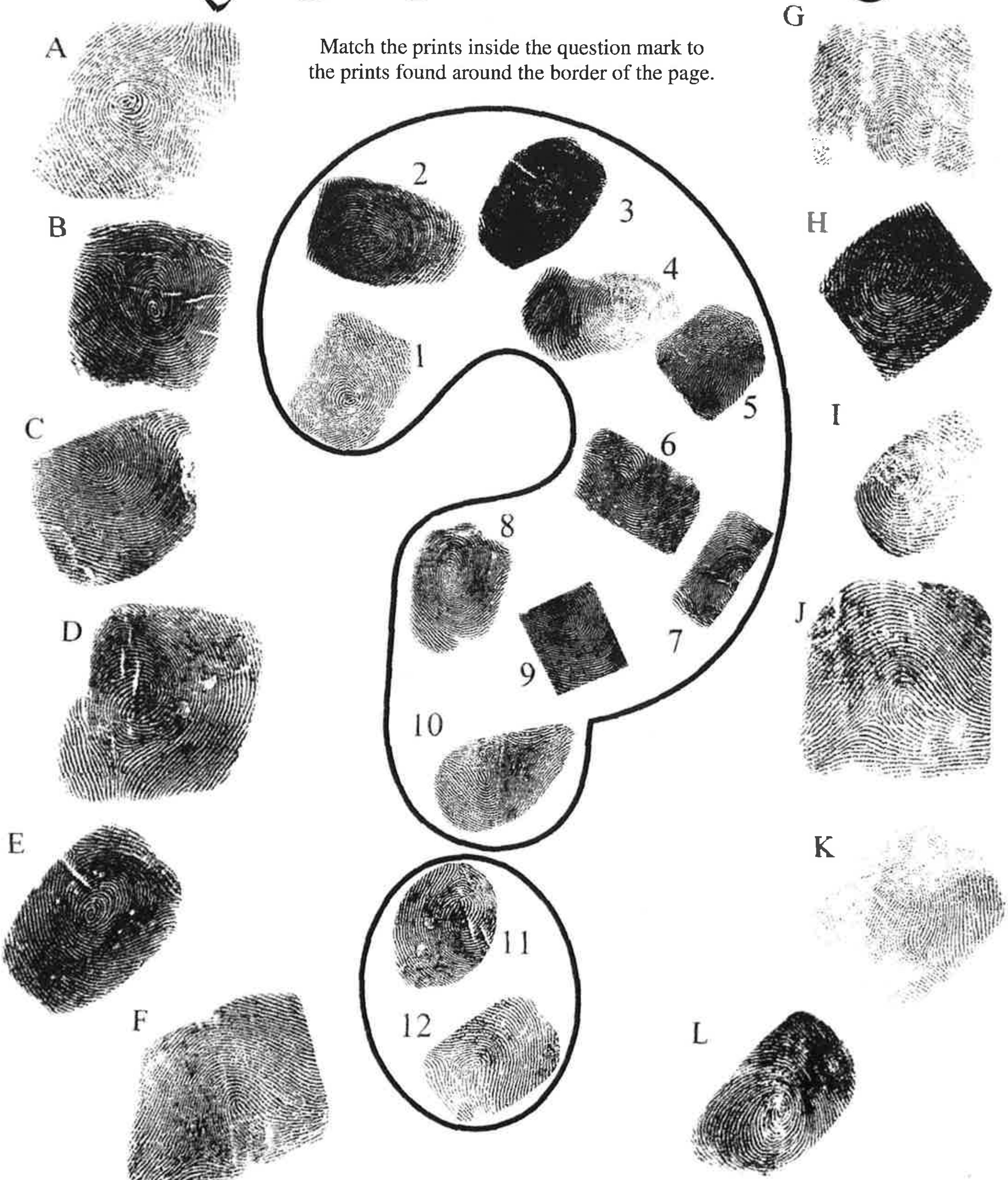
Fingerprint Challenge

Match the prints inside the question mark to the prints found around the border of the page.



Answer Key:
A – 1, B – 7, C – 9, D – 11, E – 3, F – 10, G – 6, H – 2, I – 4, J – 12, K – 5, L – 8

Note: Students are required to show at least 3 common features between prints in order to earn credit for a match. I provide them with highlighters to help them mark common features and have them # or label the highlighted portions in some way.

Investigating Fingerprints

Objective

- Help students to get to know more about the skin that covers and protects their bodies. Investigate how each individual possesses a unique se to fingerprints.
- All fingerprints are made up of three basic designs: arch, whorl, and loop.
- Have students make fingerprints using the materials and directions below.

Materials

- Magnifying glasses
- Copies of page 2
- Soft-lead pencils
- Clear tape
- Clean-up materials such as paper towels, soap, and water

Directions

1. Without letting students look, ask them what they would see if they looked very closely at their fingers. Distribute magnifying glasses and ask students to make observations about their fingers. Focus attention on the tips of the fingers and encourage students to look at their fingerprint patterns.
2. Distribute copies of page 2 and ask students to record the fingerprints of both hands on the sheet, using the methods described below. Model how to make a fingerprint impression. Then have students make their own fingerprints. After their prints are done, ask students to describe the patterns of the fingerprints. Introduce loop, whorl, and arch patterns at the bottom of page 2 and have students identify which patterns most closely resemble those made by their fingerprints.
3. To make fingerprints rub a soft-lead pencil on paper until you produce a good pencil smudge. Rub your finger in the smudge and lift the print off your finger with clear tape.

Extensions

1. Thumbprint Self-Portrait Activity
2. Pick out a set of prints made by someone in the class and ask a team of "detectives" with magnifying glasses to identify whose they are.
3. If you have identical twins at school, ask them to record their fingerprints. Compare each set of prints to see if they are also identical. (They will not be).

Fingerprinting

Left Thumb Finger	Left Index Finger	Left Middle Finger	Left Ring Finger	Left Little Finger
Right Thumb Finger	Right Index Finger	Right Middle Finger	Right Ring Finger	Right Little Finger

Examine your fingerprints to see if any of them have the same print.

Compare your fingerprints to the three basic fingerprints below. Do any of your fingerprint patterns look like one of the prints below? On the lines under your fingerprints, write the pattern (arch, whorl, or loop) that looks the most like your fingerprint.

arch

whorl

loop

Thumbprint Self-Portrait

Materials:

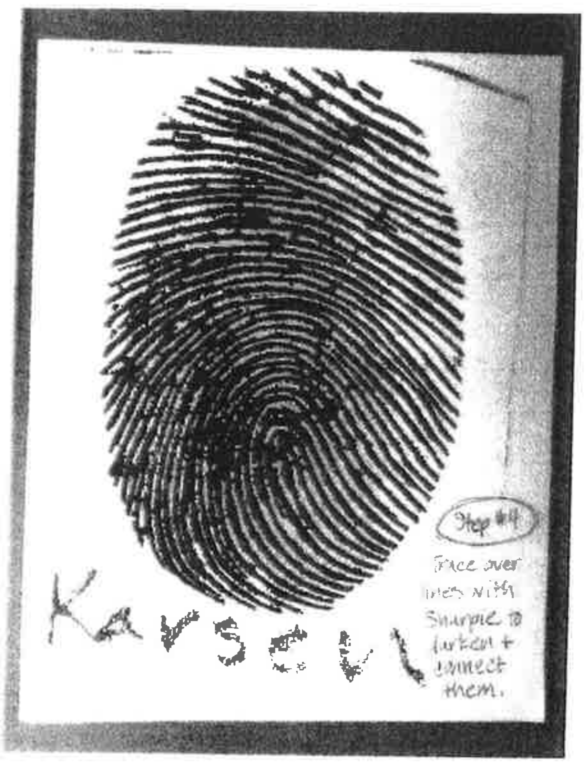
- Copy paper
- Black (F) and (UF) Sharpies
- Colored pencils
- Examples of the 3 types of fingerprints: loop, whorl, and arch.

