BioEd℠

K-1: The Senses

Teacher's Guide

Baylor College of Medicine

Barbara Z. Tharp, MS, Michael T. Vu, MS, Delinda K. Mock, BA, Christopher Burnett, BA, and Nancy P. Moreno, PhD.

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The *K-1: The Senses Teacher's Guide* may be used alone or with integrated unit components. The Learning Brain: Senses unit is comprised of the guide, a PowerPoint® slide set, "What Sound Is It?" for use with the activity, "Our Sense of Hearing," and a student storybook, *Making Sense!* (available as a PowerPoint® file and in PDF format). All files are available free-of-charge at BioEd Online (www.bioedonline.org).

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Baylor College of Medicine

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My Science Journal

Name _____

Drawing

Key Words to Use

I Observed...

The Brain: Control Central

Guiding Question

What do you know about the brain?

Concepts

- *The brain is the command center of the body.*
- *The brain has unique physical characteristics.*
- *The brain has three major parts, each with different roles.*

Time

Setup: 5 minutes
Class: 2 sessions of 30 minutes

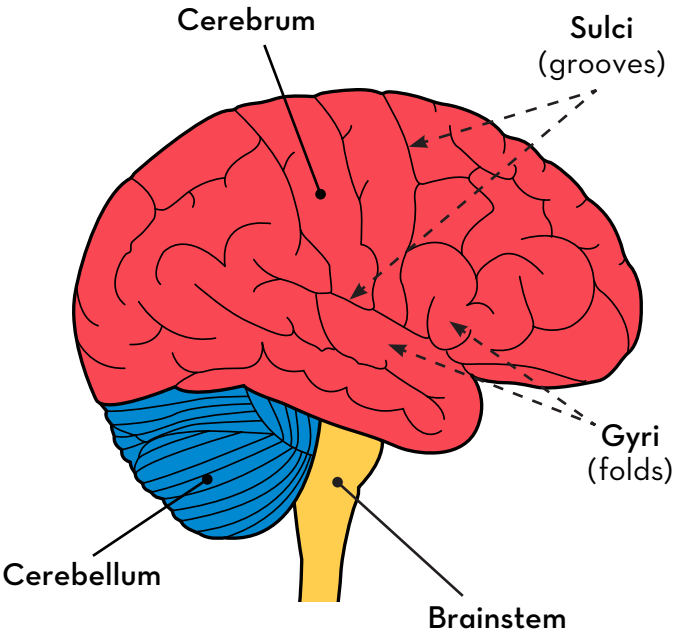


Illustration by M.S. Young © Baylor College of Medicine.

Have you ever wondered about the human brain? What does it look like? How much does it weigh? What does it feel like? Most of us will never see or touch a real brain, but we can share much of the excitement of neuroscience by teaching a few simple concepts about the brain.

The brain is the body's "command center" and most complex organ. It is part of the nervous system, a communications network that extends throughout the body. The brain is enclosed within the skull dome, or cranium, a bony shell that protects the brain and forms the shape of the head. A cushion of fluid inside the cranium, and three tough membranes covering the brain—called meninges—provide further protection.

The brain is composed of many parts, each with different roles. Its three major sections are the brainstem, cerebellum and cerebrum. The brainstem, which is connected to the spinal cord, controls automatic activities, such as heartbeat, digestion, breathing, swallowing, coughing and sneezing. The cerebellum sits at the back of the brainstem. It helps muscles work together to coordinate and learn movements, and to maintain balance and posture. It also has a role in the formation of memories. The cerebrum is the largest part of the mammalian brain. It is responsible for thinking, learning, planning, remembering, language, feeling sensations, emotions, and voluntary (on command) muscle movement.

The surface of the cerebrum has folds, called gyri, and grooves, called sulci. These wrinkles allow more cerebral surface tissue (also called the cerebral cortex) to fit into the limited space within the cranium. The size and extent of folding are related to intelligence and

motor and sensory skills, with more folds indicating greater intelligence. Most mammals with large brains have highly folded cerebral surfaces.

The brain and the rest of the nervous system play a critical role in perceiving, communicating and interpreting conditions outside and inside the body. This capacity to "sense" what is happening, both externally and internally, depends on receptors in organs such as the eyes and skin—and on the brain's ability to make meaning from the information gathered. But before we can understand the senses, we must become familiar with our "central processing unit," the brain.

This teacher-directed activity allows young students to explore the basic functions and characteristics of their brains. It is best presented as whole class instruction, with students working in pairs to share materials.

MATERIALS

Teacher (See Setup)

- 11-in. round balloon (to serve as a brain model)
- Clear, re-sealable plastic bag
- LCD projector and computer or whiteboard to project the storybook
- Package of instant oatmeal
- PowerPoint® slide set and/or PDF of the student storybook, *Making Sense!* (available for viewing or download at http://www.bioedonline.org/lessons-and-more/teacher-guides/k-1-the-senses/)
- Scale or balance (to weigh the water-filled balloon)
- Tap water

Optional: Brain and skull model

Per Student Pair

- Crayons (red, blue and yellow)
- Pair of scissors
- Tape or glue

Per Student

- Copy of "Brain Diagram 1" and "Children's Activities" pages
- Science notebook (for use throughout the unit)

SETUP

Prior to class, fill an 11-inch balloon with water. Stretch the balloon, place the open end over a faucet and add approximately three pounds (48 oz, or 1,450 mL) of water. If a scale is not available, compare the balloon to something of known weight to estimate when you have reached three pounds. When full, the balloon should be approximately the size of a large cantaloupe.

Prepare the instant oatmeal according to package directions. Let the oatmeal cool and place it in a clear, re-sealable plastic bag (or other container).

As an alternative to oatmeal, you may use softened butter or shortening.

SAFETY

Have students wash their hands after handling the oatmeal.

PROCEDURE

1. Engage students by reading the student storybook, *Making Sense!* Explain that they will be learning about the most important part of their body, the brain.

2. Ask students, *What do you know about the brain?* After discussion, make a list of students' ideas. You also might ask questions such as, *Where is your brain? Do you think it is very heavy? What would a brain feel like if you touched it? Is the brain smooth or wrinkled? Why?* Explain to students that even though scientists have learned much about the brain, there still are many unanswered questions.
3. Bring out the brain model (water-filled balloon) and have a student assistant hold it in his or her hands. Use the "Brain Facts" (right) to expand upon students' earlier comments, and discuss the following questions.
   - Did you know that the average adult human brain weighs about 1.45 kg? (3 lbs)? That is about the same weight as this balloon filled with water. (Allow students to feel the weight.)
   - Did you know that the brain is about the consistency of cooked oatmeal, butter, or shortening at room temperature? (Allow students to touch the oatmeal.)
   - So, is the brain strong or fragile? Heavy or light?
4. Ask, *Why do you think it is important to learn about the brain?* Help students understand that the brain is the control center of the body, responsible for thinking, feelings and movements. It must be protected and cared for.
5. Ask, *Where is your brain?* [Inside the head] Have students place their hands on top of their heads. Explain that there are many parts to the brain and they will be learning about three of the most important areas. Ask, *Did you know that each part of the brain has a special job to do?* The largest part of the brain is located directly under their hands. It called the cerebrum. Have students repeat the word. Explain that the cerebrum is the "thinking" part of the brain, responsible not only for thinking, but also learning, remembering, feeling sensations and emotions, and moving muscles on command.
6. Give each student a copy of "Brain Diagram 1." Direct students to place their fingers on the cerebrum area of the brain illustration. Next, have them color the area red.
7. Have students cut out the brain diagram and glue it into their individual science notebooks.
8. Give each student a copy of the "Children's Activities" page. Explain that they will match the picture of each activity to the area of the brain that controls that activity.
9. Instruct students to look at all of the images, and

Brain Facts

- The brain is the command center of the body.
- The brain contains about 100 billion neurons (main kind of cell in the nervous system). This number is comparable to the number of stars in the Milky Way galaxy.
- We each use 100% of our brains, not just 10%.
- An adult human brain is about the size of a cantaloupe and weighs about three pounds.
- The brain is about 80% water.
- Some people refer to the brain as "gray matter." If you look at the brain from the outside, it looks like a mass of grayish-pink wrinkles.
- The brain is divided into left and right halves, or hemispheres, connected by a wide, flat band of neural fibers called the corpus callosum.
- The two sides of the brain work together. It is a myth that a person can be "right-brained" or "left-brained." While certain functions tend to be concentrated on one side or the other, individuals don't have a "stronger" left or right brain network.
- The brain represents just 2% of the body's weight, but uses about 20% of the energy taken in as food.

select the activities they think are related to the thinking part of the brain (reading, writing, speaking, seeing and painting). Discuss students' choices, making certain that students understand that each brain part has specific functions. Have students color the bottom section of each "thinking" picture red.

10. Have students cut out all the pictures. They should glue or tape pictures with a red band near the cerebrum (also colored red) on their brain diagram.
11. Direct students place their hands on the lower back of the head (on the curved portion of the skull above the neck). Explain that the brain part in this location is called the cerebellum, which helps muscles work together to coordinate well-learned movements (like playing a musical instrument or mastering a complicated dance). It also controls the sense of balance and is responsible for storing automatic skills that we have learned, such as reciting the pledge of allegiance or repeating quick math facts. Have students locate the cerebellum on their brain diagrams and color it blue.
12. Have students choose pictures they think are related to the "learned movement" part of the brain (skating, swimming, dancing and walking). Discuss students' selections. Have them color the bottom bands of this new set of pictures blue, and then tape or glue the images near the blue cerebellum on their diagrams.
13. Point to the brainstem on the diagram. Make sure students understand that the brainstem is located at the back of the brain, below the cerebellum, and that it is connected to the spinal cord. Have students touch the backs of their necks to feel the spinal column (bony spine that protects the spinal cord).
14. Explain that the brainstem is in charge of our automatic functions. Ask, *What do you think "automatic functions" means?* Give student examples of body functions, things we don't normally have to think about, such as breathing, swallowing, beating of the heart, digestion, blinking, and our sense of feeling awake or sleepy. Have students locate the brainstem on their brain diagrams and color it yellow.
15. Direct students to examine the remaining pictures. Ask them to consider how the actions depicted relate to the part of the brain in charge of automatic functions (breathing, sneezing and coughing). Discuss students' ideas. Then have them color the band on each remaining image yellow, and glue or tape these pictures in place near the yellow brain stem.
16. If available, bring out the brain model for students to examine. Lead a discussion of what students know and have learned about the brain.
17. To review, have each student describe a brain function and, if appropriate, the part of the brain responsible.

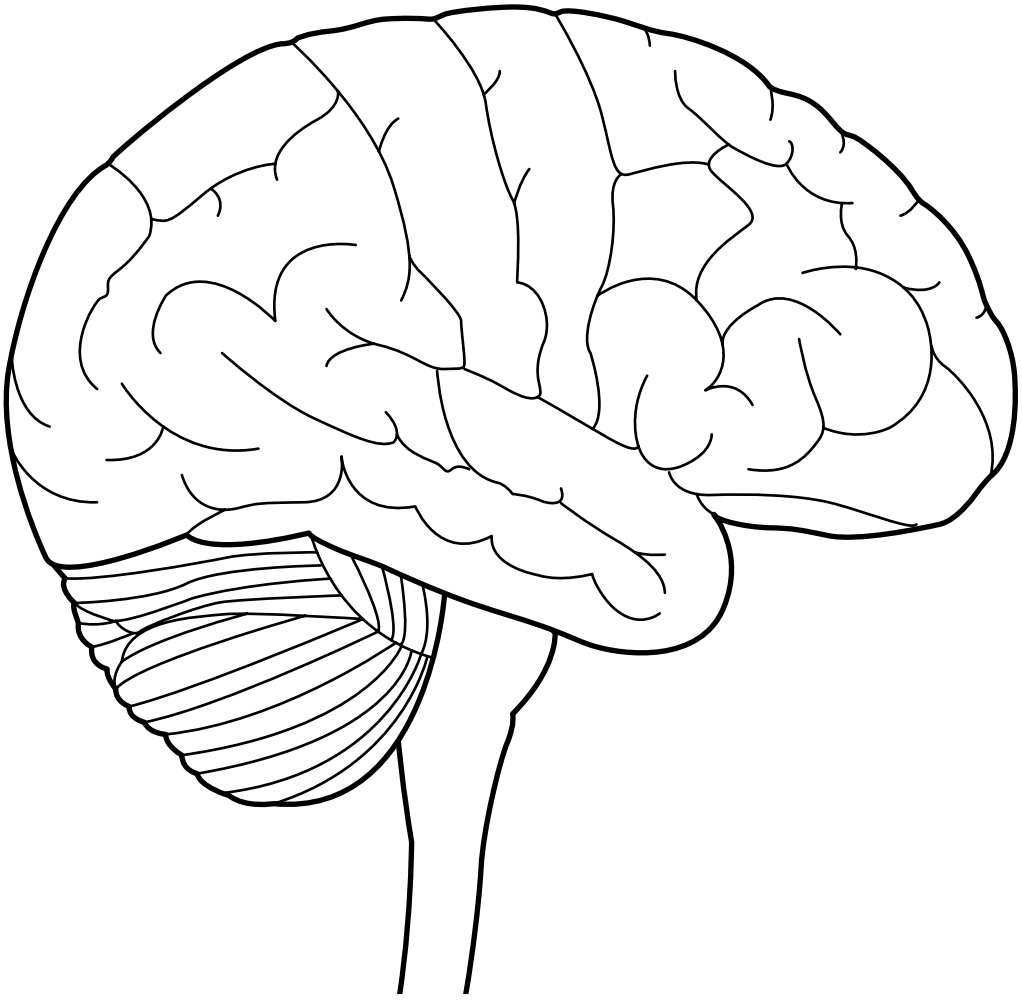
EXTENSION

The human brain weighs about three pounds. Ask students, *What other things weigh around three pounds and are about the same size as your brain or the water balloon brain? Why do you think that the water balloon brain is about the same size as a human brain?*

RECOMMENDED RESOURCE

- Guillain, Charlotte. *Our Brains (Our Bodies).* (2010) Heinemann Educational Books. ISBN: 978-1432936013

Brain Diagram 1



Children's Activities

Reading

Writing

Speaking

Walking

Dancing

Skating

Swimming

Breathing

Coughing

Sneezing

Painting

Seeing

Illustrations: Breathing, dancing, reading, seeing, sneezing, walking, writing © Images. Coughing © Lorelyn Medina. Painting © Jane Guozhova. Skating, swimming © Donggu Cho. Speaking © Stockshoppe.

