain, the spinal cord, and the network of nerves that run throughout the body.

Big Question

How do nerves support senses and movement?

Vocabulary

nerve, n. a fiber in the body that transmits impulses to and from the brain

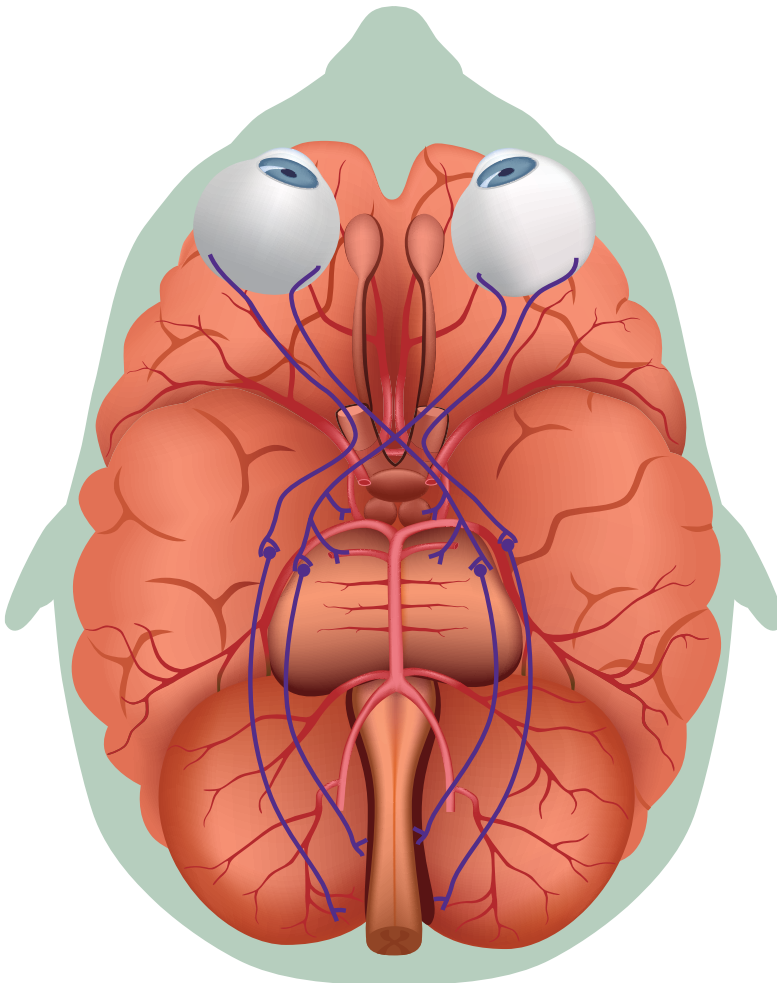


Nerves and Senses

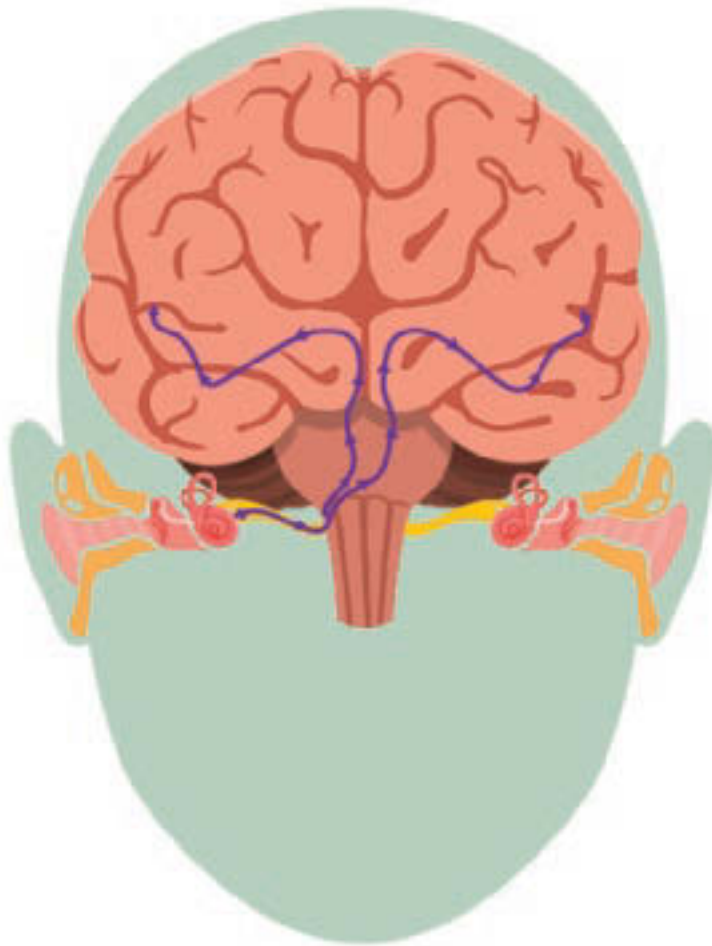
Eyes enable vision. The parts of the eye work together to focus light on the retina inside the eye. The optic nerve then transfers electrical impulses from the retina cells to the brain.