Directions:

1. Complete "Investigating Fingerprints" and "Fingerprinting" activities.

2. Next, you need to enlarge your thumbprints.

*First, cut them out and write students' names in pencil, then enlarge them one at a time. Make the **first enlargement at 400%**, then **enlarge that one 250%**, and you should end up with the desired result… a thumbprint roughly the size of your face!*



3. You'll notice that your thumbprint enlargements will be very pixelated. So, take a (F) Sharpie and trace over the lines of your thumbprint to smooth the pixelated lines as much as possible.

Don't worry if some lines start and stop, or run into each other. Just do your best to darken them and smooth them out.

4. Next, center a clean sheet of lightweight paper over the top of your thumbprint.

You may want to tape the two papers together to keep them from sliding around. (Tip: Before taping anything that you'll want to remove later, first stick the tape onto your pants, then when you lift it off, the tiny fibers that are stuck to the tape will cause it to be less tacky and less likely to tear your paper when you remove it!) If you have trouble seeing through your paper to trace your thumbprint, taping the paper to a window or light box (if you have one!) will be a huge help.

5. Now, use your (UF) Sharpie and start writing along your thumbprint lines!
Begin at the top and use the lines of your thumbprint as guide lines for your writing. You don't need to retrace the lines onto your paper — you want your writing to create the 'illusion' of lines in your drawing. And don't worry about following every line exactly — this won't be used for I.D., you just want to get the general idea of the thumbprint! So, start writing a narrative about yourself… how old you are, things you like and don't like, your hopes and dreams for the future…. that kind of stuff! If you feel more confident writing in pencil first, you can do that, but you'll need to carefully erase any pencil left showing after you trace with Sharpie!

6. Optional… use colored pencils to *lightly* add some designs in the background before tracing over your writing with Sharpie. This will personalize your self-portrait even more!

Surveying Inherited Traits

Materials (per group): graph paper/plain paper, pen or pencil
Background: Introduce students to the traits that they will be surveying prior to the activity (can or can't curl tongue; attached or unattached earlobe; widow's peak).
Have students survey the whole after school program. Then, have the groups combine their data.

State the Problem

Are some forms of inherited traits more common than others?

Formulate Your Hypothesis

Which form of each of the trains shown do you think is more common among students in your class? Write your hypothesis.

____

____

____

____

Identity and Control the Variables

Who you survey is a variable you can control. Use a sample of students, not just those who are your friends or who sit near you. Survey the same group of students for all the traits on your list. Try to survey at least 20 students.

Test Your Hypothesis

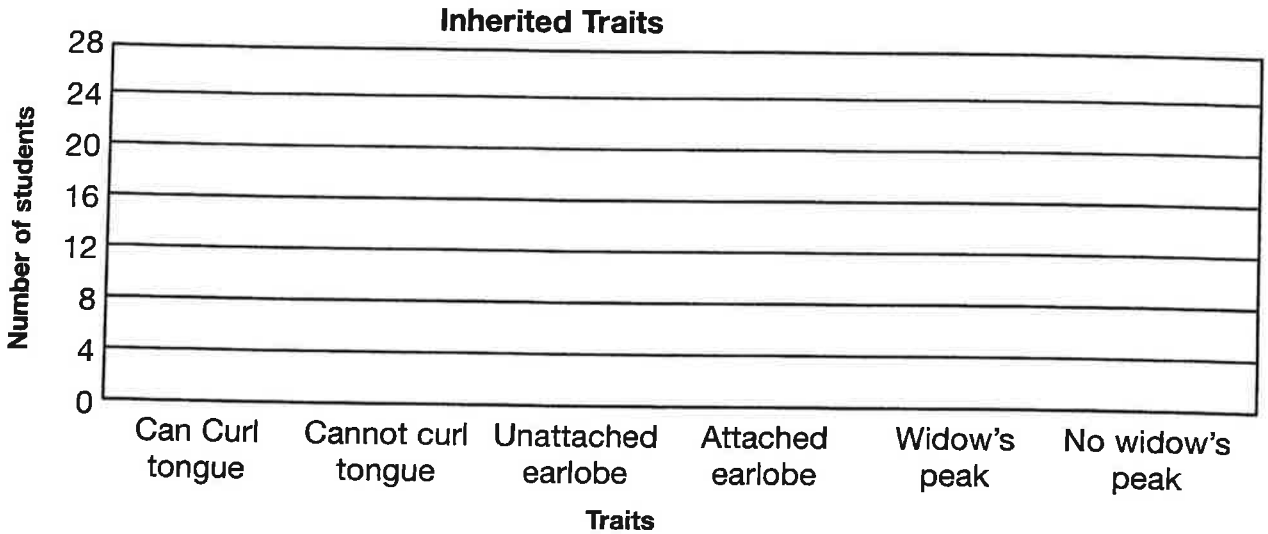
Record your data in the chart.

Collect Your Data

	Tally of students	Total
Can curl tongue		
Cannot curl tongue		
Unattached earlobe		
Attached earlobe		
Widow's peak		
No widow's peak		

Interpret Your Data

Use the data from your chart to make a bar graph.



State Your Conclusion

How do your results compare with your hypothesis? Communicate your results. Explain how the occurrence of traits varies among the students you surveyed.

The Human Body

What Goes Around Comes Around

Science Background

Even though the term is not a common one, *feedback* is critical to all living things, especially humans! Simply put, feedback is the mechanism within all living things that helps them adjust to changing conditions both inside and outside the organism. While all living things use it, feedback is most pronounced in higher animals like humans, and it's our nervous system and brain that control it. Information from all over your body is constantly being fed to the brain, which takes this "input" and compares it to a set of optimum conditions. Based on this comparison, the brain then sends out a set of impulses back to the target organs and an adjustment is made. Then a new set of information is sent back to the brain and the cycle continues—this is where the term *feedback* comes from.

One way to understand feedback is to take a look at your breathing. In humans, breathing is considered to be part of the autonomic nervous system, often called the *involuntary nervous system* because we don't consciously control it—it's taken care of automatically. Sensors in your body constantly monitor the level of carbon dioxide and oxygen in our blood, sending that information to the brain. If the oxygen level drops compared to the amount of carbon dioxide, the brain sends a message to the heart to start pumping faster so that your breathing rate increases. This happens when you start exercising or if you were to suddenly go to an area where there is less oxygen in the air, like up on a tall mountain. Once the levels of oxygen in the blood come back to normal, the brain tells your heart to slow down and your breathing rate drops.

Before You Begin

Make a copy of the "Free Fall" worksheet for each student.

Introducing the Topic

Invite a student volunteer to come forward. Have the student sit in a chair facing the class with her back to you. Stand behind the student and clap your hands loudly. More than likely, the student volunteer will jump. Ask: *Why did the student jump when I clapped?*

Objective

- ★ Students investigate how feedback systems work.

Standards Correlation

- ★ The human organism has systems for digestion, respiration, circulation, movement, control, and coordination.
- ★ The behavior of individual organisms is influenced by both internal and external cues.
- ★ Regulation of an organism's internal environment involves sensing the internal environment and changing physiological activities to keep conditions within a range required to survive.

You'll Need

(for demo)

- ★ rubber ball

(She was startled by the loud sound.) Explain to students that what they just witnessed was a case of feedback in action. *Feedback* is the process in which our brains take in information and then use it to send information back to different parts of our bodies that control our actions. Ask: *What system in our bodies sends messages back and forth from the brain? (The nervous system)*

Explain that the nervous system actually has two different parts to it. The *voluntary nervous system* is the part that we can control or change. The *involuntary nervous system* is the part that simply happens inside of us all the time. We don't control it but without it, we would be in trouble. The involuntary part of our nervous system uses feedback to keep our bodies functioning properly, and most of the time we don't even know it's going on.