The Brain: Protection

Guiding Questions

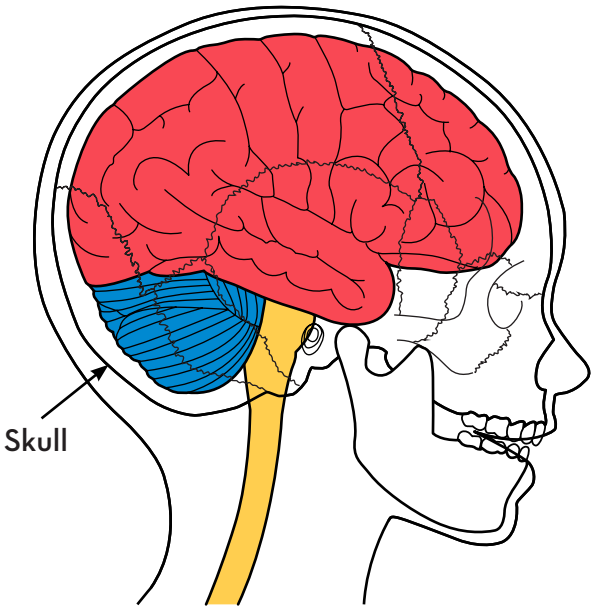
What protects the brain? Why does the brain need to be protected?

Concept

- *The skull protects the brain.*

Time

Setup: 5 minutes
Class: 1–2 sessions



The brain is 80% water, and it is fragile. It is enclosed within the skull dome, or cranium, a bony shell that protects the brain and forms the shape of the head.

Animal brains fit snugly inside their skulls, which have a size and shape to afford maximum protection. Animal brains are further protected by a cushion of fluid and a covering of three thin, tough membranes, called the meninges.

Still, our brains are vulnerable to injury. For safety, helmets should be worn when skateboarding, riding a bicycle or playing contact sports, such as hockey, baseball or football. Seat belts should be worn at all times when riding in a motor vehicle, to protect the brain from injury during a collision.

MATERIALS

Teacher (See Setup)

- 120-cm sheet of butcher paper or poster board to make a classroom human body diagram
- Copy of the student pages

Optional: Brain and skull model

Per Student

- Pair of scissors
- Science notebook
- Tape
- Copy of the three student pages (make sufficient numbers of handouts, based on the size of your class)

SETUP

Before class, create a life-sized outline of a child on butcher paper (use a student model or draw the outline free-hand). Be sure the head is turned to the right to match the illustration on "Brain Diagram 2." This will serve as a classroom human body diagram.

Display the diagram on a wall or bulletin board in the classroom. You will add information to it throughout the unit, as students learn more about the brain and senses.

This activity is teacher-directed and is best presented as whole-class instruction.

PROCEDURE

1. Ask students, *What protects the brain?* Discuss their answers. Then, have students place their hands on their heads and ask, *What do you feel?* Tell students that the hard surface is the skull, which is made of several bones.
2. Distribute a copy of "Brain Diagram 2" to each student. Instruct students to cut out the brain and glue it into their notebooks.
3. Distribute a copy of "Skull Diagram" to each student. Have students cut out the skull and arrange it over the brain in their notebooks.
4. Ask, *Does the skull fit over the brain?* After students have discovered the correct orientation for the skull, have them tape down the top of the skull over the brain. Discuss ways in which we protect our brains and skulls in everyday life. Examples include using helmets while riding bicycles and wearing seat belts while riding in a motor vehicle.
5. If available, display a brain/skull model. Show students how the brain sits inside the skull. Ask, *How is the model like a real brain and skull? How is it different?* Give students time to make their own observations.
6. Ask students, *What comes next, over the skull?* Give each student a copy of the "Head" page and ask the class where it might belong. Students will discover that it fits right over the skull. Next, have each student color the face to match his/her own features, as much as possible. Have them tape it into place.
7. Have students examine their final layer, the face and external features. Lead a class discussion of what they know about each sensory organ. Ask, *What do your eyes, ears, nose, mouth and skin tell you about the world?*
8. Refer to the life-sized student outline created earlier. Show students a copy of "Brain Diagram 2," and ask where on the outline it should be located. Cut out the brain and tape it appropriately inside the head on the drawing.
9. Explain that students will learn more about how each sensory organ communicates with the brain to help us understand what is happening around us.

Seat Belts and Child Safety

The Centers for Disease Control and Prevention report that motor vehicle crashes are a leading cause of death for children in the U.S. In fact, one-third of children who died in crashes in 2011 were not buckled up. Seat belts should be worn for every trip, even for short distances!

Source: CDC.

RECOMMENDED RESOURCES

- Chudler, Eric. "Neuroscience Coloring Book." Neuroscience For Kids. Washington University, Web. 13 Feb. 2015. https://faculty.washington.edu/chudler/experi.html
- Guillain, Charlotte. *Our Brains (Our Bodies).* (2010) Heinemann Educational Books. ISBN: 978-1432936013

Brain Diagram 2

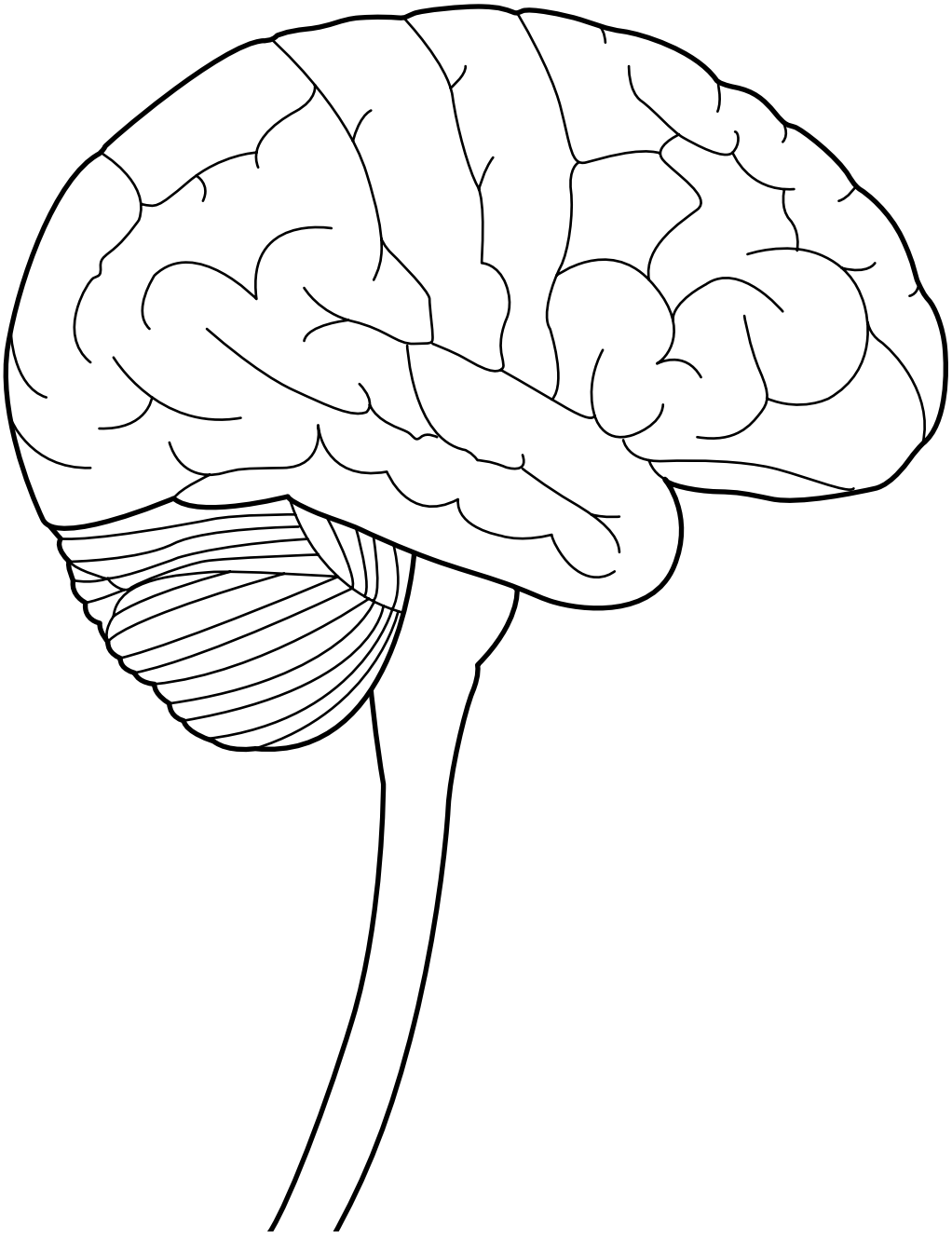
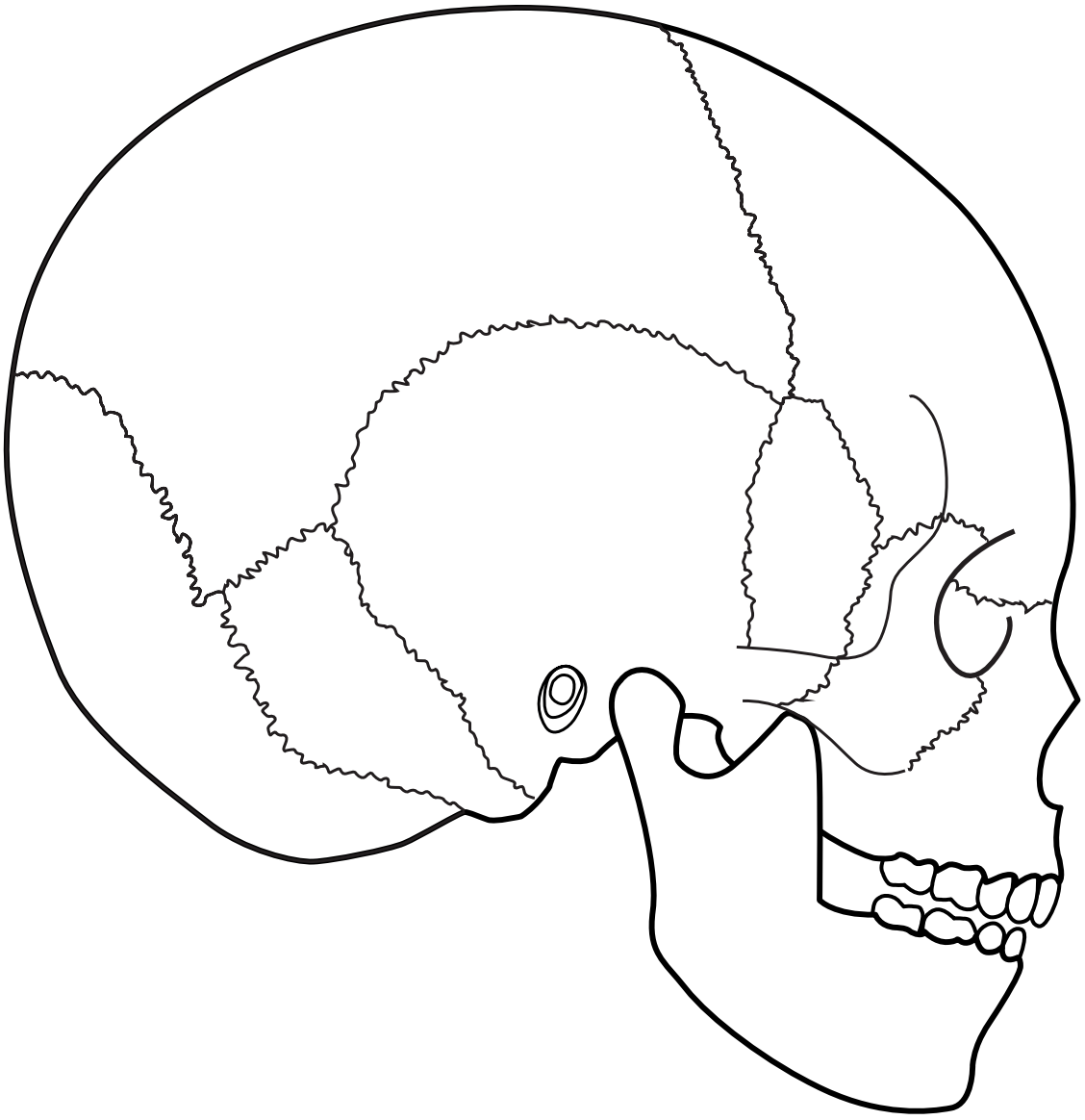


Illustration by M.S. Young © Baylor College of Medicine.