The brain interprets these electrical impulses as the images that you see.

The optic nerve extends from the back of both eyes. It joins to a single strand, combining the information from both eyes. This is how the brain combines information from two eyes into one picture.



Like eyes, ears send nerve impulses to the brain. The cochlear nerve transfers electrical impulses from the cochlea to the brain. The brain interprets the information as the sounds that you hear. Another nerve in the inner ear helps you maintain balance and coordination.



Other types of sensory nerves extend throughout the body. They also send impulses to the brain. We experience impulses through these other nerves as the senses of smell, taste, and touch.

Nerves and Movement

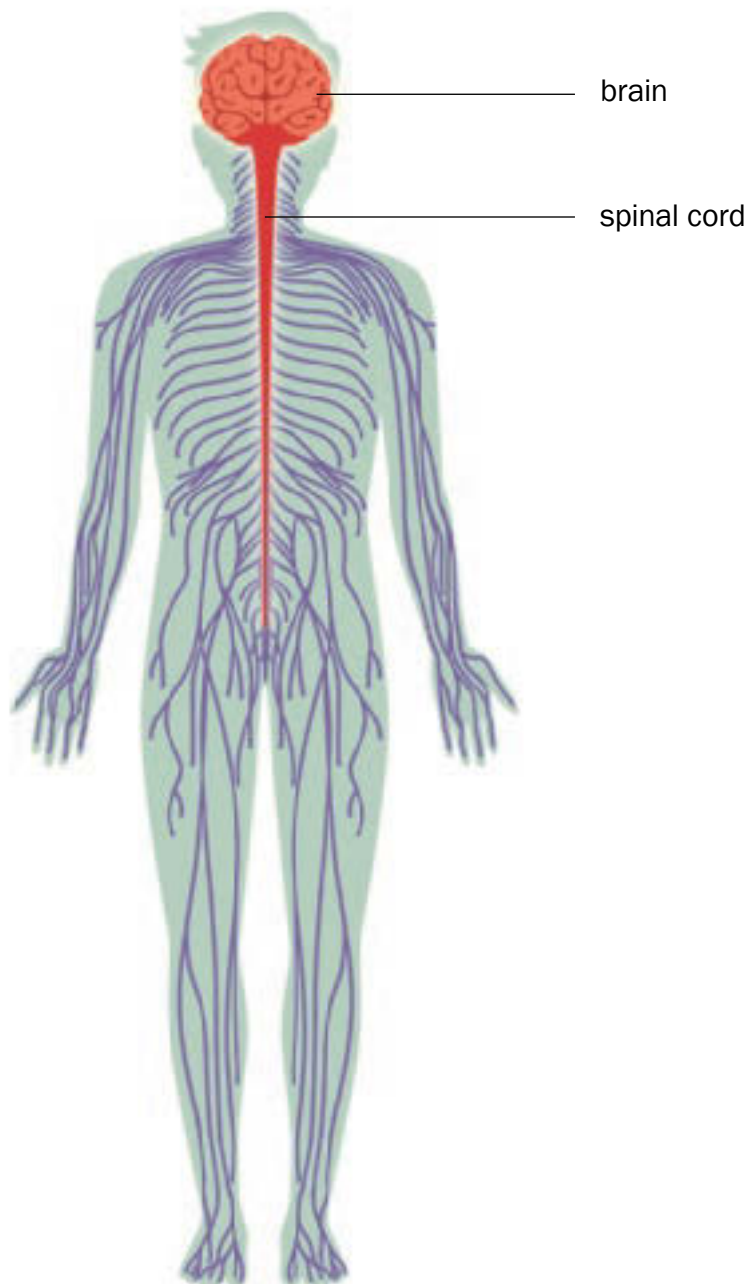
The brain receives information from nerve impulses. The brain also sends information. Motor nerves send impulses from the brain to muscles. The impulses tell muscles when to contract and relax. Most human movement is directed by the brain.