Call on another volunteer to stand a few feet away from you across the front of the room. Tell the volunteer that you're going to play a game of catch. Pick up the ball and gently toss it to the student. Ask: *How did he know when and where to catch the ball? (The eyes sent a message to the brain, and the brain sent a message to the hands to move into the correct spot.) Was this a voluntary or involuntary response? (Voluntary)* Explain that the student didn't have to catch the ball. But even though this was a voluntary response, he still used feedback to make it happen.

Invite the class to try another feedback experiment. In it they will test their reaction time, which is a measure of how fast they can react to change. Pair up students and give each pair a ruler and each student a copy of the "Free Fall" worksheet. Review the procedure on how to do the reaction time test with the class before beginning the activity.

ame ______________________________ Date ______________

Student Worksheet

Free Fall

What is your reaction time and how does it change?

Get It Together

- ★ a partner
- ★ ruler
- ★ pencil or pen

(1) Decide which person will go first. The person doing the testing will hold the ruler by the 30-cm end in front of his partner. The person taking the test will place her thumb and forefinger on either side of the ruler where it says 1 cm. Make sure that the person who is taking the test is not actually touching the ruler. The person who is giving the test will let the ruler drop without saying when it is going to happen. The person who is taking the test will try and catch the ruler when it begins to fall by squeezing her fingers together. Record the number where she grabs the ruler on the data sheet below. The lower the number, the faster the reaction time. Conduct the experiment a total of 10 times and then switch so that the other partner goes. After you have both completed all ten trials, complete the rest of the questions on the worksheet.

Reaction Time Data Sheet

Trial 1 ______ cm

Trial 2 ______ cm

Trial 3 ______ cm

Trial 4 ______ cm

Trial 5 ______ cm

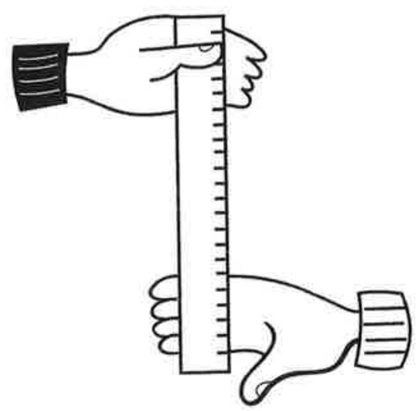
Trial 6 ______ cm

Trial 7 ______ cm

Trial 8 ______ cm

Trial 9 ______ cm

Trial 10 ______ cm



Student Worksheet

Free Fall *continued*

2. Based on the data you collected, did your reaction time change over the 10 trials? How so?

3. Is reaction time a voluntary or involuntary response? Explain your answer here:

4. In this experiment, explain how feedback helped you catch the ruler. (In other words, what steps had to happen in order for your hand to react in time to catch the ruler?)

Think About It

For many people who do this experiment, their reaction time improves after their first try, but then after a while they get slower again. Based on what you know about feedback, can you explain why this might happen?

Going Further

Blocking Feedback: Even though most feedback systems in our bodies are designed to adjust to changing conditions, they don't always work as well as you might want them to. Take your sense of balance, for instance. Under normal conditions it keeps you walking in a straight line even if you are changing direction or elevation. But what happens to your sense of balance after you spin around a few times? Try this simple test with your classmates: Put a piece of masking tape or stretch a piece of rope across the floor to make a straight line about 3 meters long. Have students line up at one end and then "walk the line." Most should have no problem doing it. Have them repeat the experiment, but this time have them spin slowly in place three or four times before they attempt to walk the line. You'll soon discover that the feedback system doesn't always work the way you expect! Test and see who is affected least and also how long it takes for this person to fully recover.

Life

The Human Body

You've Got Heart!

Science Background

The human heart is truly an amazing device. Weighing a little less than a pound, this fist-size muscle beats about 100,000 times each day, pumping blood through more than 64,000 km of blood vessels that run through our bodies. The human circulatory system is a closed system made up of arteries coming from the heart and veins returning to the heart.

The human heart, like those of all mammals and birds, is made up of four separate chambers. Two upper chambers called *atria* take blood in from the body, and the two lower chambers called *ventricles* pump the blood out. Blood enters the right atrium, filling the chamber, and flows through a valve into the right ventricle. From here it is pumped through the lungs, picking up oxygen. The oxygenated blood then flows back into the heart through the left atrium and, in the process, nourishes the heart muscle. From there the blood flows through another valve into the left ventricle, where it is pumped through the rest of the body. It takes blood about 15 minutes to make one complete loop through the circulatory system.

Think of blood as the body's distribution system. Not only does it bring oxygen and food to every cell, but it also removes wastes and carries special cells that fight off diseases and foreign objects. Blood is composed of *red blood cells* (which carry oxygen), *white blood cells* (which are the body's primary defense mechanism), and *plasma* (which is about 90 percent water). Blood also contains tiny spherical particles called *platelets*, which help blood clot and seal a wound when there is a break in the circulatory system.

Before You Begin

Before conducting the student activity, make sure that none of your students has any health conditions that might be affected by doing the activity. These children can serve as timekeepers. To make the simulated blood for the introductory activity, mix 8 to 10 drops of red food coloring with a liter of water. Copy the diagram of the heart (page 134) onto an overhead transparency or use it to draw a picture of the heart on the chalkboard. Make a copy of the "Pump It Up" worksheet for each student.

Objective

- ★ Students discover how the heart and circulatory system works.

Standards Correlation

- ★ The human organism has systems for digestion, respiration, circulation, movement, control, and coordination.
- ★ The behavior of individual organisms is influenced by both internal and external cues.
- ★ Regulation of an organism's internal environment involves sensing the internal environment and changing physiological activities to keep conditions within a range required to survive.

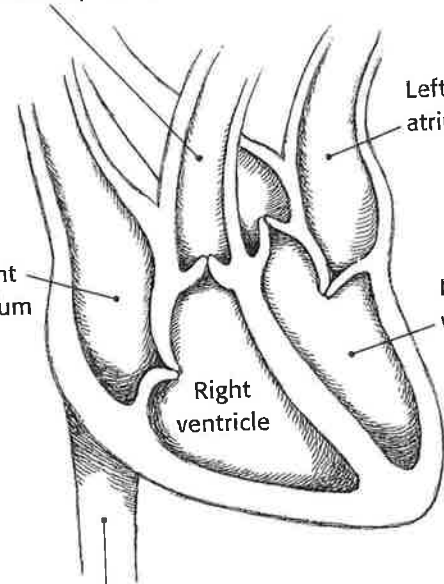
You'll Need

(for demo)

- ★ clear 1-liter soda bottle filled to the top with red water
- ★ 12-inch round balloon
- ★ overhead projector or chalkboard

Introducing the Topic

Introduce the activity by asking the class to place their hands on their chests. Ask: *How many of you can feel something happening inside your chest? What do you think it is? (Their heart beating) When the heart is beating, what is going on? (The heart is pumping blood through the body.)* Have students place the fingers of their left hand on their necks just below their right ear. Ask: *Can you feel a little throbbing in your fingers? What do you think that is? (Their pulse)* Explain that the pulse is caused by blood flowing through blood vessels in their neck.



Explain that the heart is really a muscle with four parts or chambers. Two of the chambers are called *atria*. They take the blood into the heart. The other two chambers are called *ventricles*. They pump the blood out of the heart. Display the heart diagram above on the overhead projector or on the chalkboard and point out the four chambers. Explain that all muscles, including the heart, act by contracting, or pulling tighter. Ask students to make a fist. The fist closes because the muscles of your fingers have contracted. In fact, your closed fist is about the same size as your heart!