Skull Diagram



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The Head

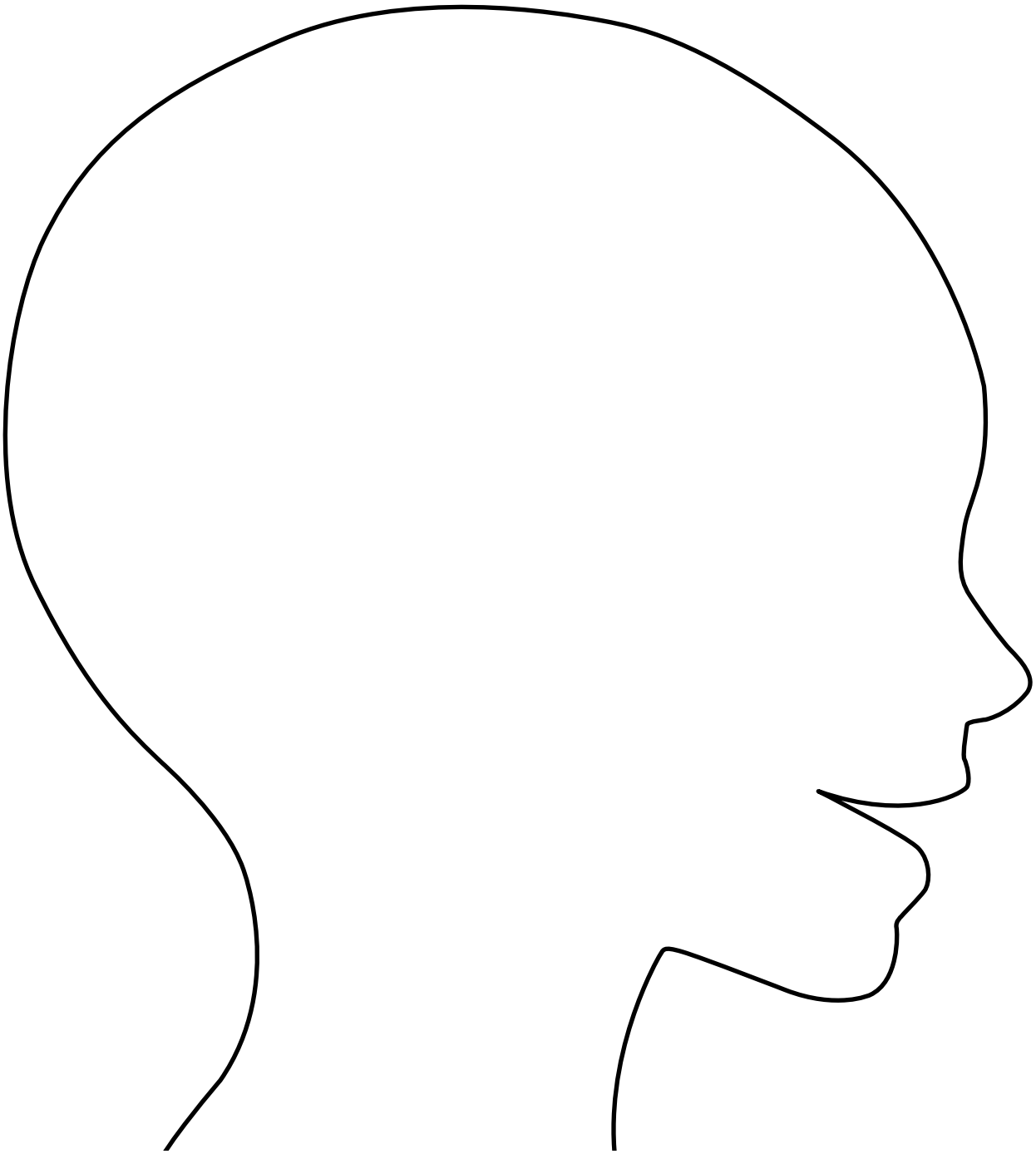


Illustration by M.S. Young © Baylor College of Medicine.

The Brain: Communication

Guiding Question

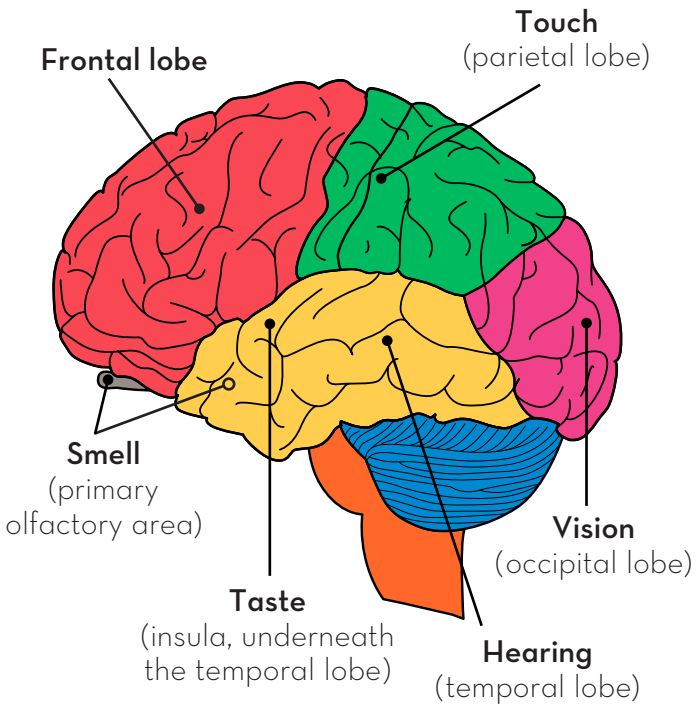
How does information from different parts of the body reach the brain?

Concepts

- *The brain and nervous system receive and act on information from inside and outside the body.*
- *The senses gather and process different kinds of information.*

Time

Setup: 5 minutes
Class: 45 minutes



Every organism must collect and process information about the surrounding world to find food, avoid danger and locate other individuals. Even single-celled organisms are able to detect and respond to changes in their environments, such as the availability of food, that affect survival. In animals, this ability is provided by the "senses" or the sensory system—which is part of the nervous system.

Young children tend to associate the senses, such as vision or hearing, with receptor organs, such as the eyes or ears. However, the ability to receive and interpret information from inside and outside the body actually is coordinated by the brain and rest of the nervous system.

We are able to perceive, or "sense," many different kinds of external and internal stimuli, such as light, sound, pressure, the position of our limbs, and even pain within our own bodies. Our eyes, ears, nose, skin and other sensory organs have specialized cells, called receptors, which respond to specific kinds of stimuli. For example, receptors in the nose respond to chemicals, which we

interpret as odors. Receptors in skin respond to pressure or temperature, and receptors in the eye detect light. These receptors translate information about the physical world and conditions inside the body into impulses that travel to the brain along nerve cells, also known as neurons.

Different parts of the brain are specialized to receive information from each of our senses. For example, a region of the cerebrum in the back of the brain is dedicated to processing information from the eyes. The diagram right) shows the primary processing area for each sense (vision, hearing, taste, smell, touch). It should be noted that all sensory information, except for the sense of smell, is routed through a central location deep inside the brain, known as the thalamus before being sent to the appropriate sensory area.

After being received and processed by a primary processing area, sensory signals are forwarded to other areas of the cerebrum for more complex integration. Eventually, all information gathered by the senses is combined. Input from several senses often enables us to understand a situation better than information from only one sense. Through this process, senses enable us to interpret and react to our environment; participate in the world; and learn, achieve, discover and communicate.

MATERIALS

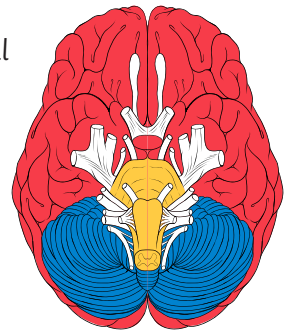
Teacher (See Setup)

- 120-cm length of yarn
- Ball of yarn (cut sections to model spinal cord and nerves on the body model)
- Classroom human body diagram (see Activity 2, "The Brain: Protection")

Per Student Team of Two

- 45-cm length of yarn
- 10-cm sections of yarn
- Brain cutout from the "Brain Template" page (pre-cut into individual pieces by teacher)
- Pair of scissors

The 12 pairs of cranial nerves (in white), as opposed to spinal nerves, emerge directly from the brain or brainstem. Cranial nerves exchange information between the brain and parts of the body, primarily to and from regions of the head and neck.



- Set of Body Puzzle pieces to make one body
- Sheet of construction paper
- Tape or glue

SETUP

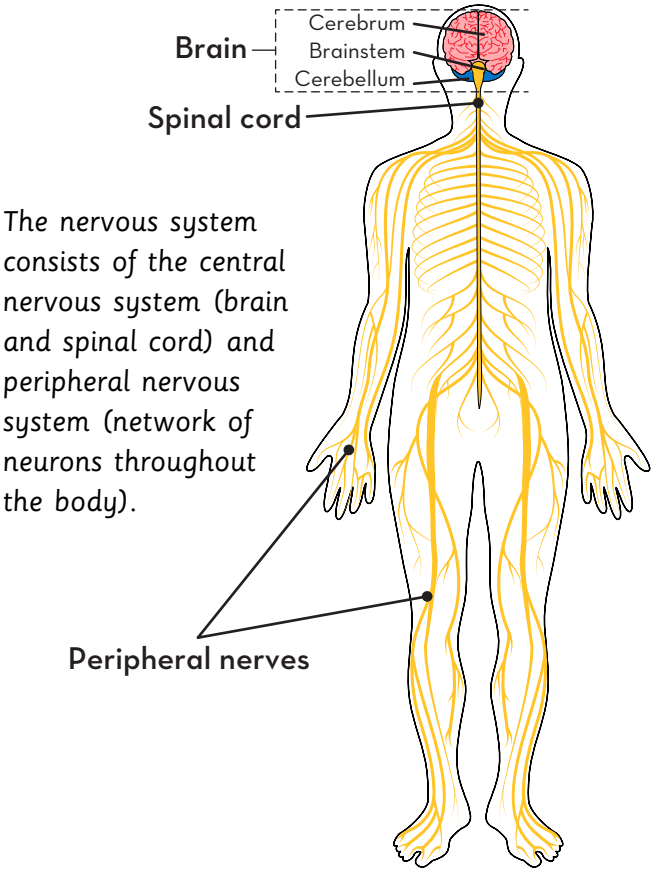
In advance, cut out one set of body parts ("Body Puzzle" page) and a brain illustration (see "Brain Template" page) for each pair of students, unless students are able to cut out the sections themselves during the lesson.

This activity is teacher-directed and best presented as whole-class instruction.

PROCEDURE

1. Refer to the life-size body outline displayed in the classroom, and have students point to the brain. Ask, *What other parts of the body do you know?*
2. Give each student a sheet of construction paper and a set of Body Puzzle parts (or give each student a copy of the "Body Puzzle" page and let students cut out the parts for themselves). Explain that each student will assemble a set of body parts. Students may work in pairs to place body parts in the correct locations on the construction paper.
3. Check students' work. When all students have built their models, give each student a brain cutout to place on his or her body puzzle (in the head).
4. Ask students, *Have you ever bumped your toe, cut yourself, or had a fall? Do you remember feeling*

The Central Nervous System



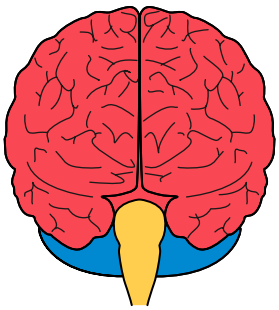
the pain? How do you think you received that information? Allow students time to respond. Clarify for them, *Your brain received the pain messages and told you! But how does it work?*

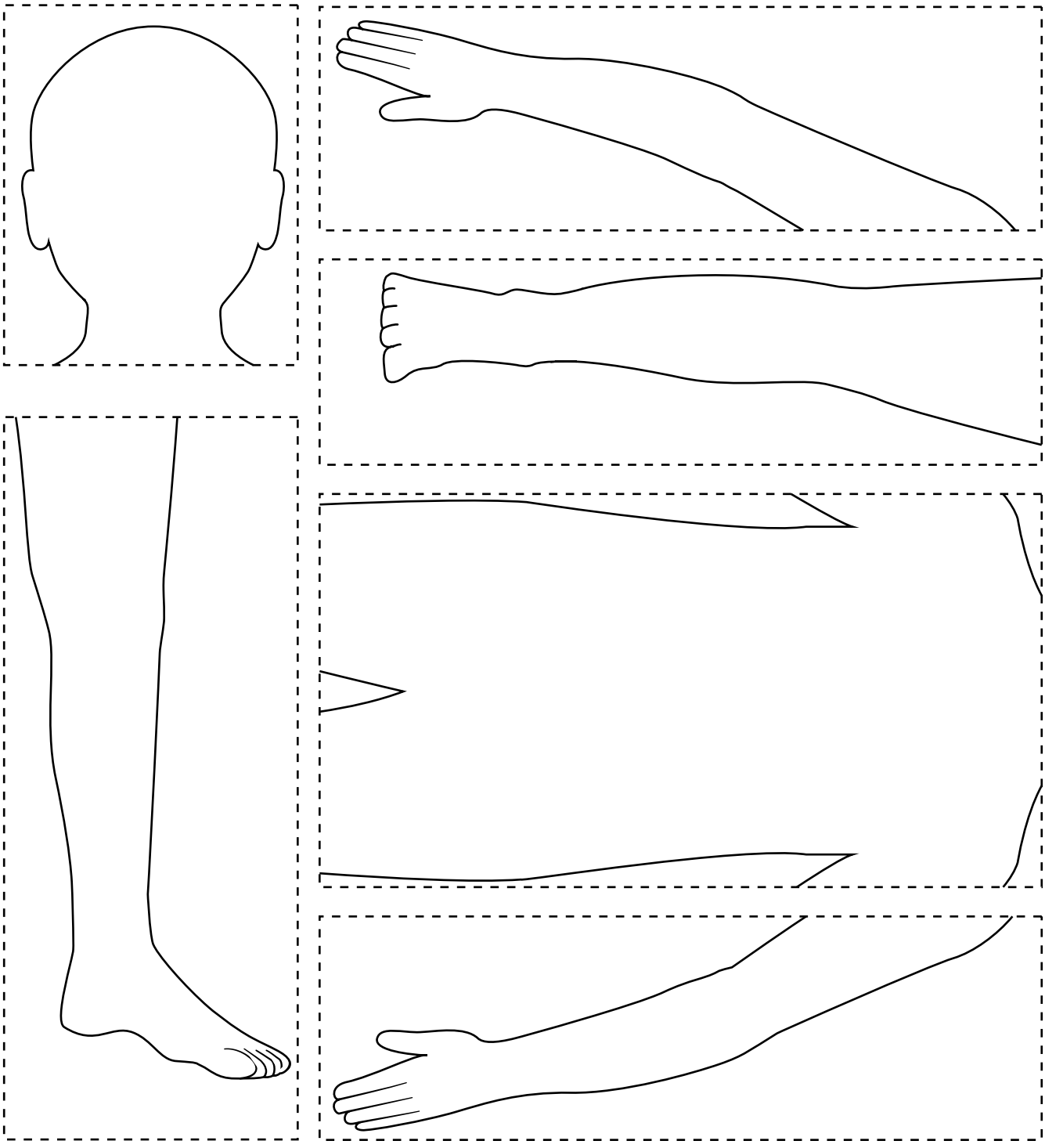
5. Explain that the person represented in the body outline on the board has just bumped his or her toe. Immediately, he or she feels the pain. Ask, *How does a person detect an injury so quickly?* Request a student volunteer. Give him or her a piece of yarn to connect the toe to the head of the body cutout.
6. Ask, *Do you think this is how it works? Can a signal travel through air from your toe to your brain? If not, what path might it follow?*
7. Entwine several strands of yarn and extend them from the base of the brain to below the waist. Ask students what the yarn might represent. Help them understand that nerve fibers connect all parts of the body and brain, and that the bundle of yarn represents the spinal cord. Explain that bones protect the spinal cord, just as the skull bones protect the brain. Have each student feel his or her own backbone (spinal column).
8. Extend another piece of yarn from the toe to the spinal cord, and on to the brain. Explain that nerves throughout the body send signals to the brain, and that those signals travel through the spinal cord. (Signals from the face and head are an exception; they connect through the brainstem to the brain.)
9. Have each student use several strands of yarn to create a spinal cord for his/her body puzzle, and then connect the spinal cord to the toe with an additional piece of yarn. In real life, nerves conduct signals in only one direction. So one set of connected neurons would send a pain signal to the brain, and different neurons would send messages back to muscles to move away from the source of pain.
10. Encourage students to create "nerve" connections from different parts of their puzzle bodies to the spinal cord, and from the spinal cord to the brain. The class may do this as a group by using the classroom human body diagram. Instruct students where to add connections, if you feel they need more guidance.
11. Explain that all of parts of the body, including sensory organs (eyes, ears, skin, etc.) are connected to the brain. Note that students will be learning how the different sensory receptors interact with the environment and send information to the brain.
12. If you wish to create "vertebrae" for the large classroom model, cups cut in half vertically or paper strips can serve as model for the backbone.