Wiggle all your fingers and toes at the same time. You have three joints in every finger and two joints in every toe. That's fifty joints bending and straightening! It takes a lot of muscle contractions to make that all that action happen. Nerves reach out from the spinal cord into every muscle.

How many body parts can you move at the same time?



All nerves that reach from your hands, arms, feet, and legs connect to your spinal cord. The spinal cord is a complex bundle of nerves that allows communication between your brain and all the body parts below your neck. The brain and spinal cord make up the central nervous system.



Protecting the Brain and Spinal Cord

The brain controls all the functions of the entire body. It controls senses, voluntary movement, and involuntary life processes. The way the brain controls the body is through nerve impulses. And all nerves in the body below the neck communicate through the spinal cord. This makes the brain and spinal cord important to human life.

Injuries to the brain or spinal cord are serious. They can be life threatening. Spinal cord injuries can cause paralysis, the inability to move. And the spinal cord rarely heals from injury. It is important to protect both the head and spine from injuries during rugged activities.



Helpful Body Technology

Chapter 7

Sometimes body parts don't work properly. In these cases, devices can help. They can aid if a person's senses or movement are impaired. The person can then complete tasks.

Big Question

How can inventions help with senses and movement?

Help with Vision

Eyeglasses and contact lenses correct blurry vision for people who are nearsighted or farsighted. Books can be printed with very large text for readers who are nearly blind.

Words to Know

Technology is the use of science in solving problems.

Impaired means not fully functioning.

Other technologies help people with complete vision loss. Braille enables blind readers to read using touch instead of sight. It uses raised bumps on pages to represent letters.

Bumpy sidewalk surfaces and specially trained dogs help blind people know where to cross streets. Blind people can push special buttons that give off sounds to help them know when it is safe to cross streets through traffic.



In some cases, artificial vision technology can restore the ability to detect light to blind people. The technology uses a device that is implanted in the back part of the eye, the retina. The placement of the implant is a surgical procedure.

The person with the implant wears glasses with built-in cameras. The cameras in the glasses detect light. They send signals to the implant. The implant stimulates the optic nerve, which relays the impulses to the brain.

This kind of artificial vision does not produce clear images. It does not completely correct blindness. However, it does enable people to detect objects and movement around them. It enables people to do many things more easily than they could before. For example, blind people with artificial vision can detect where doorways and people are located in a room.



Help with Hearing

A hearing aid is a small device worn inside the ear that makes sound louder to help people who have some hearing loss.



Captioning is text that appears on the screen of a TV show or movie. It

allows hearing-impaired viewers to read what people are saying if they cannot hear it.



Special phones can provide captioning, too. They convert the voice of a caller to text that the user can read instead of listen to.

A cochlear implant is similar to artificial vision technology. A surgeon implants a small electronic device into the cochlea of the inner ear.

The external part of the device sits behind the ear. The external part contains a microphone. The microphone picks up sound. It sends signals to the implant. The implant then stimulates the cochlear nerve to relay the impulses to the brain.

A cochlear implant does not restore complete hearing. However, it enables people to detect sounds around them. It enables people to recognize speech and sounds from telephones and alarms.



Help with Movement

Sometimes people need additional support to stand or walk. A cane or crutches can help. In other cases, a wheelchair is a better solution. Ramps and elevators make buildings more accessible to people who cannot climb steps. Lifts make it easier to get wheelchairs in and out of vehicles.

Wheelchairs are specially made for different needs. Motors operate power wheelchairs. Athletic wheelchairs allow seated athletes to participate in sports.



Artificial limbs can help people who are missing limbs. An artificial body part is called a prosthesis. People with prosthetic legs are able to walk and run. People with prosthetic arms can pick up and carry objects.