Invite a student volunteer to assist you. Give the student the bottle filled with red water. Place the round balloon over the open top of the bottle. Explain that the bottle represents one of the ventricles of the heart. The balloon represents an *artery*, which is a blood vessel leaving the heart. Have the student gently squeeze the bottle and have the class observe what happens. Some of the water goes out of the bottle and into the balloon. Explain that in the heart, muscle surrounding the ventricles contract just like the volunteer's hand did. As the muscles get tighter, they literally squeeze the blood out into the arteries.

Ask the class to predict what will happen when the volunteer relaxes his or her grip. *(The water will flow back into the bottle.)* Explain that when the muscles around the ventricle relax, blood flows back into the chamber, but instead of coming from the artery, it comes from one of the two atria. Now ask the volunteer to squeeze and relax several times in a row. Students should see the balloon fill and empty with a regular pumping action.

Explain that blood takes about 15 minutes to make one trip through all the blood vessels of the body. Ask: *What does your blood do? (It carries oxygen and food to all the cells in your body and removes waste products and carbon dioxide.) Does your heartbeat always stay the same rate? (No)* Invite the class to do an experiment to see how different actions change their heart rate. Divide the class into groups. Give each student the "Pump It Up" worksheet and demonstrate how to measure heart rate.

Name ______________________________ Date ____________________

Student Worksheet

Pump It Up

How does your heart rate change when you exercise and rest?

Get It Together

- ★ watch or clock with second hand
- ★ pencil or pen

IMPORTANT: If you have any medical problems that prevent you from exercising or participating in gym class, tell your teacher and DO NOT DO this activity.

1. Place your hand on your chest and feel for your heart beat. Sit quietly for about one minute. Next, count how many beats your heart makes in 30 seconds. Use the timer or have someone else time you. This number will be your resting heart rate. Record the number of beats in 30 seconds here: __________

2. Now you are going to see how exercise affects your heart rate. You are going to hop up and down on one foot for 30 seconds. What do you think will happen to your heart rate when you start exercising? Write your prediction here:

   ____

   ____

3. Hop on one foot for 30 seconds. As soon as the time has passed, sit down and measure your heart rate for 30 seconds. This will be your active heart rate. Record the number of beats in 30 seconds here: __________

4. What happened to your heart rate after you exercised? Did your prediction come true? Why do you think you got the results that you did?

   ____

   ____

Student Worksheet

Pump It Up *continued*

5 What else happened to your body when you began to hop? How might these explain your change in heart rate?

____

____

6 Now sit quietly for five minutes. What do you think will happen to your heart rate? Why? Write your prediction here:

____

____

7 After your five-minute rest period, measure again how many times your heart beats in 30 seconds. Record your number here: ________

8 After sitting for five minutes, did your heart beat more closely match your resting heart rate or active heart rate? Why do you think this is so?

____

____

Think About It

Based on your experiment, what do you think happens to your heart rate when you are asleep? Explain.

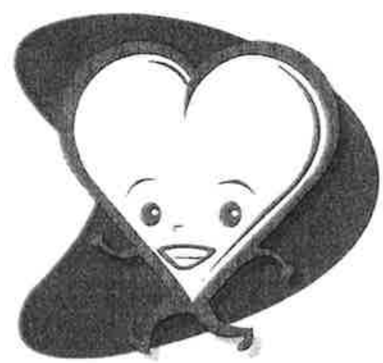
Going Further

Blood Types: While all humans have blood, not all human blood is identical. Over the past century scientists have discovered that different people have different blood types and giving a person the wrong type of blood through transfusion could have dire consequences. There are four major human blood groups, labeled A, B, AB, and O. If possible, find out your own blood type, along with your classmates. Then graph the results. Is one blood type more common than others? How does the class distribution match the general population? These are just a few of the questions that this type of study can lead to.

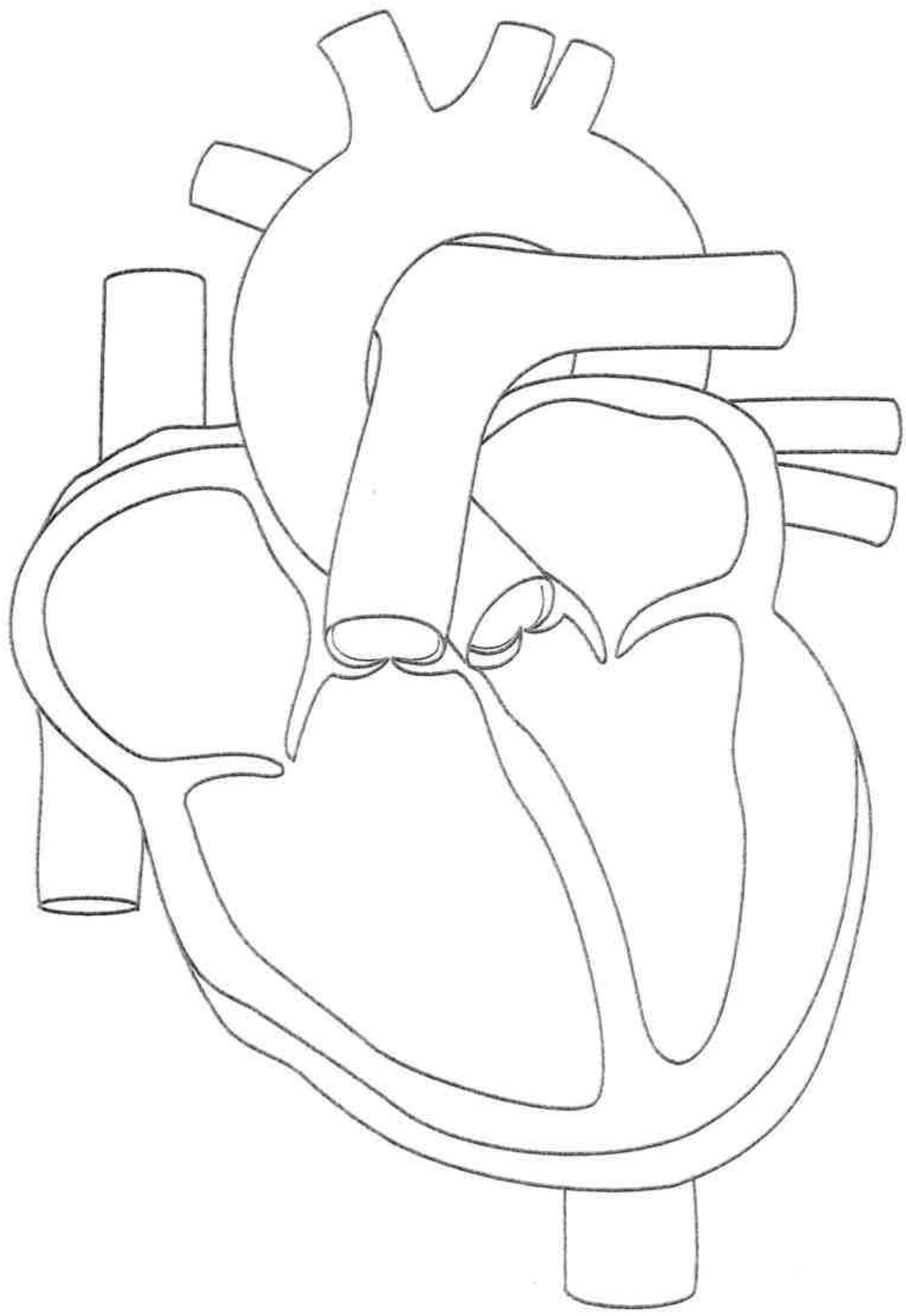
Chart Your Heart

By: ____________

	Standing still	Walking	Jogging	Jumping	Running	Jumping Rope				
# of Heartbeats										



The Parts of the Heart



The Human Body

Can You Feel It?