RECOMMENDED RESOURCE

- Olien, Rebecca. *The Nervous System (Human Body Systems).* (2006) Bridgestone Books. ISBN: 978-0736854122

Body Puzzle





Brain Template

Our Sense of Vision

Guiding Questions

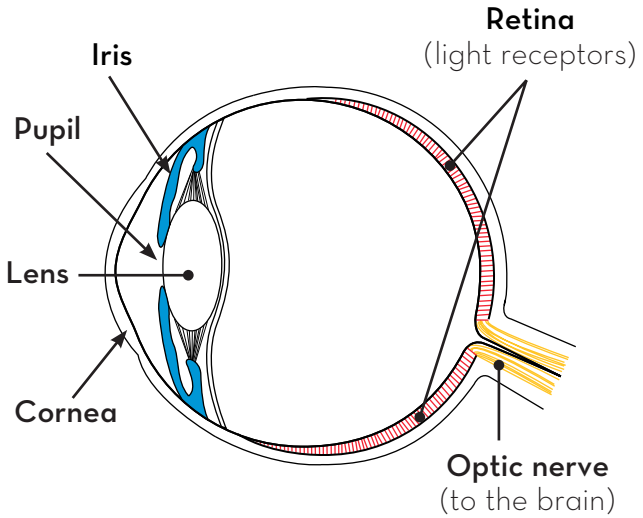
Which parts of the body are involved in vision (seeing)? Is light important for vision?

Concepts

- *All of the senses are connected to the brain.*
- *Our senses let us know what is going on inside and outside our bodies.*
- *The sense of vision (or sight) allows us to process information from light.*
- *Light is essential for vision.*
- *The brain processes information from the eyes, which are "light detectors."*

Time

Setup: *15 minutes*
Class: *2 sessions of 30 minutes*



Much of our understanding of the environment is made possible by our sense of vision. We are able to "see" because our eyes and brain transform signals produced by light energy into perceptions of movement, color and form. The capacity to recognize a face, identify an object under different light conditions, or interpret the components of a landscape is a product of complex processes that occur in numerous areas of the cerebrum (thinking part of the brain). Even our most sophisticated computers and software cannot duplicate the strategies used by the brain to enable our sense of vision.

We understand many aspects of how the visual system works. First, light enters the eye through the cornea, the transparent outer layer. The cornea bends (refracts) light rays that pass through the pupil (round hole in the center of the eye), and the iris (colored area that surrounds the pupil), opens and closes to regulate the amount of light that enters. After passing through the pupil, light is focused by the lens onto the retina, where it activates

special light-sensitive cells, known as rods and cones. These cells convert light energy into electrical signals that travel along the optic nerve to the visual centers of the brain.

The primary visual cortex, where signals are first processed, is located at the back of the head. However, at least 20 additional areas of the cerebral cortex are devoted to processing visual information. Cells in different areas of the visual cortex respond to different characteristics of objects (for example, motion, form and color). This information is assembled along parallel routes, not yet fully understood, to form a three-dimensional mental perception of what is being viewed.

MATERIALS

Teacher (See Setup)

- 8 sheets of silver foil paper (shiny, reflective foil with paper backing, available from art supply stores. One 8.5-in. x 11-in. sheet will provide enough material for three kaleidoscopes.)
- 1-2 sheets of black construction paper
- Apple, orange or other brightly colored object
- Classroom human body diagram (see Activity 2, "The Brain: Protection")
- Flashlight
- Kaleidoscope template (see illustration below)
- Metric ruler
- Pair of scissors

Optional: Hole punch

Per Student

- 17-cm x 9-cm piece of silver foil paper
- 3-in. x 5-in. white card
- Clear tape
- Colored markers and/or crayons
- Small mirror
- Science notebook

SETUP

Using a copy of the template below, cut out enough kaleidoscopes for all students. Prepare each kaleidoscope for folding by scoring the fold lines (dotted lines) with a ballpoint pen and straight edge. This will facilitate

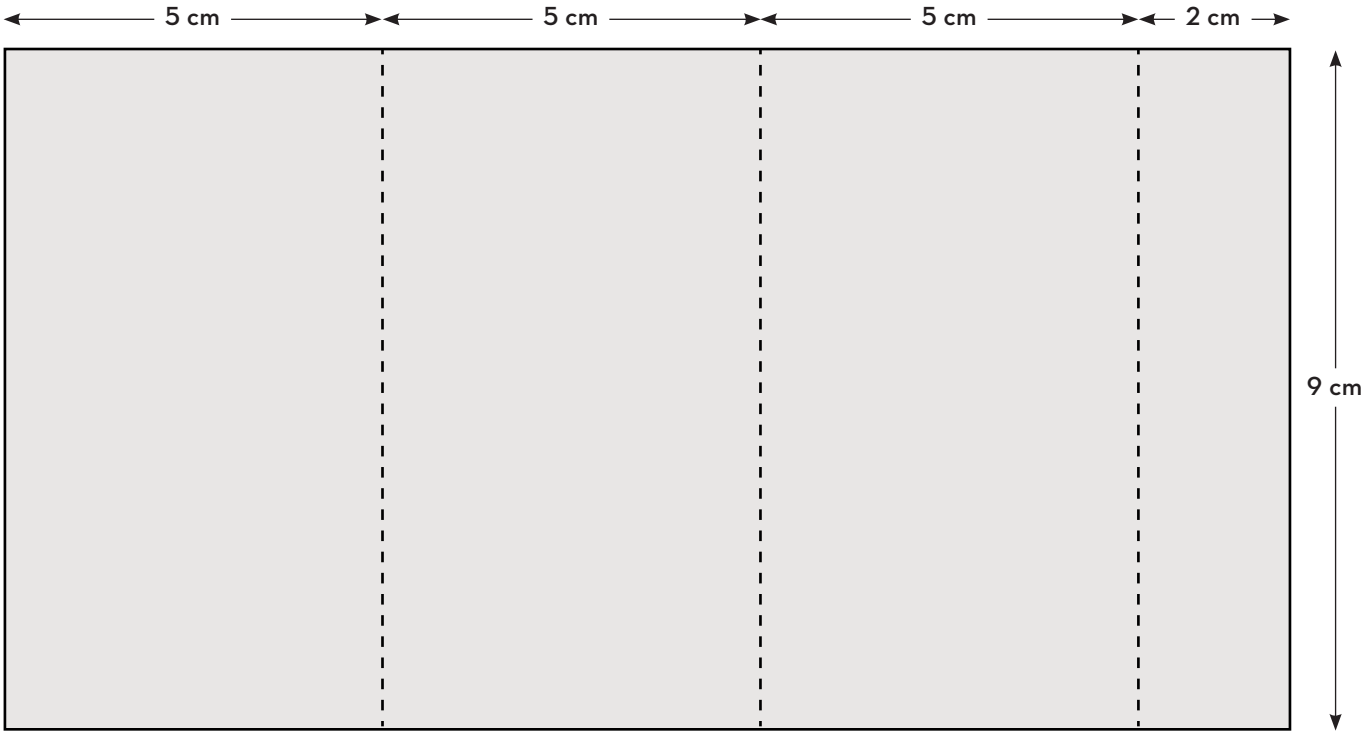


Illustration by M.S. Young © Baylor College of Medicine.

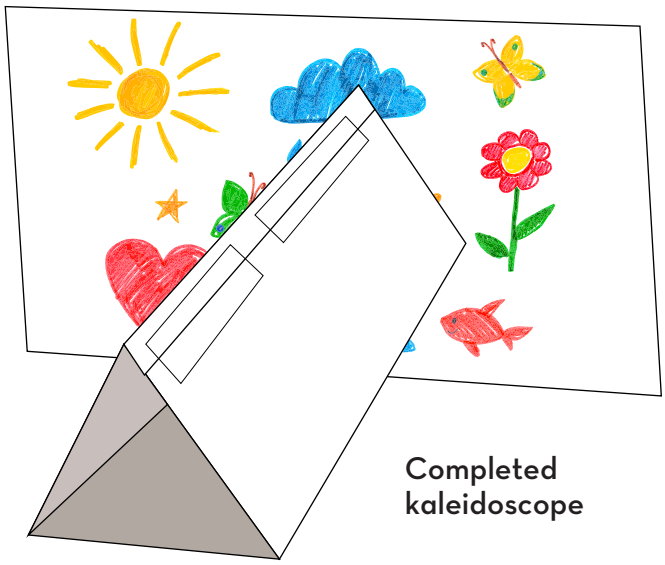
accurate folding. If students are not capable, fold the kaleidoscopes in advance, but let students refold and tape them together during the lesson.

Make a small hole in the sheet of construction paper (see Part 2, item 7).

PROCEDURE

Part 1

1. Have students sit in a circle. Place an apple, orange or other colorful item in the center of the circle. Ask students to share observations about the item. Make sure they mention the color. Ask, *how do you know the color of the object and how are you able to describe so many details?* Students should mention "vision," "eyes" or "seeing" as being essential for describing the object.
2. Have all students close their eyes. Turn the lights off and darken the room as much as possible. Tell students to open their eyes and observe the object once again. Ask, *Does it look the same? If not, how is it different?* Students should notice that with limited light, the color is not as bright. Depending on the level of darkness attainable, the object may even be barely visible. Explain to students that light is necessary for vision ("seeing"), and the object's appearance has changed because less light is available.
3. Explain that they are going to make kaleidoscopes, which will enable them to see new combinations of shapes and colors. Give each student a cut out template for the kaleidoscope. Demonstrate how to make the folds, and help students tape the flap over the top edge.
4. Instruct students to use their kaleidoscopes to explore the classroom. Ask, *What is happening?* Hopefully they will notice that they are seeing reflections of objects in the room on the inside panels of the kaleidoscopes. This may be a good time to talk about the word, "reflection."
5. Ask, *What happens when you place your hand over the opening? Can you still see the reflections? Why or why not?* Students should notice that they need light to be able to see.



Completed kaleidoscope

6. Distribute the 3-in. x 5-in. cards. Instruct students to create colorful art on one side of the card. Have them position their kaleidoscopes over the decorated cards. Prompt students to look through the open end. Ask, *What do you see? What is happening?* [No light]
7. Next, have students hold the decorated cards to the end of their kaleidoscopes. Ask them to lift the kaleidoscopes up and look through the open end. Light should filter through the card, making colorful patterns on the inside panels.
8. Lead students to understand that eyes are light detectors that take in the light reflected from every surface. When students cover one end of the kaleidoscope with their hands (or the desk), light is blocked, and they cannot see.
9. Have students tape the decorated cards into their notebooks.

Part 2

1. Have students work in pairs. Direct students first to observe their own eyes with a mirror, and draw and label what they observe in their science notebooks.
2. Have students observe their partner's eye and then discuss ways in which their eyes are similar and different. Students should consider variables such as color, shape, size, etc.

.3. Ask, *Do all eyes have the same parts?* Use either a diagram of the eye or draw a picture on the board. Point to the different parts of an eye and ask students which parts they were able to see. [Students will be able to observe the iris and pupil, and will notice their eyelids and eyelashes, which protect the eyes. It is not necessary or important for students to know the names for the parts, just to know that they exist.]
4. Tell students they are going to look at their eyes again and identify the iris and pupil. Explain that the circular colored part (membrane) is the iris. It regulates the amount of light entering the eye by adjusting the size of the pupil. The black circle in the center of the eye is the pupil. It contracts (gets smaller) when exposed to strong light or focusing on a near object, and dilates (enlarges) when in the dark or focusing on a distant object. Explain that light enters the eye through the pupil, similar to the way light entered the kaleidoscope through the end of the paper tube.
5. Have students use the mirror to observe the size of their pupils with the lights on. Then, turn off the lights for a few minutes. Explain that students should be ready to observe the size of their pupils again, as soon as the lights are turned back on. Make sure everyone's mirror is ready, and then turn on the lights. Ask, *What happened to your pupil?* Students should notice that their pupils became larger while the lights were out.
6. Explain that the iris and pupil work together to allow light into the eye. When the room was darker, their pupils opened wider so their eyes would receive more light.
7. Remind students that light is essential for vision. Reinforce this idea with a flashlight and the sheet of construction paper. Turn off the room lights again. Cover the flashlight beam with the prepared sheet of black construction paper. Have students observe how much light gets through the small hole in the paper to illuminate a white surface. Enlarge the hole in the paper and again have students observe how much reaches the white surface. Ask, *Do you notice a difference? Why do you think this happened?* (The larger hole, like a wider pupil, allows additional light to pass through.)
8. Ask, *How do you think information about the objects you see travels from your eyes to your brain?* Have one student use a piece of yarn to connect the eye and brain on the class body cutout. Encourage students to recall how signals travel through the spinal cord, all the way to the brain. Similarly, information gathered in the eyes travels to the brain via optic nerves. (Specifically, the retina sends nerve impulses along the optic nerve to areas in the brain.)
9. Ask, *Do you think it takes a long time for information to travel from your eyes to the brain? Why or why not?* Help students understand that information travels rapidly in the nervous system.
10. Have students write one or more sentences in their science notebooks about vision.