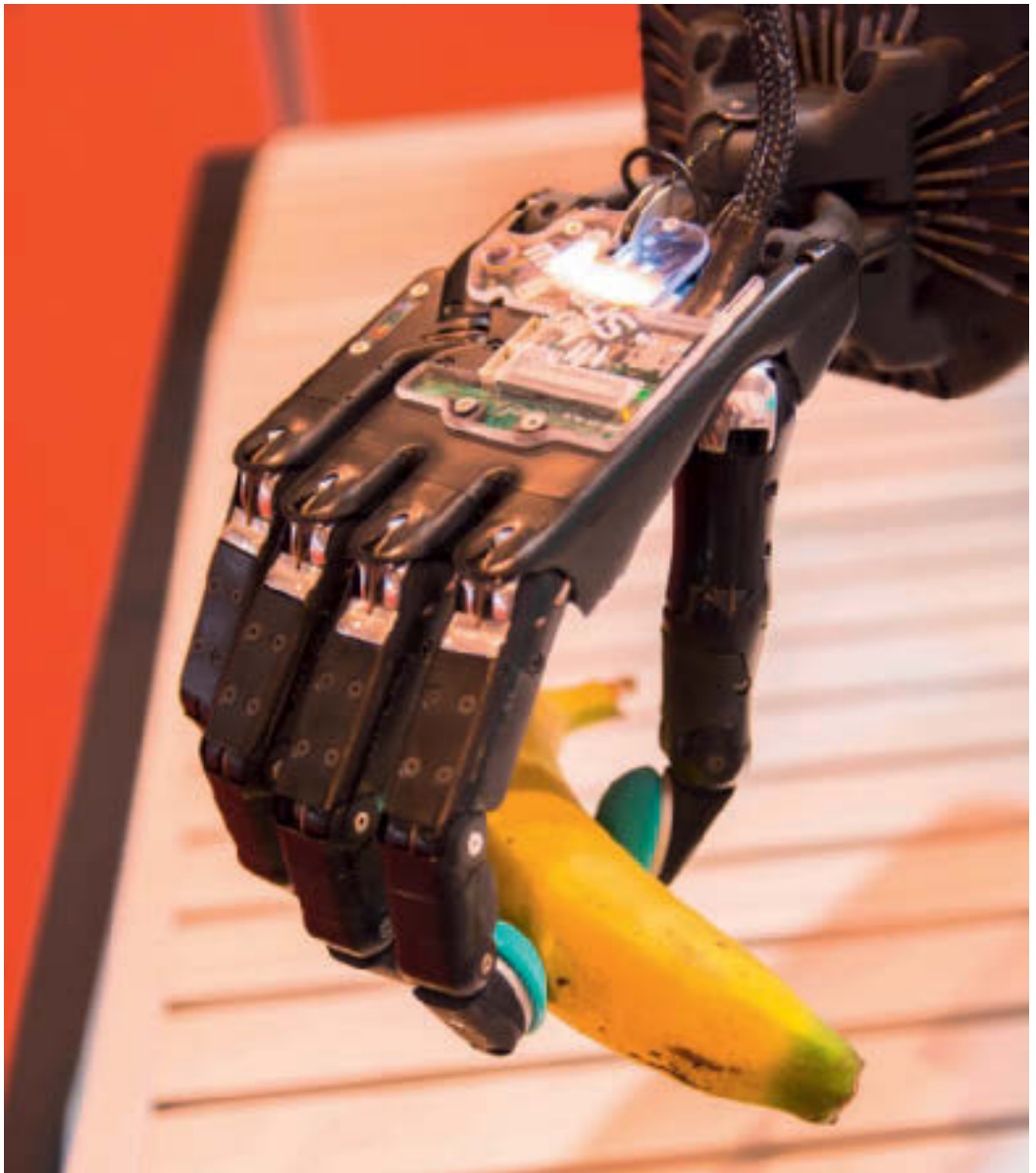
Prosthetic limbs function as closely as possible to the body parts they replace. For example, a prosthetic leg has joints at the knee and ankle.

Some prosthetic limbs are designed to look just like natural limbs. However, the parts do not need to look like actual flesh to work well. In fact, high-performance limbs that athletes use work better if they are not made to look like flesh limbs.



Robotics

Some prosthetic limbs are robotic. They have electronic sensors that pick up signals from the user's muscles or nervous system. Computer controls in the artificial limb operate tiny motors. The motors make mechanical parts of the limb move. This can make the fingers on an artificial hand open and close. The user can grip and release objects.



An exoskeleton is a skeleton on the outside of a body. A robotic exoskeleton provides movement to limbs that cannot move. A user whose legs are paralyzed wears the exoskeleton. The device enables some people who can't move their legs to stand and walk. The exoskeleton provides powered motion at the knees and hips.



Glossary

B

bone, n. rigid body material that provides structure and protection

C

connective tissue, n. tissue that joins bones to muscles or other bones

H

hearing, n. the ability to sense vibration as sound

I

involuntary muscle, n. muscle tissue that contracts without conscious thought

M

muscle, n. soft body tissue that contracts

N

nerve, n. a fiber in the body that transmits impulses to and from the brain

S

sound, n. vibration detected by the sense of hearing

V

vibrate, v. to move back and forth very quickly

vision, n. the ability to detect objects that reflect light; the sense of sight

voluntary muscle, n. a muscle that moves as a result of conscious thought



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