Science Background

Quick . . . What's the largest organ in the human body? No, it's not the liver, or the heart, or even the brain. It's your skin! While we don't usually think of the skin in the same way as the other organs of the body, it serves a number of critical functions. First, it protects us from the outside world. Your skin is the first layer of defense against invading organisms that can do great damage. It also helps control our body temperature. When we perspire, glands under the skin release sweat, which evaporates and cools our bodies.

One of the most important roles that our skin performs is as a sense organ. Specialized nerves directly under the outer layer of skin (called the *epidermis*) sense temperature and pain and give us the ability to "feel" the texture of different objects. While humans tend to rely mostly on the eyes for gathering information about the world, the skin can judge slight differences in size and shape even more accurately. Fingers can feel slight differences in texture that the eyes could not see without the aid of a hand lens or microscope.

The sense of touch does not stop at the skin, however. A variety of nerves are directly connected to the bottom of the hairs on your arms and legs so that the hair itself becomes an extension of the skin. In fact, hair is actually made of modified skin cells, as are your fingernails and toenails. While beauty may be only skin deep, the advantages provided by this unique set of cells goes much deeper!

Before You Begin

For the student activity, ask each student to bring in a set of gloves or mittens. If necessary, they can share with a partner. Make a copy of the "Get a Grip" worksheet for each student.

Introducing the Topic

Ask students: *Have you ever had to find something in the dark? If you can't see an object, how can you identify it? (You can feel it.)* Explain that we depend on our sight more than any other sense, but if we lose it, our sense of touch can give us a pretty good picture of what something looks like just by the way it feels.

Objective

★ Students observe how their sense of touch allows them to gather information about their world.

Standards Correlation

★ The behavior of individual organisms is influenced by both internal and external cues.

★ Regulation of an organism's internal environment involves sensing the internal environment and changing physiological activities to keep conditions within a range required to survive.

You'll Need

(for demo)

★ a common classroom object, such as an eraser or piece of chalk

★ hand lenses

★ blindfold (a bandanna-type handkerchief works well)

Ask a student volunteer to assist you. Blindfold the student and have him sit on a chair facing the class. Ask the volunteer to hold out a hand and give him an object to hold. The object should be a common classroom item like a pencil, piece of chalk, or a board eraser. Ask the volunteer to describe how the object feels and, if possible, identify it. If time permits, have a few more students play the game using different mystery objects.

Explain to students that our skin is a highly developed organ that not only protects our bodies from things like bacteria, but also helps us sense the world around us. Pass out the hand lenses and ask students to closely examine their fingertips. What do they see? *(Little ridges)* Ask: *Why do you think it would be helpful to have little ridges on the palms of our hands and fingers? (The ridges help us get a grip on things.)*

Now have students look at the skin on the back of their hands. How does it look compared to the front? *(There are no ridges, but little holes and hairs are present.)* Explain that the hairs on our arms and legs are actually an extension of our skin, and they can sense things as well. Have students hold out their right arm and, with their left hand, gently brush over the hair on their arm WITHOUT touching the skin. Ask: *How does this feel? (It might tickle a bit.)* Next, have them gently blow across their arm. Ask: *How does this feel? (Cold)* Explain that not only does our skin feel pain and allow us to grasp objects, but it also can tell us what the temperature is like.

Invite students to conduct a "hands-on" investigation into the workings of our skin and see what happens when some information is blocked from our skin. Give each student a copy of the "Get a Grip" worksheet.

Student Worksheet

Get a Grip *continued*

5. Take your hand out of the plastic bag and hold the penny in your bare hand. Describe how it feels this time. Which details can you feel compared to Steps 1 and 3?

____

____

6. Place the penny on the desk again and try to pick it up with your bare hand. How did this trial compare with Steps 2 and 4? Why?

____

____

7. Based on your experiment, why do you think doctors use "skintight" gloves when examining patients?

____

____

Think About It

If you had to work outside on a cold day, what type of gloves would you use to keep your hands warm while still being able to feel with your fingers?

Going Further

Some Like It Hot: One of the most important roles played by our skin is sensing temperature. If you've ever accidentally touched a hot pan or stove you know that temperature receptors on our fingertips are extremely sensitive, causing us to pull away before we get severely burned. It is possible to "fool" these receptors by sensitizing them first. Here's a simple experiment to try: You'll need three cups of water: one warm, one room temperature, and one ice cold. Place a finger from your left hand in the cold water and one from your right hand in the warm water. Let them sit for about 30 seconds. Then place both fingers in the cup of room-temperature water. The finger that was in the cold water will now feel warm and the one that was in the warm water will feel cold—even though both fingers are in water with the same exact temperature!

8-23

Name ______________________________ Date ________________

Student Worksheet

Get a Grip

How does your sense of touch work in different conditions?

Get It Together

- ★ penny
- ★ large plastic food storage bag
- ★ mitten or thick winter glove
- ★ pencil or pen

1. Place a mitten or winter glove on the hand that you don't write with. Put the penny into the hand with the glove. Describe how it feels in as much detail as possible below.

   ____

   ____

2. Place the penny on the desk in front of you. Try to pick it up with the hand that has the glove on. Is it easy or difficult to do? Explain why.

   ____

   ____

3. Take the glove off your hand and place the same hand inside the large plastic bag. With your other hand place the penny in the hand that is inside the bag so that you are feeling the penny through the plastic. Describe how it feels this time. How does it feel compared to Step 1?

   ____

   ____

4. Place the penny back on the desk and try to pick it up using the hand that's in the plastic bag. How did you do this time? Was it easier or harder than in Step 2? Explain.

   ____

   ____

The Human Body

The Eyes Have It

Science Background

Humans are visual animals. Biologists tell us that we rely on our sight more than any of our other senses for getting information about the world around us. We see color and depth, and we can see almost as well at night as during the daytime.

The human eye is a complex device made up of many parts all working together. (See diagram, page 142.) Light enters through the *pupil*, the dark spot in the center of the eye. Surrounding the pupil is the colorful *iris*, a muscle that opens and closes the pupil depending on the amount of light entering the eye. After passing through the pupil, light enters a transparent elastic ball called the *lens*, which focuses the light on the *retina* located at the back of the eye. The retina is lined with light-sensitive cells called *rods and cones*. This is where the image of what you are seeing is recorded and passed onto the brain. Rod cells produce vision by sensing light, while cone cells produce color. When an image hits the retina, it is upside down and full of holes. From the retina, electrical impulses travel to the brain, which flips and sharpens the image so what we see is clear and right-side up.

While color vision happens because of cells in the eye, our ability to see depth and judge distance is affected by the placement of our eyes on our heads. Humans, like most predatory animals, have two eyes in front of the head. Because of this, each eye can be brought into focus on the same object at the same time. Since our eyes are separated by about 5 cm, each eye sees the same thing but at a slightly different angle, creating two overlapping fields of view. When the information from each eye is sent to the brain, the brain takes those two images and merges them into one. Result: We see in 3-D. People who lose vision in one eye often have trouble judging distances because the brain is getting only half the information it needs to see depth.

Before You Begin

Make a transparency or photocopy of the eye diagram to show students. If mirrors are not available for the introductory activity, have students work in pairs and look at each other's eyes. Make a copy of the "Eye Spy" worksheet for each student.

Objective

- ★ Students discover how their sense of vision lets them see color and depth.