Did You Know?

- When you blink, you shut your eyes for 0.3 seconds. That's a total of 30 minutes each day!
- More than half of all people in the U.S. use some type of lens to correct their vision.
- People sometimes have red eyes in photographs because light reflects off of the retina.
- Blinking helps lubricate your eyes. Remember to blink when reading a book or working on a computer.
- Smoking increases the risk of some eye diseases such as age-related macular degeneration and cataracts.
- Color blind means that you have trouble telling the difference between certain colors.
- Ninety percent of eye injuries could be prevented by using protective eyewear.

RECOMMENDED RESOURCE

- Rissman, Rebecca. *Seeing (The Five Senses).* (2010) Heinemann. ISBN: 978-1432936853

Source: See All You Can See Eye Fun Fact Calendar. National Eye Institute, National Institutes of Health. https://nei.nih.gov/kids/

Our Sense of Hearing

Guiding Questions

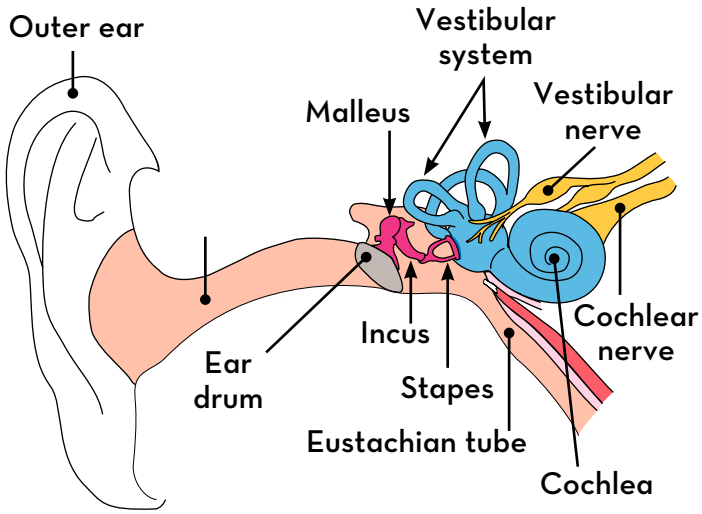
What causes sound? How do our ears detect sound? How do our brains recognize sound?

Concepts

- *All of the senses are connected to the brain.*
- *Our senses let us know what is going on inside and outside our bodies.*
- *The sense of hearing allows us to detect sounds.*
- *Sound is produced by vibration.*
- *Objects vibrate when they move back and forth in a regular fashion.*
- *Information about sound is collected by sensory receptors in the ears and transmitted to the brain.*

Time

Setup: 5 minutes
Class: 2 to 3 sessions of 45 minutes each



Sound is produced when an object vibrates in air (or another medium, such as water) and produces alternating bands of high and low pressure, known as sound waves (or compression waves). Sound waves possess very low levels of energy, but our ears and brain are able to detect the frequency and loudness of many sounds, and to locate sound sources.

Listening to loud music through ear buds can lead to hearing loss. To protect hearing, avoid listening at high volume levels (above 85 decibels) or for long periods of time.

The human ear is designed to collect sound waves and detect minute changes in air pressure outside the body. The outer ear consists of the ear flap and a short passageway, known as the auditory canal. The eardrum, or tympanic membrane, is located at the inner end of the auditory canal. It bulges inward or outward in response to pressure changes caused by sound waves. The three tiny, interconnected bones of the middle ear (malleus, incus, stapes) amplify this movement.

Another membrane separates the middle ear from the inner ear, a complicated labyrinth of interconnected fluid-filled chambers and canals called the vestibular system. The upper group of canals is critical to our sense of balance. The lower canal, known as the cochlea, is coiled like a snail shell and filled with fluid. It converts

pressure waves into impulses that are sent along sensory neurons to the auditory centers in the brain. A special part of the cerebrum receives and interprets information about sound.

Humans and many other species have specialized organs to produce sounds, such as those in speech or songs, which are important for communication. Most mammals, reptiles and amphibians have a larynx, or voice box, in their necks. The larynx contains the vocal cords, which produce sound as air is expelled from the lungs. The tongue, lips and mouth also have important roles in configuring the sounds produced.

MATERIALS

Teacher (See Setup)

- 20-cm piece of string
- Aluminum pie pan
- Classroom human body diagram (see the activity, "The Brain: Protection")
- Large rubber band
- Pair of scissors
- Ping pong ball
- Set of images of "sound settings" (locations where a variety of sounds might be expected, such as a zoo, farm, band performance, stormy weather, etc.)
- Tape
- Tuning fork
- LCD projector and computer or whiteboard
- "Ear Diagram" page in PDF format (to project)
- Web Metronome's online metronome (see Setup)
- "What Sound Is It?" slide set (http://www.bioedonline.org/lessons-and-more/teacher-guides/k-1-the-senses/

Per Student

- 2 paper cups
- Mirror
- Pair of scissors
- Copy of both "What Sound Is It?" pages

SETUP

Collect pictures of settings where different sounds can be heard (zoo, farm, band performance, stormy weather, freeway, etc.). Gather enough images for groups of 2–4 students to share.

Make copies of the "What Sound Is It?" pages.

Part 1. Tape a 20-centimeter long piece of string to the ping pong ball.

Fill the pie pan halfway with water.

Prior to class, access the online metronome on the Web Metronome page (http://www.webmetronome.com), and adjust the volume so that a faint sound can be heard.

Part 2. Load a PDF of the "Ear Diagram" page for projecting.

Part 3. Load the slide set "What Sound Is It?" which contains audio files. Adjust the sound level for students to hear.

How Loud Is Too Loud?

The sound is too loud when any of the following occur.

- *You have to raise your voice to be understood by someone standing nearby.*
- *The noise hurts your ears.*
- *You develop a buzzing or ringing sound in your ears, even temporarily.*
- *You don't hear as well as you normally do until several hours after you get away from the noise.*

If you are around noises at this level, take protective action.

- *Turn down the sound.*
- *Avoid the noise (walk away).*
- *Block the noise (wear earplugs or earmuffs).*

Source: It's a Noisy Planet. National Institute on Deafness and Other Communication Disorders, National Institutes of Health. http://www.noisyplanet.nidcd.nih.gov/info/Pages/howloud.aspx

PROCEDURE

Part 1

1. Discretely start the online metronome. The volume should be just loud enough for students to hear the ticking sound.
2. Instruct students to sit quietly in a circle around you and tell them to listen carefully for sounds. After a minute or so, have students share their observations. Ask, *What sounds did you hear? Did you notice any sound that you don't normally hear? What do you think is causing the sound?* After discussion, reveal

the source of the sound and turn it off. Explain that students will be investigating their sense of hearing.

3. Ask, *How are sounds created?* Allow students to share ideas. Hold up a large rubber band and stretch it between your hands. Select a student to come up and pluck the rubber band. Have students listen carefully, and ask if they can hear a sound. It may be slight, but they should be able to hear the rubber band. Ask, *What did you observe when the rubber band made the sound?* (It moved back and forth.) Tell students this rapid back-and-forth motion is called vibration. Ask if they can think of any other place where they have seen vibration. Discuss their ideas.
4. Hold up the tuning fork. Ask if anyone knows what the object is and/or what it does. Direct students to be very quiet and listen. Make the tuning fork vibrate by holding the handle lightly and striking one of the tines or prongs on the sole of your shoe, or (softly) on a harder-edged surface. Be careful not to strike too hard, as the tuning fork could break.
5. Ask, *What did you hear? Was the sound loud or soft?* Strike the tuning fork again and move around the room so that all the students have a chance to hear the sound and observe the tuning fork up close.
6. Ask, *Can you see the tuning fork vibrating?* [It is usually not possible to observe the vibration.] Next, ask students to observe what happens when you strike the tuning fork and then dangle the ping pong ball next to it. Ask, *What happened?* (The ping pong ball will bounce back and forth when it touches the side of the vibrating tuning fork.)
7. For another demonstration, use an aluminum pie pan half-filled with water. As students look on, strike the tuning fork and immediately place the tip into the water. Ask, *What is happening?* Students will observe that the water "jumps" when it is contacted by the vibrating tuning fork.
8. Tell students that they can experience sound caused by vibration in their own bodies. Instruct them to hum softly while placing two fingers on the front of their throats. Ask, *Are you making sound? What is moving?* Explain that when they hum, talk or sing, or make any sound, air moves inside their throats and across the vocal cords, causing them to move back and forth. Make sure students understand that all sound is caused by vibration.
9. Tell students that a vibrating object pushes the material (air, water, etc.) that surrounds it. If an object vibrates in air, for example, the air is pushed outward in waves, like the movement they observed with the ping pong ball, or water in the pan. Have students draw and label the tuning fork and ball using wiggly lines to indicate vibration.

Typical Sounds in Decibels (dB)

160	Perforated eardrums possible: Rocket launches
150	Firecrackers
140	Jet engine takeoff
130	Immediate pain: Jackhammers
120	Immediate discomfort: Emergency sirens
110	Music concerts, sporting events
100	iPod/MP3 player with earbuds at full volume
90	OSHA required protection: Power tools, mowers
80	Busy traffic, school cafeteria
70	Vacuum cleaners, hair dryers
60	Normal conversation
50	Average home in the city, quiet office
40	Refrigerators
30	Whispers
20	Rustling leaves
10	Breathing
0	Threshold of human hearing (1,000 Hz)

Part 2

1. Ask, *Which sense enables you detect sounds?* [Hearing] Follow by asking, What part of your body enables you to hear? Ask students to point to their hearing detectors. [Ears] Remind students that they have been learning about how all of our senses are all connected to. . . what? Hopefully, they will reply, "The brain!"
2. Give each student a mirror with which to carefully observe his or her own ears. Students should then draw their ears in their notebooks. Or, have students observe and draw the ear of a partner.
3. Ask, *Are your ears like those of other animals?* Discuss. For instance, ask, *What do rabbit ears look*

Source: It's a Noisy Planet. National Institute on Deafness and Other Communication Disorders, National Institutes of Health. http://www.noisyplanet.nidcd.nih.gov/info/Pages/howloud.aspx

like? How do they compare to yours? Why do you think the ears of different animals are shaped differently, and are larger or smaller? Explain that ears are "sound catchers" that funnel sound into the ear canal.

4. Tell students that they observed the outer ear, which captures sound from vibrating objects. Follow by explaining there are many more parts inside our ears that help us to hear. Show students the "Ear Diagram." Point out the various parts without emphasizing the names of the parts. Note that sound travels through the ear to receptors that gather and send information about sounds to the brain.
5. Lead a simple investigation in which students test "outer ears" made from paper cups. Have students cut off the bottoms of the cups and place the cups over and around their ears. Then, they can investigate how "pointing" the cup toward a sound impacts their ability to hear it.
6. Using yarn and tape, connect one pair of cups to the brain on the classroom human body diagram. The yarn represents the nerve cells that collect information and deliver it to the brain.
7. Review the following concept with students: the ear receives sound and transmits information to the brain, which makes sense of what is heard. Our brain allows us to recognize and remember sounds, and determine the direction from which a sound is coming.

Part 3

1. Ask students to cheer (all say "yeah" together). Then ask, *Where have you heard cheering before?* Allow students to share answers with the class. Examples could include a ball game, spelling bee, musical event or pep rally.
2. Give each student a copy of both "What Sound Is It?" pages. Tell students that you will be playing some sounds, but instruct them not to shout out answers about what they hear. Instead, students should circle the picture that best represents each sound. Play sounds from the "What Sound Is It?" slide set. After the students have listened to all the sounds, lead a class discussion in which they share their answers. Review the correct answers with the class. (Answers: 1. Ice cream truck. 2. Duck, 3. Beach. 4. Fire truck. 5. Recess. 6. Baby).
3. To extend the lesson, show a picture of a zoo. Ask students to think about sounds they have heard at the zoo, and then share those sounds with the class.
4. Group the class into teams of four students, and provide a different "sound setting" image (collected during setup) to each group. Each image should depict a scene or location where many different sounds can be heard. Explain to students that they will create sounds to accompany their pictures. Allow time for them to brainstorm and practice their sounds.
5. Have each group share its sounds with the class, without identifying their setting. After each presentation, ask the other groups to guess where the sounds might be heard. After several attempts, have the presenting group show its image to the rest of the class.
6. Close by reminding students that all or their senses are controlled by the brain.
7. Have students write one or two sentences about what they learned about sound from this activity.

EXTENSION

Create a simple instrument to observe vibration and sound production. String three large rubber bands around a tissue box. Pluck the rubber bands near the hole of the box. Have students observe what happens. Then, ask, *Are the rubber bands moving back and forth? What is this motion called? Is this vibration producing a sound?*

RECOMMENDED RESOURCE

- Rissman, Rebecca. *Hearing (The Five Senses).* (2010) Heinemann. ISBN: 978-1432936860

What Sound Is It?

Name _____

Circle your answer.

1. What made this sound?

Ambulance

Fire Truck

Ice Cream Truck

2. What made this sound?

Duck

Pigeon

Parrot

3. What made this sound?

Pond

Beach

Waterfall

What Sound Is It?

Name _____

Circle your answer.

4. What made this sound?

Garbage Truck

Fire Truck

Helicopter

5. What made this sound?

Recess

Art

Music

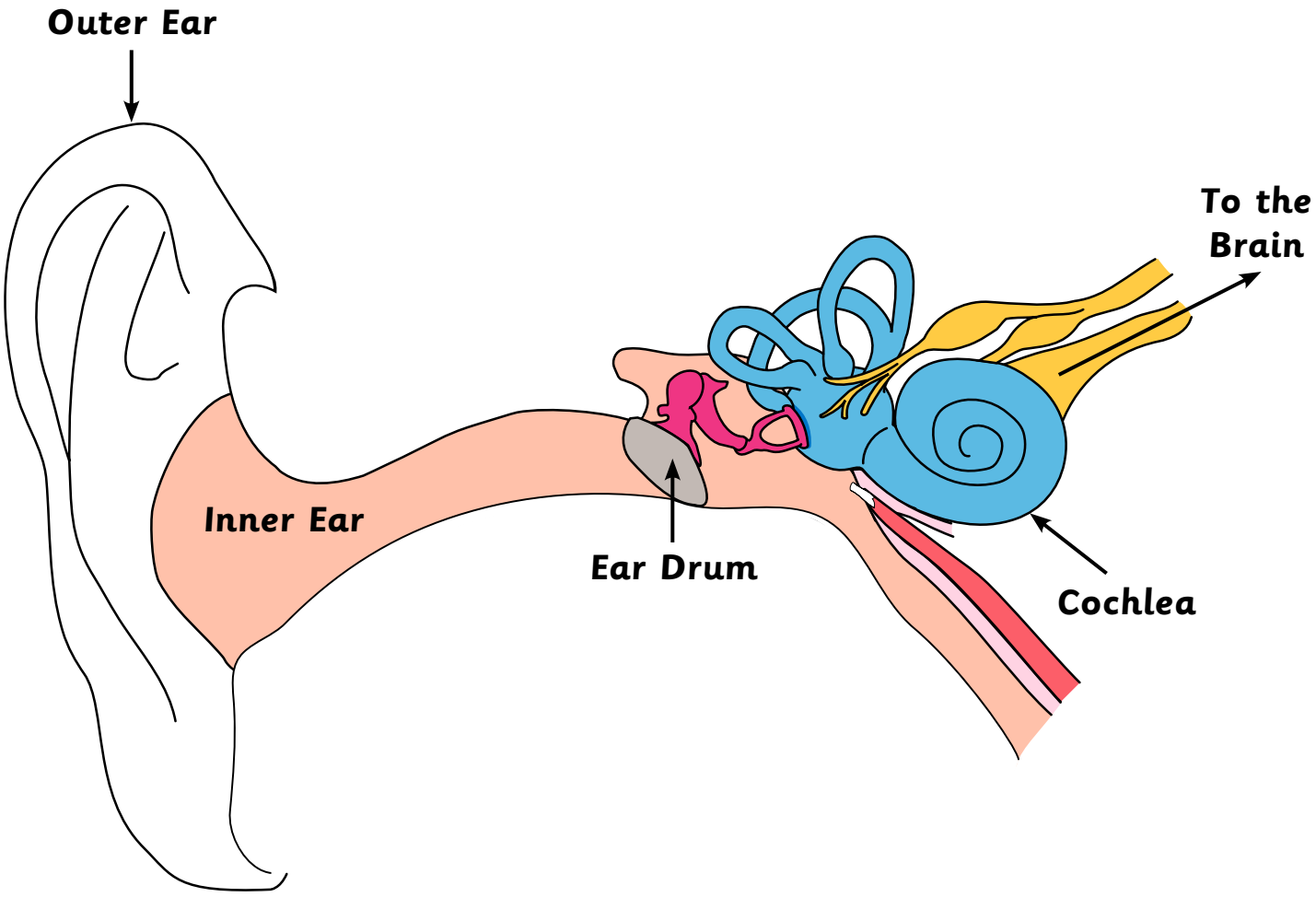
6. What made this sound?

Kitten

Puppy

Baby

Ear Diagram



Our Sense of Taste

Guiding Questions

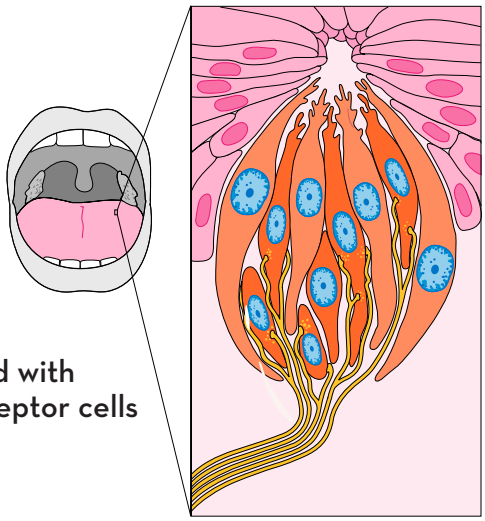
What are the basic tastes? Where is information about taste detected in the body?

Concepts

- *All of the senses are connected to the brain.*
- *Our senses let us know what is going on inside and outside our bodies.*
- *One of our senses is taste.*
- *The tongue is covered with taste buds, which contains taste receptors.*
- *Taste receptors communicate with the brain, which determines the flavors we experience.*
- *Taste buds detect sweet, sour, salty, bitter and umami (savory) tastes.*

Time

Setup: *10 minutes*
Class: *30 minutes each for Part 1 and Part 2*



Taste bud with taste receptor cells

Why does chocolate ice cream taste delicious and sour milk taste awful? Scientists believe that taste evolved to help identify potentially nutritious foods and avoid eating things that are harmful.

Taste begins in our mouths, with the chemical receptors that dot our tongues. The tongue's surface is coated with thousands of small bumps, called papillae. Each papilla holds approximately 10,000 taste buds, which renew themselves about every 10 days, unless they are damaged by infection or smoking. Each taste bud contains 50–150 taste receptor cells.

When you eat, saliva dissolves certain chemicals from the food. The chemicals enter openings in your taste buds and interact with taste receptor cells. The receptor cells send signals to the brain, where they are combined with information from the sense of smell to create what you experience as flavor.

We generally recognize four tastes: sweet, sour, salty and bitter. A fifth taste, umami (savory) occurs when we eat foods with glutamate (like MSG). Bacon,

mushrooms and fermented foods, such as cheese and soy sauce, are rich in umami. Beyond allowing us to taste, the tongue can sense pressure, temperature and pain. That's why we are able to experience certain foods as spicy or minty, and distinguish among different food textures. The sense of smell also contributes to the flavors we experience. Odor qualities, such as floral, fruit, burnt or putrid, shape our food-related sensory experiences.

Some people, called "supertasters," have more taste buds than average and are highly sensitive to certain tastes. One's genes can make him or her more sensitive to certain tastes, as well. And over time, many people experience a change in taste sensitivities. That's why adults sometimes become more tolerant of—and even enjoy— foods, such as broccoli or Brussels spouts, that they avoided as children.

Many older textbooks feature a "map" of the tongue with different regions specialized for particular tastes, such as sweet or sour. This interpretation of the distribution of taste receptors is inaccurate. In fact, receptors for all tastes are distributed throughout the tongue, and even are present in other areas of the mouth.

MATERIALS

PART 1

Teacher (See Setup)

- 16-oz bottle of lemon juice
- 1/4 cup of sugar
- 1/4 cup of salt
- Classroom human body diagram (see Activity 2, "The Brain: Protection")
- Marker
- Water

Per Student

- 4 crayons or markers
- Set of labeled portion cups containing 1/8 tsp of the following substances: salt in cup 1, sugar in cup 2, water in cup 3, and lemon juice in cup 4.
- 2 cotton swabs (Q-tips® style)

- Plastic spoon
- Plain paper or foam plate
- Small hand mirror
- Science notebook

PART 2

Teacher (See Setup)

- 16-oz bottle of lemon juice

Per Student

- 6 plastic spoons
- 4 plastic cups half-filled with water
- 1/2 cup of sugar
- 1/4 cup of lemon juice
- Tray

SETUP

Part 1

Prepare a set of four portion cups, labeled 1, 2, 3 and 4. Place 1/8 teaspoon of each of the following substances into the cups: salt in cup 1, sugar in cup 2, water in cup 3, and lemon juice in cup 4. Place each set of cups, along with two cotton swabs, on a plate for each student.

Part 2

Prepare a half-full cup of water for each student. Place the cups of water, 1/2 cup of sugar, 1/4 cup of lemon juice and six spoons on a tray for each group.

Have students work in groups of four, with their own sets of materials for Part 1, and with shared materials for Part 2.

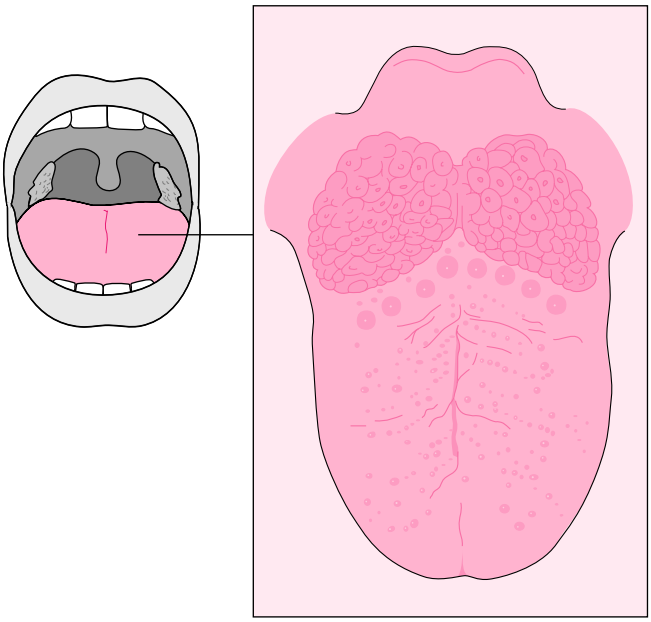
SAFETY

Have students wash their hands before and after the activity. Instruct students not to share cotton swabs.

PROCEDURE

Part 1

1. Ask students to think about their favorite flavors. Conduct a short class discussion about the foods they mention. Students will probably share foods that are sweet, salty, and sour; but they may describe complex combinations of flavors. Explain that you will create a class "taste" chart. Draw a table on the board and list "Sweet," "Sour" and "Salty" across the top. Note that the tongue can detect two additional tastes: bitter and umami (savory). Bitter is more common, and can be detected easily, so add a "bitter" column to the table. Then, have students assign the favorite foods they mentioned, or other examples, by adding words or drawings to each category of the class chart.
2. Ask, *Where is your flavor detector?* Hopefully students will point to the tongue. Ask, *Did you know your tongue is connected to the brain?* Discuss how the brain receives and manages "taste" information (receptors in the tongue detect different chemicals and communicate with the brain; the brain interprets the messages as flavors).
3. Ask, *Have you ever really looked at your tongue?* Give each student a mirror with which to exam his/her tongue. Ask, *Do you notice little bumps on your tongue?* Explain that these bumps contain taste buds, which detect the flavors of anything we place in our mouths. Write the number 10,000 on the board, and tell students that there are at least 10,000 taste buds on a typical person's tongue!



4. Have each student draw and color his/her life-sized tongue in his/her notebook.
5. Tell students that they will be conducting an investigation using their sense of taste. Emphasize that scientists normally do not taste materials, but that, in this case, tasting is necessary and completely safe.
6. Give each student a disposable plate (paper or foam) and a set of small portion cups that are pre-numbered (1 through 4) that contain the mystery substances. Tell students that they should test only the substances on their own plates and should not share with any other student.
7. Give every student one cotton swab. Demonstrate how to dip the tip of a swab into a container and touch your tongue with the sample. Instruct students to test container 1. Ask, *How did the substance taste?*
8. Instruct students to use the other end of the swab to test container 2. Ask, *How did this substance taste?* Encourage students to pair-share their observations.

9. Give each student a second swab and have them test containers 3 and 4, using one end for each sample. Again have them share the taste with their partners.
10. Ask students, *How were you able to identify the contents of each container? What was the taste of the sample in container one? How about number two, etc.? Which part of the body allowed you to recognize the different tastes?* [The brain]
11. Remind students that taste buds in the bumps on our tongues collect information about the flavors of food, and then send that information to the brain. Add a piece of yarn to connect the tongue to the brain on the classroom human body diagram.

What Is Flavor?

Flavor is the sensory impression of a food or other substance, and is mainly determined by the senses of taste and smell working together.

Part 2

1. Give each student a plastic spoon and a clean, clear plastic cup half full of water. Tell the class that they will experiment with their senses of taste.
2. Ask, *What does lemon juice taste like without sugar?* [Sour] *Why do people add sugar to lemon juice?* [To make it taste sweet] *Do you like things very sweet or only slightly sweet?* Give students time to respond. Then, direct each student to put one spoonful of lemon juice and one spoonful of sugar into his or her cup and stir gently. Be sure students understand that they should use only one spoon for each container.
3. Prompt students to take a small sip. Ask, *Was your lemonade sweet enough? Does the lemonade still taste sour? What other things have* you tasted that were sweet and sour?
4. Instruct students to add another spoonful of sugar to their cups, stir gently and taste again. Ask, *Did you like the lemonade more or less after adding the second spoonful of sugar?* Explain that preferences (likes and dislikes) are shaped by information in the brain, and differ from one person to the next. Also mention that preferences can change over time.
5. Have students write a sentence in their notebooks about what they have learned.

EXTENSIONS

- If students have questions about the taste, "bitter," allow them to sample small pieces of unsweetened (bitter) dark chocolate.
- Have students identify foods or drinks that have a combination of tastes. [For example, sweet and sour sauce, sweet and salty candy, or bittersweet chocolate.] Conduct a tasting session with some of these items.
- Take a class survey of favorite foods and record the answers on a chart. Determine which tastes are most and least popular. Make a class graph of the numbers of students who select each taste.
- Explore the connection between taste and smell by having students conduct a taste test of lemonade while pinching their noses.