Standards Correlation

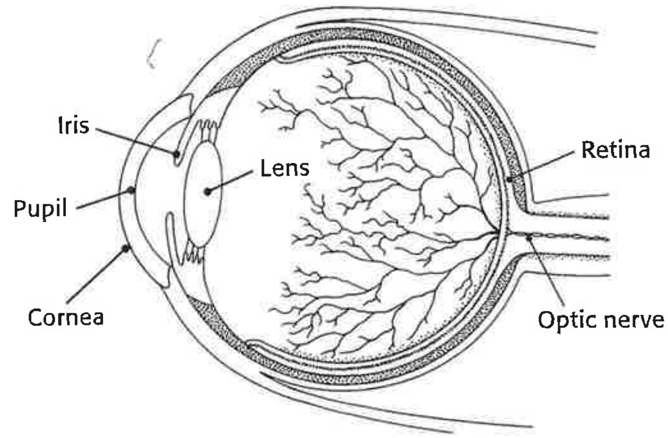
- ★ The behavior of individual organisms is influenced by both internal and external cues.
- ★ Regulation of an organism's internal environment involves sensing the internal environment and changing physiological activities to keep conditions within a range required to survive.

You'll Need

(for demo)

- ★ zipper-style sandwich bag filled with water and sealed tight
- ★ small mirrors
- ★ hand lenses
- ★ 8-1/2-by-11-inch sheets of paper

Introducing the Topic



Pass out the mirrors or pair up students so that they can look at each other's eyes. Have students take a close look at their eyes. Ask: *What shape are they? (Oval) What do you see in the middle of the eye? (A black spot surrounded by a colored circle)* Explain that the black spot is called the *pupil* and that it's a hole in the eye that lets in light. The colored ring is called the *iris*, and it's a muscle that opens and closes the pupil. Tell students to observe the eye closely as you dim the lights. Ask: *What happens to the pupil when it gets darker? (It gets bigger.)* Turn the lights back on, and the pupil will get smaller again. Explain that the pupil gets larger when it's dark to let in more light, but shrinks back when the light is bright.

Explain that behind the pupil is the *lens*. Give each student a hand lens. Have students hold the hand lens up to their eyes and look at a distant object. Ask: *How does the object look through the lens? (Upside down)* Explain that the lens in your eye is similar to the magnifying lens, except that the one in your eye is very elastic and can change shape, similar to a water-filled plastic bag. Walk around the room holding up the bag filled with water in front of your face. Explain that once the light passes through the lens, it reaches the back of the eye and hits the *retina*. The retina is covered with light-sensitive cells, which send the image to the brain. When the image hits the retina, it's upside down, out of focus, and full of holes. But your brain flips it back the other way so the world looks normal. Display the eye diagram on the overhead or the board to review the different parts of the eye.

Next, ask students: *Why do you think we have two eyes instead of one?* Explain that having two eyes enables our brain to get twice as much information about our world. Most of the time, this is a good thing. But sometimes it can confuse our brains. Give each student a piece of paper. Have students roll the paper into a tube about 3-cm wide and hold the paper tube up to one eye. Instruct students to look straight ahead while keeping both eyes open. Have them hold up one hand so that the palm is about 30 cm away from their face. With both eyes still open, have them move the palm of their hand so it touches the side of the paper tube. Ask: *What do you see? (It should look like they have a hole in their hand.)* Explain that most of the time when both eyes are looking at an object, they both see the same thing and send the same message to the brain. Because of the tube, each eye is seeing something different. Since your brain doesn't know this, it tries to make one image out of the two. So it looks like you have a hole in your hand.

Most of the time binocular vision helps us a great deal. Invite the class to conduct their own experiment to see how having two eyes is better than one! Give each student a copy of the "Eye Spy" worksheet.

Name ______________________ Date ______________

Student Worksheet

Eye Spy

How does binocular vision help us judge distance?

Get It Together

- ★ pen or pencil

1. Stretch out your right arm in front of you with your thumb sticking straight up in the air. Close one eye and move your thumb so that it is blocking out some distant object in the room, such as a clock or picture on the wall. Without moving your thumb, close the first eye and open your other eye. What does your thumb appear to do?

____

____

Explain why you think this happens:

____

____

2. Return to the position you started with in Step 1, only this time, instead of stretching your arm all the way out, hold your thumb up so that it is only a few inches in front of your open eye. Does your thumb appear to be bigger or smaller? Why do you think this is so?

____

____

3. With your thumb a few inches in front of your open eye, block out a distant object as you did in Step 1 and then switch eyes again without moving your thumb. How did this compare with the first time you tried the experiment? What do you think caused the difference?

____

____

Student Worksheet

Eye Spy *continued*

4) Because our eyes are spread a little bit apart, we see the same thing from two slightly different directions. This helps us judge how far away things are. Based on your observations, if an object is up close to us, will it appear to shift more or less than a distant object?

____

5) Not all animals have their eyes located in front of their heads. Can you think of any that have their eyes on the side of their heads? List a few here:

____

____

6) Can you think of any other animals that have eyes in the front of their heads like we do? List a few here:

____

____

7) Most animals that are predators have their eyes in the front of their heads, just like us. Based on your observations, why would this be helpful?

____

____

Think About It

Animals that are usually hunted by other animals tend to have the eyes on the side of their heads. How do you think this helps them from being eaten?

Going Further

Animal Eyes: While humans have very advanced vision, most animals have some type of eyes that enable them to sense light. But that doesn't mean that they see the way we do! For example, bees see in a totally different range of colors. Flies have compound eyes with dozens of tiny lenses. And even though bulls are supposed to hate the color red, they are actually color-blind. Select an animal and research how its vision compares to ours.

sounds. Simply record some common sounds from around the school or home on a cassette recorder. Sounds can include car horns, pots clanging, power tools, and even a toilet flush! Make a copy of the "Sounds Around" worksheet for each student.

Introducing the Topic

Challenge the class to identify a few common sounds that you have recorded. Ask students to listen quietly and raise their hands when they think they know what each sound is. Play each sound and allow students to guess. When you are finished ask: *How did you know what each of these sounds was if you couldn't see what was making them? (They were common sounds so they were easy to recognize.)*

Explain that even though we use sight more than any other sense, our sense of hearing also provides us with a great deal of information about our world. Our ears hear sounds because sound is a form of mechanical energy. When something makes a sound, it vibrates. Ask: *What is a vibration? (Something moving back and forth)*

Place the meterstick on top of a desk and have a student hold it down firmly so that a length of about 40 cm is hanging over the edge of the desk. Ask another student to pull down on the edge of the stick and let it go. The free end of the stick should begin vibrating and produce a sound. Explain that the faster something vibrates, the higher the pitch of the sound. Humans can normally hear sounds that vibrate between 20 and 20,000 times per second. In order for us to hear sounds, the vibrations have to get into our ears and enter a tube called the *auditory canal*. At the end of this canal is a thin flap called the *eardrum*. Hold up the model eardrum made from the coffee can and balloon. Explain that the rubber from the balloon is similar to the eardrum. Place the can on a desk and place some rice cereal on top of the balloon. Invite a student to come up, put her mouth near the can, and sing a scale (do-re-me . . .). Guide students to notice that as the volunteer sings, the pieces of rice cereal bounce up and down.

Explain that once the eardrum starts vibrating, it transfers the energy to three bones in the middle ear, which finally transfer the sound to an organ in the inner ear called the *cochlea*. The cochlea is filled with little hair-like growths that pick up the vibrations, turn them into electrical impulses, and send them to the brain where they are finally interpreted as sound. Not only are our ears designed to hear sounds, but they can also tell us where sounds are coming from. To see how this works, invite students to do a sound experiment. Pair up students and give each student a copy of the "Sounds Around" worksheet.