RECOMMENDED RESOURCES

- Cole, Joann. *The Magic School Bus Explores the Senses.* (2001) Scholastic, Inc., ISBN: 978-0590446983
- Cuda-Kroen, Gretchen. "Baby's Palette And Food Memories Shaped Before Birth." NPR. Web. 02 Feb 2015. http://www.npr.org/2011/08/08/139033757/babys-palate-and-food-memories-shaped-before-birth
- Rissman, Rebecca. *Tasting (The Five Senses).* (2010) Heinemann Educational Books. ISBN: 978-1432936891

Our Sense of Smell

Guiding Question

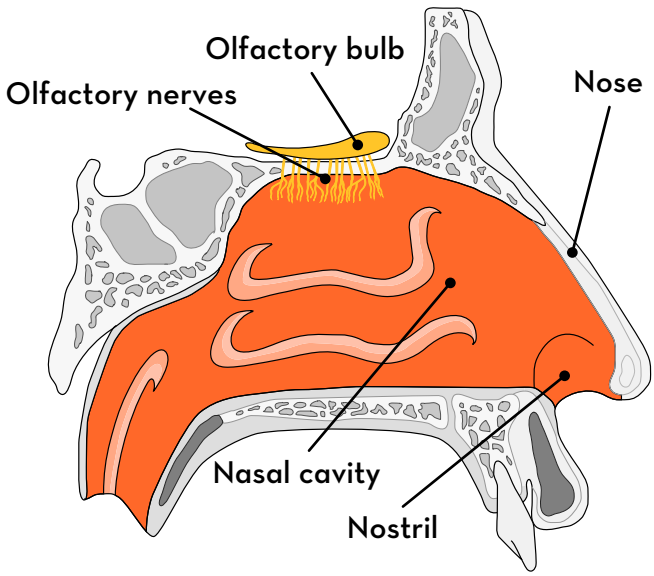
How does our sense of smell work?

Concepts

- *All of the senses are connected to the brain.*
- *Our senses let us know what is going on inside and outside our bodies.*
- *One of our senses is smell (olfaction).*
- *Our noses detect, or smell, very small particles in air.*
- *Information is sent from the nose to the brain, which helps us to experience, remember and recognize smells.*

Time

Setup: *10 minutes*
Class: *30 minutes each for Part 1 and Part 2*



Much like taste, the sense of smell allows us to detect chemicals in the environment. In fact, smell and taste often work together to gather information about our surroundings. Flavor is a perception that is based on input from taste, smell and even touch.

With the sense of smell, molecules carried through the air and into the nose land on the moist lining (olfactory epithelium) of the nasal passages and bind to olfactory neurons in the lining. The binding process triggers these neurons to send messages directly to the olfactory bulbs in the brain, and on to the olfactory cortex. Information about odors being detected also is sent to the thinking portion of the brain.

The olfactory system enables humans to distinguish among thousands of odors, all of which are classified into six major groups: floral, fruity, spicy, resin, burnt and putrid.

The sense of smell is closely related to memory and emotions. Have you ever smelled something that evoked a childhood memory, a location or an experience? Scientists believe these associations are due to the close proximity of the olfactory cortex to the amygdala and hippocampus. The amygdala is responsible for emotional memory and the hippocampus plays an important role in consolidation of information from short-term memory to long-term memory and spatial navigation.

MATERIALS

Part 1

Per Class

- Classroom human body diagram (see Activity 2, "The Brain: Protection")

Per Student Group

- 4 re-sealable plastic bags, each containing a different flavor of dry powdered soft drink mix (Kool-Aid® brand preferred: grape, lemonade, orange and cherry; use approximately one envelope per bag)

Per Student

- Small hand mirror
- Science notebook

Part 2

Per Student Group

- 16 cotton swabs (Q-tips® style)
- 7 small paper cups
- 4 plastic spoons
- 4 re-sealable plastic bags with dry powdered soft drink mix used in Part 1
- Set of orange, purple, red and yellow crayons (to match powdered soft drink mix colors)

Per Student

- Copy of "Let's Get Fruity!" page on cardstock

SETUP

Organize the class into groups of four students. Each group will need four re-sealable plastic bags, each containing a different flavor of soft drink mix (grape, lemonade, orange and cherry work). Each bag should contain the contents of one envelope of soft drink.

Make copies of the "Let's Get Fruity" page on cardstock.

Fill six paper cups halfway with water.

SAFETY

Have students wash their hands before and after the activity.

PROCEDURE

Part 1

1. Ask students to locate their noses by pointing with their fingers. Ask, *What does your nose enable you to do?* Discuss all ideas.

2. Give each student a mirror and ask him or her to closely examine his/her nose. Point out that our noses have two openings, called nostrils, which allow air to enter the nasal passages. Emphasize that the nose is critical for breathing. Have students inhale and exhale slowly to become aware of how air enters and leaves the nose. Show a diagram of the inside of the nose, or draw one for the class.
3. Ask students if they have ever really looked at his/her nose. Give each student a mirror to closely examine their the nose. Have students draw their noses in their notebooks, and label the outer parts.
4. Give each group of students a set of four flavors of soft drink mix powder in small re-sealable plastic bags. Let each student hold one bag, but instruct students not to open the bags. Ask them to predict what the powder in their bags might smell like, and discuss their predictions with their groups. Ask, *On what did you base your predictions?*
5. Next, instruct students to smell their bags, but not open them. Students should not be able to smell the contents.
6. Ask, *Were you able to check your predictions with the bag closed? Why do you think you can't smell the powders in the bags?* Invite students to share their ideas.
7. Tell students they will try to smell the powders again,

Photo © Maria Dryfhout.

with the bags open. Show students how to carefully open a bag, keeping the powder in the bottom. To demonstrate how to properly smell an unknown substance, gently wave your hand and-forth over the open bag. This is called wafting.

8. Let each student open his/her bag, and waft the scent to his/her nose to identify it. Have students pass their bags around their groups, so that each student can smell all of the substances.
9. Ask, *Can you identify the scents? Have you smelled anything similar before?* If they haven't identified the scents, inform students that they smelled orange-, cherry-, grape- and lemon-flavored soft drink mixes.
10. Tell students that all scents are made of small particles/chemicals that mix with, and float in the air. When these particles enter our nasal passages, they are detected by neurons in the nose, which send a message to the brain. Our brains then help us to recognize, remember and identify scents.
11. Review with students that the scents they smelled are collected inside the nose, and are identified via messages sent to the brain. Have a student add a piece of yarn from the nose to the brain on the classroom human body diagram.
12. If you are not conducting Part 2 immediately, have students reseal the bags to keep the contents fresh for later use.

Part 2

1. Tell students that they will use the powdered soft drink mix to create artwork that smells delicious. Give each group 4 small paper cups, a cup half-filled with water and 4 spoons. Instruct each student to carefully add one spoonful of water to one bag of drink mix. Students should then seal the bags and gently shake them, so that the powder dissolves into the water. They now will have created "Smelly Paint."
2. Instruct students to carefully pour their "paint" into a small paper cup. Alternately, you may pour the "paint" for students.
3. Give each student 4 cotton swabs ("paintbrushes"). Remind students to use each cotton swab with only one color.
4. Hand out copies of the "Let's Get Fruity" page. Direct students to pick a crayon that matches one fruit on the page, and outline the fruit with that crayon. Tell students that they will paint the fruits with the corresponding scented paints. For more fragrant pictures, encourage students to paint two layers on each picture.
5. Allow the paper to dry. Then, demonstrate how to activate the smell, by gently scratching the dry paint.
6. Ask, *What parts of the body enable you to smell?* Have students refer to the body diagram, if needed. They should understand that nerve connections between the nose and the brain are necessary for the sense of smell.
7. Have students write one sentence in their notebooks about what they have learned about smell.

EXTENSIONS

- If students have questions about the taste, "bitter," allow them to sample small pieces of unsweetened (bitter) dark chocolate.
- Have students identify foods or drinks that have a combination of tastes. [For example, sweet and sour sauce, sweet and salty candy, or bittersweet chocolate.] Conduct a tasting session with some of these items.
- Take a class survey of favorite foods and record the answers on a chart. Determine which tastes are most and least popular. Make a class graph of the numbers of students who select each taste.
- Explore the connection between taste and smell by having students conduct a taste test of lemonade while pinching their noses.

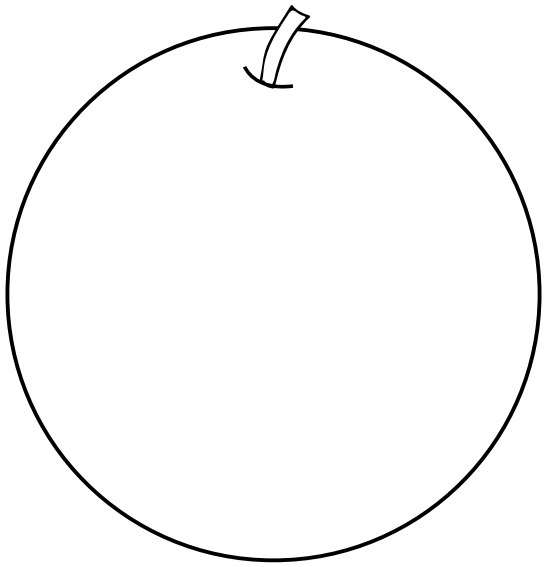
RECOMMENDED RESOURCE

- Rissman, Rebecca. *Smelling (The Five Senses).* (2010) Heinemann Educational Books. ISBN: 978-1432936877

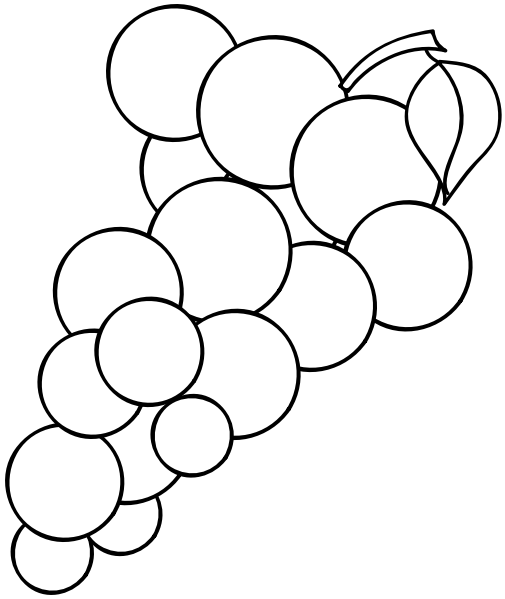
Let's Get Fruity!

Name _____

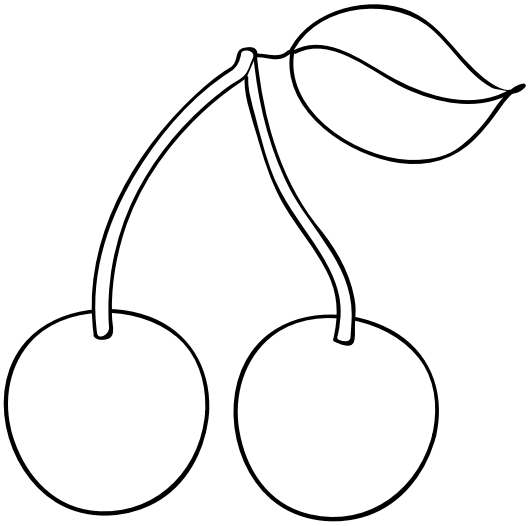
Orange



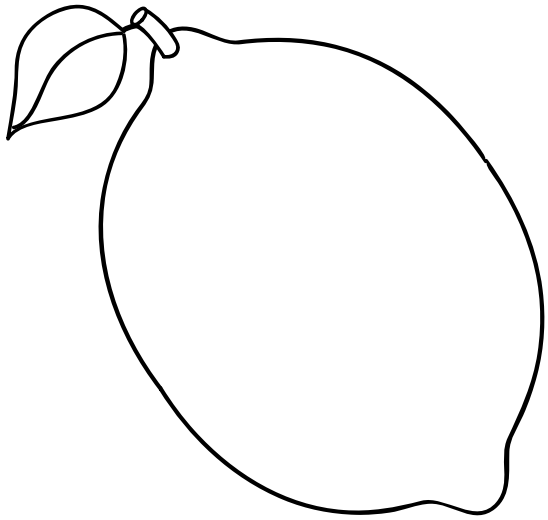
Grape



Cherry



Lemon



Illustrations modified by M.S. Young © Iryna Novytsky.

Our Sense of Touch

Guiding Questions

How does the sense of touch work? Is the sense of touch more sensitive in some parts of the body, such as fingertips, than in others?

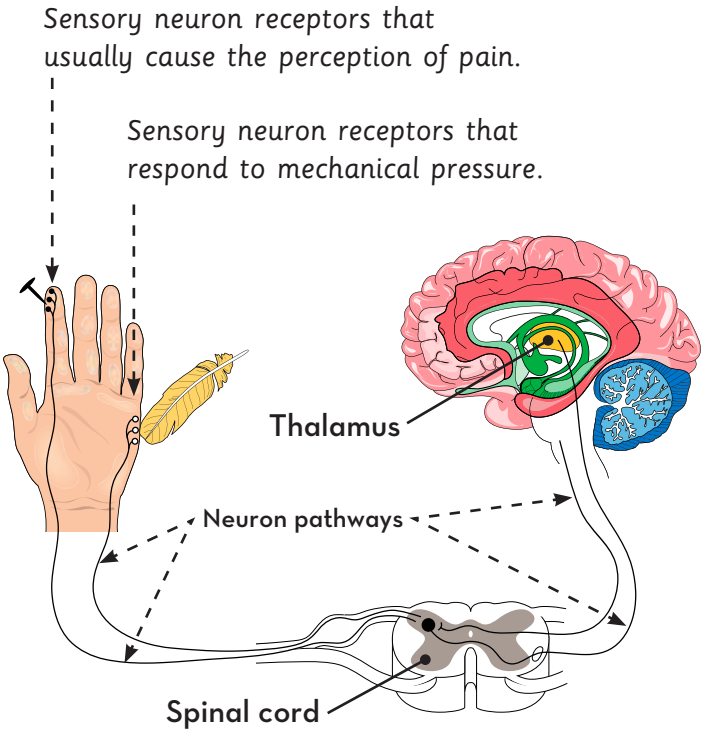
Concepts

- *All of the senses are connected to the brain.*
- *Our senses let us know what is going on inside and outside our bodies.*
- *One of our senses is touch.*
- *The sense of touch varies on different parts of the body.*
- *Touch receptors on the skin send information to the brain.*
- *The brain is able to discriminate among many tactile objects.*
- *The sense of touch actually includes several distinct senses, such as pressure, temperature and pain.*

Time

Setup: 10 minutes
Class: 30 minutes

Touch commonly is referred to as a single sense. However, the ability to distinguish between the brush of a feather and the pain of a pinprick involves many different kinds of receptors in skin.



The tactile sense, traditionally called "touch," encompasses a large group of more or less separate somatic senses ("somatic" refers to features of the body). The sensations of touch, pressure, vibration, temperature and pain all are detected in the skin and deeper tissues. The sense of proprioception uses signals from joints and muscles to provide information about the position of the body and limbs.

Illustration modified by M.S. Young © Peter Lamb.

Receptors, or "sensors," respond to different kinds of stimuli. For example, pressure receptors at the base of each hair detect minute movements that correspond to contact, or being touched. Other specialized receptors register temperature. Pain is detected by free nerve endings.

Receptors for different sensations are not distributed equally. In any given area, there usually are more pain receptors than pressure or temperature receptors. In addition, some areas of the body have more sensory receptors of a particular kind than other areas have. For example, there are more pressure-sensitive receptors on the tip of the tongue and on the fingertips than anywhere else in the body.

In this activity, students will compare the relative sensitivity of skin on two different parts of their bodies (upper arm and fingertips). By trying to feel the difference between two similar objects with slightly different textures, students discover that the skin is more sensitive in areas that have greater numbers of touch receptors, and less sensitive in areas with fewer receptors.

MATERIALS

Teacher Materials

- Classroom human body diagram (see the activity, "The Brain: Protection")
- 12 brown paper lunch bags
- 12 sets of two similar materials that can be discriminated by touch (at least 1-in. square in size). Suggested items are as follow.
  - Aluminum foil and wax paper
  - Coin and button (similar sizes)
  - Coin and washer
  - Construction paper and glossy paper from a magazine
  - Cotton and wool cloth
  - Cotton ball and synthetic fur
  - Different grits of sandpaper
  - Fine and coarse sandpaper
  - Smooth and rough cardboard
  - Smooth and rough fabric
  - Smooth and rough pebbles
  - Copy paper and paper towel
  - String and yarn
  - Wire and rubber band
- Teddy bear

Per Student

- Cotton ball

SETUP

Prior to class, make two sets of 6 pairs of similar objects in numbered (1–6) brown paper lunch bags. See materials list for suggested items. You will need one bag per student team.

Conduct this activity with students working in teams of two.

PROCEDURE

1. Give each student a cotton ball to examine closely. Ask, *What does it feel like? Does it feel like a teddy bear? How do you know?* Let students touch a teddy bear or other stuffed animal to compare the textures.
2. Ask, *What are your fingers telling you?* Have students describe the texture of the cotton ball. If they are unfamiliar with the term, "texture," explain that it usually refers to how something feels when touched. Ask the class to think of words that

describe textures (such as smooth, rough, firm, soft, bumpy, prickly, gritty, etc.). You may want to place the words on a chart or word wall.

3. Remind students that they have learned about vision, hearing, taste and smell. Each sense involves receptors that gather information from the environment, which then is transmitted to the brain.
4. Ask, *Where are your touch receptors?* Most students will say, "the fingers." Ask, *Can you feel with your elbow?* Have students rub the cotton ball over their elbows. Ask, *Does it feel the same on your elbow as on your fingers?* Make sure students draw the conclusion that all skin has touch receptors.
5. Have students sit in pairs. Give one of the bags you have prepared to each pair.
6. Instruct one student (the "subject") in each pair to close his or her eyes. Have the other student (the "tester") remove the two items from the bag and gently rub one item at a time on the subject's forearm or upper arm. Have each tester ask the subject, *Can you tell any difference in the two items? Do you know what they are?*
7. Have the same student (tester) gently rub the same two items on the subject's fingertips and ask if the subject can tell a difference between the items, and/or identify either item.
8. Rotate the sample bags among pairs of students, making sure that teams have a different numbered bag for each investigation. Have the students in each pair trade jobs and repeat steps 6 and 7, as time allows.
9. Ask the class, *Were you able to feel the difference between each pair of items with both your arm or finger? What was the difference in how the items felt on your arm and fingers? Why do you think this is the case?* Explain that the entire body has nerve endings that "feel," but that some areas have more sensory receptors than other areas do. Areas with more sensory receptors are more sensitive.
10. Follow by asking, *What else can our skin tell us, besides shape, size and texture? Have you ever been too hot, too cold or in pain?* Explain that certain sensory receptors in the skin communicate other conditions directly to the brain to keep us safe.
11. Conclude the lesson by having a several students use pieces of yarn to connect different places on the skin to the brain on the classroom human body diagram.

EXTENSIONS

- Fill three small containers: one with warm water, one with cold water and one with room temperature water. Have students explore their abilities to detect temperature by placing one finger in the warm water, and one finger in the cold water for a few seconds. The skin does not perceive exact temperatures, but will sense temperature differences. Next, have students place both fingers in the room temperature water. Ask, *Is the water warm or cold?* Explain that the brain just received confusing messages from the senses in their fingers. To a warm finger, the water will seem cold, while to a cold finger, the same water will feel warm.
- Place several common objects of different sizes and shapes inside a container of warm water. Have students identify the objects using only their sense of touch. Ask, *Could you also detect the water temperature at the same time?* Students will learn that they can sense temperature and size/texture simultaneously.

RECOMMENDED RESOURCE

- Rissman, Rebecca. *Touching (The Five Senses).* (2010) Heinemann Educational Books. ISBN: 978-1432936884

Using All the Senses to Understand Our World

Guiding Questions

How do we use our senses to understand our surroundings? What types of input are provided by the different senses?

Concepts

- *Senses work together to provide information about conditions inside and outside of the body.*
- *Sensory information is communicated to the brain, which interprets the signals detected by sense organs.*

Time

Setup: 15 minutes
Class: 30 minutes

Like all other forms of life, we humans must interact with our surroundings to obtain water and nutrients, protect ourselves from danger and reproduce. Our senses allow us to obtain the information we need for survival. Senses also work within our bodies to provide cues about the state of our internal organs and positions of our muscles and limbs.

Simple one-celled organisms, such as the amoeba, detect light, acidity, temperature and other characteristics of their environment over much of their external surfaces. More complex animals have evolved special cells, called receptors, which respond to specific aspects of the environment. Receptors translate information about the physical world and conditions inside the body into impulses that travel along nerve cells, or neurons. Most receptors are specialized to respond best to a particular kind of stimulus. For example, the simple nerve endings in the skin respond to pressure or temperature, while rods and cones, receptors in the back of the eye, react only to the presence of different kinds of light.

Specific regions within the brain receive and integrate information detected by sensory receptors. Through this process, we are able to interpret and react to the environment. Senses enable us to participate in the world—to learn, to achieve, to discover, to communicate. In this culminating activity, students use as many senses as possible to figure out what is inside "mystery" bags.

MATERIALS

Teacher Materials (see Setup)

- 12 brown paper lunch bags
- 6 cups of plain, unsalted popcorn, popped and cooled
- 6 cups of plain, salted popcorn, popped and warmed (or freshly popped)
- Classroom human body diagram (see Activity 2, "The Brain: Protection")
- Measuring cup
- Tape or stapler

Optional: Project "The Five Senses" page when reviewing the primary senses (item 7)

Per Student

- Hand lens
- Science notebook

SETUP

This activity will lead students to think about the basic scientific questions, "What do you think is happening?" and "How do you know?" Students will use as many senses as possible to figure out the contents of "mystery" bags" (two prepared bags per group of four students).

Label six paper lunch bags with the letter "A," and six paper lunch bags with the letter "B."

Prepare at least six cups of microwave popcorn. Place one cup of warm, salted popcorn in each of the six bags marked "A." Previously popped popcorn can be warmed in a microwave for a few seconds.

In each of the six bags marked "B," place one cup of cooled, unsalted popcorn. To keep students from peeking, tape or staple the bags closed.

Conduct the activity with students in groups of four.

PROCEDURE

1. Place one bag "A" and one bag "B" on the table or floor in front of each group of students. Direct students not to touch the bags or look inside until instructed to do so.
2. Ask, *What do you think is in the mystery bags?* Give students time to respond. Then, direct them to pick up each bag from the top and shake it gently. They should listen carefully to the sounds produced. Repeat the question, *What do you think is in the mystery bags?* Most students now will be able to determine that the bags contain small objects, and some may guess that the bags contain popcorn. Follow by asking, *How did you know?* Students should mention sound as a clue. Some also may have smelled the popcorn.
3. Have students smell the bags, still without opening them. Repeat the questions, *What do you think is in the bag? Why?* Students should mention that they used the sense of smell to identify the contents of one or both of the bags. If necessary, allow students to open the bags just enough to smell the contents.
4. Ask, *What is different about the two bags?* Let students touch the bags again. This time students should notice that one bag feels warmer. Ask, *Which sense enabled you to notice the temperature difference between the bags?* [touch, which includes pressure sensors and temperature receptors]
5. Now ask, *Is either batch salted or flavored? Which sense or senses would allow you to determine this?* [taste, smell and vision] Allow students to open the bags and remove some of the popcorn to observe with hand lenses. They may notice tiny salt crystals on some of the kernels. Have students draw and label the two kinds of popcorn in their notebooks.
6. Finally, allow students to confirm which batch is salted by sampling one kernel from each bag. Have them describe the flavors of each popcorn sample.
7. Conclude with a class discussion about how students

were able to solve the popcorn mystery. Be sure to reinforce the concept that senses collect information from inside and outside the body and transmit it to the brain. Briefly review the primary senses that students have explored throughout this unit (vision, hearing, smell, taste, touch).

8. Ask students to identify all parts of the body and nervous system that they used in during this investigation (eyes, nose, mouth, tongue, ears, fingers, brain, neurons, etc.).
9. Stimulate further discussion by asking, *How did the information get from your sense organs to your brain?* ["sense organs" being eye, ear, fingers, nose, etc.] Students should be able to communicate that information, such as vibration from shaking the bag of popcorn, was detected by a sense organ and transmitted to the brain. The brain compiled and made sense of all information gathered during this investigation. Refer to different areas on the classroom human body diagram to summarize students' ideas.
10. Have students revisit their notebook entries. Ask them to share what they have learned. Ask, *Why is the brain important?*
11. You may want to end the unit with a "popcorn" party.

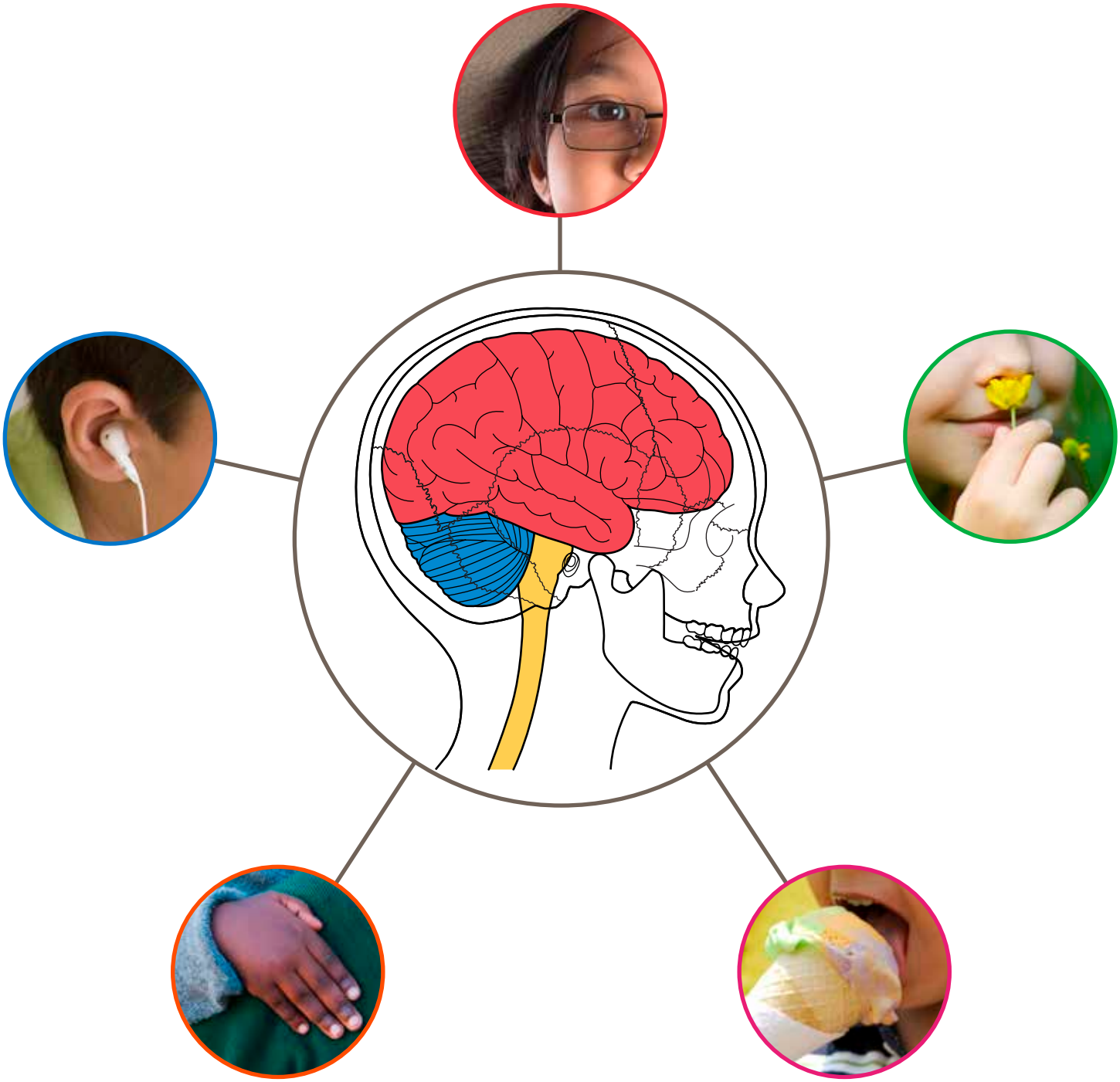
EXTENSION

Use additional flavors of popcorn in separate bags and have students make more observations. For instance, students can compare and contrast different kinds of popcorn in terms of appearance (color and shape), sound (while being shaken in a bag), aroma, flavor and temperature.

RECOMMENDED RESOURCE

- Rissman, Rebecca. *Using Your Senses (The Five Senses).* (2011) Heinemann Educational Books. ISBN: 978-1432954956

The Five Senses



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