The Human Body

Now Hear This

Science Background

While we humans tend to be "visual creatures," we also depend heavily on our sense of hearing. Like the eye, the human ear is a complex device with many parts working together. The outermost part of the ear (the only part we see) is called the *auricle*. Its main job is to collect sound waves and direct them into the *auditory canal*, where they strike a thin, fleshy membrane called the *eardrum*. Behind the eardrum are three small bones called the *malleus*, *incus*, and *stapes*. When the eardrum vibrates, the motion is transferred through these bones and into the inner ear. Inside the inner ear is the *cochlea*, which resembles a tiny snail shell. In this organ, mechanical vibrations are picked up by thousands of tiny hair-like receptors and turned into electrical impulses. The impulses then travel to the brain via the auditory nerve and we recognize it as sound.

Humans, like all mammals, have *binaural hearing*. Because we have two ears on opposite sides of our heads, we don't just hear a sound, we also can sense what direction it's coming from. A sound coming from the right hits our right ear first and is a little louder than when it reaches the left ear. Our brain takes the differences in these two signals and tells us where to look. If a sound is coming from straight ahead (or behind), it reaches both ears at about the same time with the same intensity.

The human ear is designed to register frequencies between 20 and 20,000 vibrations per second (vps), but it's most sensitive in the range of 1,000 to 4,000 vps, which coincidentally is the normal speaking range of most people. Over time, our ability to hear diminishes, especially when we are regularly subjected to loud sounds. Recent studies have shown that the use of personal stereos is having a major negative impact on our ability to hear!

Before You Begin

For the introductory activity, you'll need to build a model eardrum. Cut the valve part off a round balloon and stretch the remaining rubber over the top of the coffee can. It should be tight like a drum. Use two or three rubber bands to secure the balloon to the can top. You will also need to get a recording of several different

Objective

- ★ Students discover how their sense of hearing works.

Standards Correlation

- ★ The behavior of individual organisms is influenced by both internal and external cues.
- ★ Regulation of an organism's internal environment involves sensing the internal environment and changing physiological activities to keep conditions within a range required to survive.

You'll Need

(for demo)

- ★ empty coffee can
- ★ 12-inch round balloon
- ★ large rubber bands
- ★ scissors
- ★ rice cereal
- ★ meterstick
- ★ recordings of some common sounds

Name ______________________ Date ______________

Student Worksheet

Sounds Around

How can we tell the direction of sound?

Get It Together

- ★ a partner
- ★ pencil or pen

1. In this activity, you're going to see how our ears help us locate the direction of a sound. You and your partner will take turns creating the sound. The best way to make a sound is to snap your fingers or clap your hands lightly. When making the sounds, try to keep the volume the same each time and try not to be too loud.

2. Listen to the sound that your partner is making. Have your partner move closer to you while still making the sound. Describe what happens to the volume of the sound as you get closer to it. Why do you think this happens?

   ____

   ____

3. Predict: What will happen to the volume of the sound when you move farther away from it? Write your prediction here:

   ____

   ____

   Move farther away from your partner. Was your prediction correct? Why do you think this happened?

   ____

   ____

4. In the next part you are going to try your hand at locating a sound when your eyes are closed. Your partner is going to move around in different directions and you will point to where you think the sound is coming from. Your partner should stop in one spot for a few seconds and you should

Student Worksheet

Sounds Around *continued*

point to where you think he is. Open your eyes and check your results a few times. Describe how accurate you were below. When was it the most difficult to locate the sound?

____

____

5. Predict: How might covering one ear affect how well you can locate a sound? Write your prediction here:

____

____

6. Test your prediction by covering one ear and repeating Step 4. How well did you do? Why do you think that you got the results that you did?

____

____

7. The next test will be done with your eyes open. Have your partner stand about 3 meters in front of you and make the sound again. This time, cup your hands behind your ears so that your ears are spread open. What happens to the volume of the sound when you do this? Why do you think this happens?

____

____

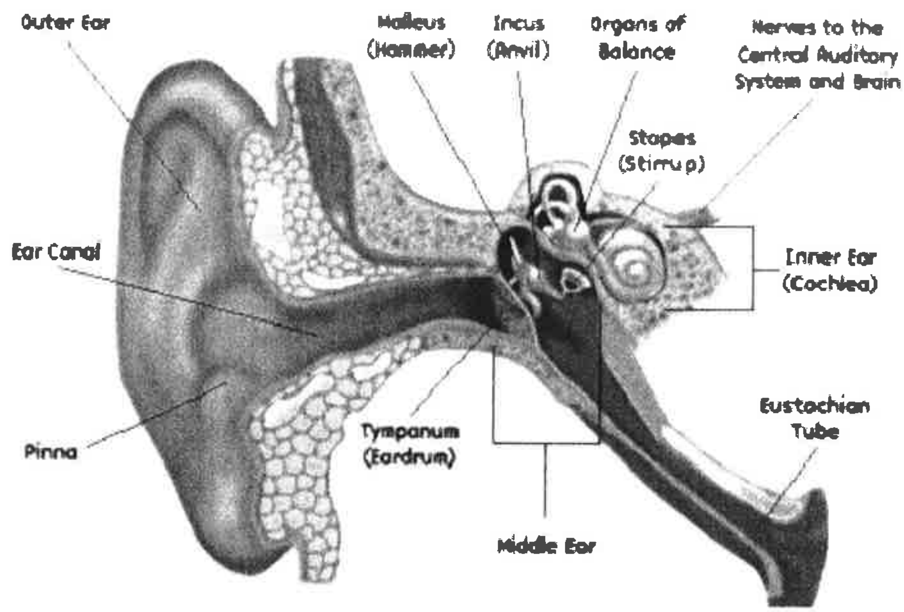
Think About It

Based on your observations, how would you go about locating a sound that was coming from somewhere in your house using just your body and your hands?

Going Further

Build a Better Ear: All hearing starts with the auricle—the fleshy part of the ear that actually sticks out of our heads. Basically the auricle can be thought of as a "sound scooper," directing sound waves into the ear canal. Logic dictates that the more sound waves you have getting into the ear, the better you will hear the sound. Using paper cutouts, experiment with different-shaped ears to see if you can come up with a design for a better auricle. You may want to take your cues from some of our animal neighbors who are known for good hearing. Do rabbit ears really work better? How about a fox's ears? This is not only a fun craft activity but it teaches some of the basics of design and invention as well.

Hearing



How do we hear?

Hearing depends on a series of mechanical events that transform sound waves in the air into electrical impulses in the nerves which are then carried to the brain.

1. Sound waves first enter the ear through the fleshy, cup-like portion of the outer ear which collects sound and funnels it towards the brain.
2. These sound waves then travel a few centimeters down the auditory canal, the pathway to the middle ear, before striking the delicate tympanic membrane, commonly known as the ear drum.
3. This thin, skin-covered membrane, which separates the external and middle sections of the ear, vibrates with incoming sound waves and transmits these vibrations to three tiny bones in the middle ear, collectively referred to as the ossicles. The ossicles amplify ear drum vibration and carry them to the inner ear.
4. More amazing than this smooth transition of sound waves is the size of the ear's high-fidelity equipment. For example, the three bones of the ossicles—the malleus, incus and stapes (or the hammer, anvil and stirrup)—are spectacularly small and fit into an area the size of an orange seed.
5. The third bone of the ossicles, the stirrup-shaped stapes, transmits the amplified vibrations through the oval window and into the fluid that fills the inner ear.
6. The final destination for sound vibrations is the snail-shaped cochlea. The fluid-filled cochlea coils about itself three times and contains the organ of Corti, named after the Italian scientist who first described it. It is in the hair cells of the organ of Corti that sound energy is transformed to electrical nerve impulses.
7. Hair cells are special sensory hearing cells fringed with fine hairs that stick up into the fluid of the inner ear. The vibrations in the fluid move these hairs and trigger internal changes in the sensory cells that lead to the production of electrical signals.
8. Finally, the hearing or auditory nerve carries electrical signals to the brain.

In summary, sound waves are funnelled into the outer ear and amplified in the middle ear. Sound waves are then carried through the oval window and into the fluid of the inner ear. Waves of fluid of the inner ear, in turn, move the ultrasensitive hair cells. Sounds of different frequencies and intensities move the hair cells in slightly different ways, thus allowing the brain to differentiate between sounds.[8-32]

The Human Body

Mr. Bones

Science Background

Humans are *vertebrates*—our skeleton is inside our body. Combined with our muscles, the human skeletal system provides support and allows us an incredible range of movement while protecting our vital organs.

Even though they look hard and inanimate, bones are living tissue. They continue to grow and change throughout our lifetime. When you were born, you had about 350 bones. As you grow, many bones fuse together so that as an adult, you have about 206 bones.

Bones come in three main shapes. *Long bones*, like the femur in the leg and the radius in the arm, are used primarily for locomotion and large movement. *Short bones*, like those found in the wrist and feet, allow for fine movements and give us incredible dexterity. *Flat bones*, like the ribs and the bones in the skull, serve as body armor, protecting vital organs inside.

The point where two bones come together is called a *joint*. Without joints, we would not be able to move. There are three major types of joints. *Hinge joints*, like your knee and elbow, allow a back-and-forth motion. *Ball-and-socket joints*, like your shoulder and hip, allow rotation as well as up-and-down movement. *Pivot joints*, like your head and neck, allow you to move in multiple directions. To help minimize the wear and tear at joints, a spongy layer of *cartilage* acts like a shock absorber.

Bones also serve as connection points for muscles and ligaments. While bones support us, muscles move us. A *muscle* consists of a mass of fibers that are grouped together into bundles. The heart and our digestive system are made of specialized muscles, but the muscles that give us movement are called *striated muscles*. Most striated muscles are attached to bones by tendons, and most work in pairs on opposite sides of a joint. Muscles work by *contraction*, which means that they can only pull. When you bend your arm, the biceps muscle gets shorter, pulling the two bones on either side of a joint closer together. To straighten your arm, the biceps relaxes and the triceps on the opposite side of the arm contracts.

Before You Begin

Before the introductory activity, you will have to build a model arm. Take two small boards that are the same size and connect

Objective

- ★ Students investigate how their muscles and skeletal system support and move their bodies.

Standards Correlation

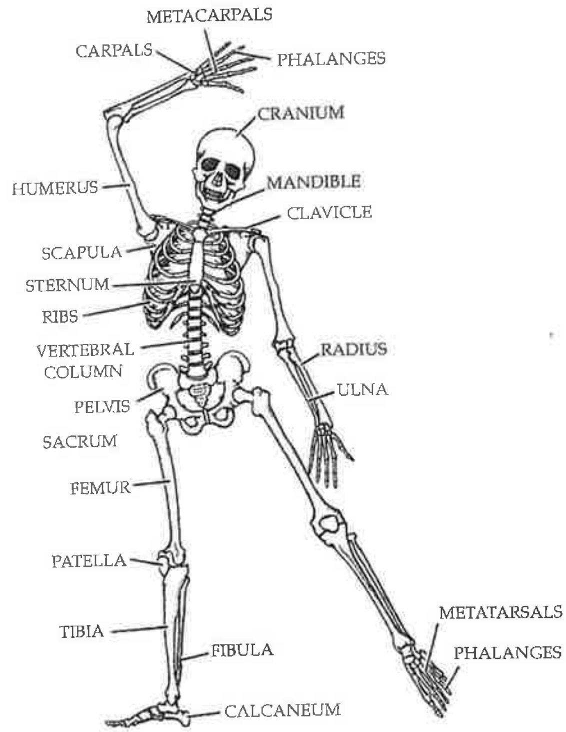
- ★ The human organism has systems for digestion, respiration, circulation, movement, control, and coordination.

You'll Need

(for demo)

- ★ 2 small boards, each about 8-by-20-cm
- ★ 8-cm door hinge with screws
- ★ 2 large heavy rubber bands
- ★ screwdriver
- ★ stapler or staple gun
- ★ picture of a human skeleton
- ★ overhead projector

their two ends together by screwing in the door hinge between them. Cut the rubber bands to make two long elastic strips and staple one end to each board across the hinge. Flip the boards over and do the same thing on the backside of the board. The hinge represents the elbow joint, and the rubber bands represent the biceps and triceps muscles. Copy the graphic of the human skeleton onto an overhead transparency. Make a copy of the "Double Jointed" worksheet for each student.



Introducing the Topic

Invite students to stand up and do a little exercise. Have them bend over and touch their toes. Next, have them place their hands on their hips and twist their bodies to the left and the right. Finally, have them hold up their right index finger and bend it a few times. Have them return to their seats and ask: *In all these exercises we just did, what part of our bodies did we use to move? (Muscles)* Explain that without our muscles we wouldn't be able to move much, but our muscles don't work alone. Ask: *What part of our body do the muscles pull on? (Bones)*

Explain that our muscles and bones work together as a system. Bones are like a framework inside our bodies. Show students the overhead projection of the human skeleton. Unlike insects and spiders that have their skeletons outside their bodies, humans, along with many other animals, have an internal skeleton.

Explain that muscles pull on the different bones to make them move. All our muscles work the same way—by contracting, or getting smaller. Have students extend their right arm and place their left hand on top of their right biceps. Ask them to bend their right arm as if making a muscle. Ask: *What do you feel the muscle in your arm do? (Bunch up and bulge)* Next, have them rest their left hand on the back of their right arm on the triceps and bend the arm again. Ask: *What happens to the triceps muscle when the biceps gets tighter? (It stretches.)*

Show students the model arm that you built. Bend the arm a few times so that they can see the action of the rubber bands as the arm moves. Explain that most muscles work in pairs. When one side contracts and gets tighter, the other muscle relaxes and stretches out. In order for muscles to work properly, however, the different bones have to join together. Ask: *In my model arm, what does the metal hinge represent? (The elbow)* Explain that the elbow is a joint, and we have joints wherever bones come together. Not all joints work the same way. Invite students to do an investigation of their own bodies to see what types of joints they have. Students need no materials other than the "Double Jointed" worksheet and a pen or pencil.

Name ______________________ Date ______________

Student Worksheet

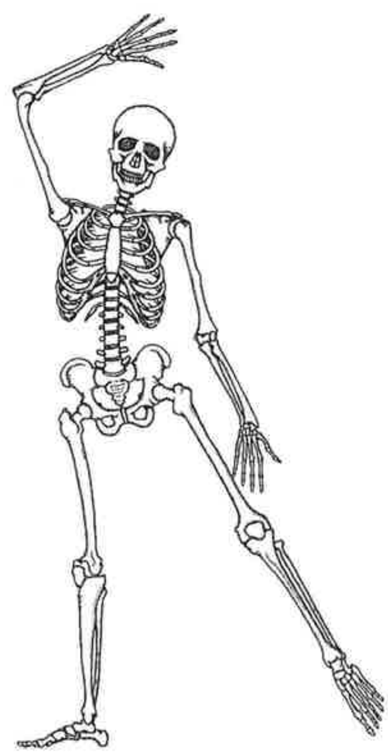
Double Jointed

How do the joints between different bones allow us to make different movements?

Get It Together

- ★ your body
- ★ pencil or pen

1. When you are an adult, you have about 206 different bones in your body. Each bone is connected to another bone by a joint. In this activity, you're going to examine the structure of some of your joints to see how they allow you to move. Refer to the picture of the human skeleton when you are recording your information.



2. Let's start with the elbow joint. Scientists call this a *hinge joint*. Bend you elbow back and forth a few times and observe the way your arm moves. How many different directions can you move the elbow joint?

____

3. Why do you think the elbow joint is called a *hinge joint*?

____

____

4. Look at your body as well as the picture of the skeleton. Can you see any other joints in your body that act like a hinge joint? List them here:

____

____