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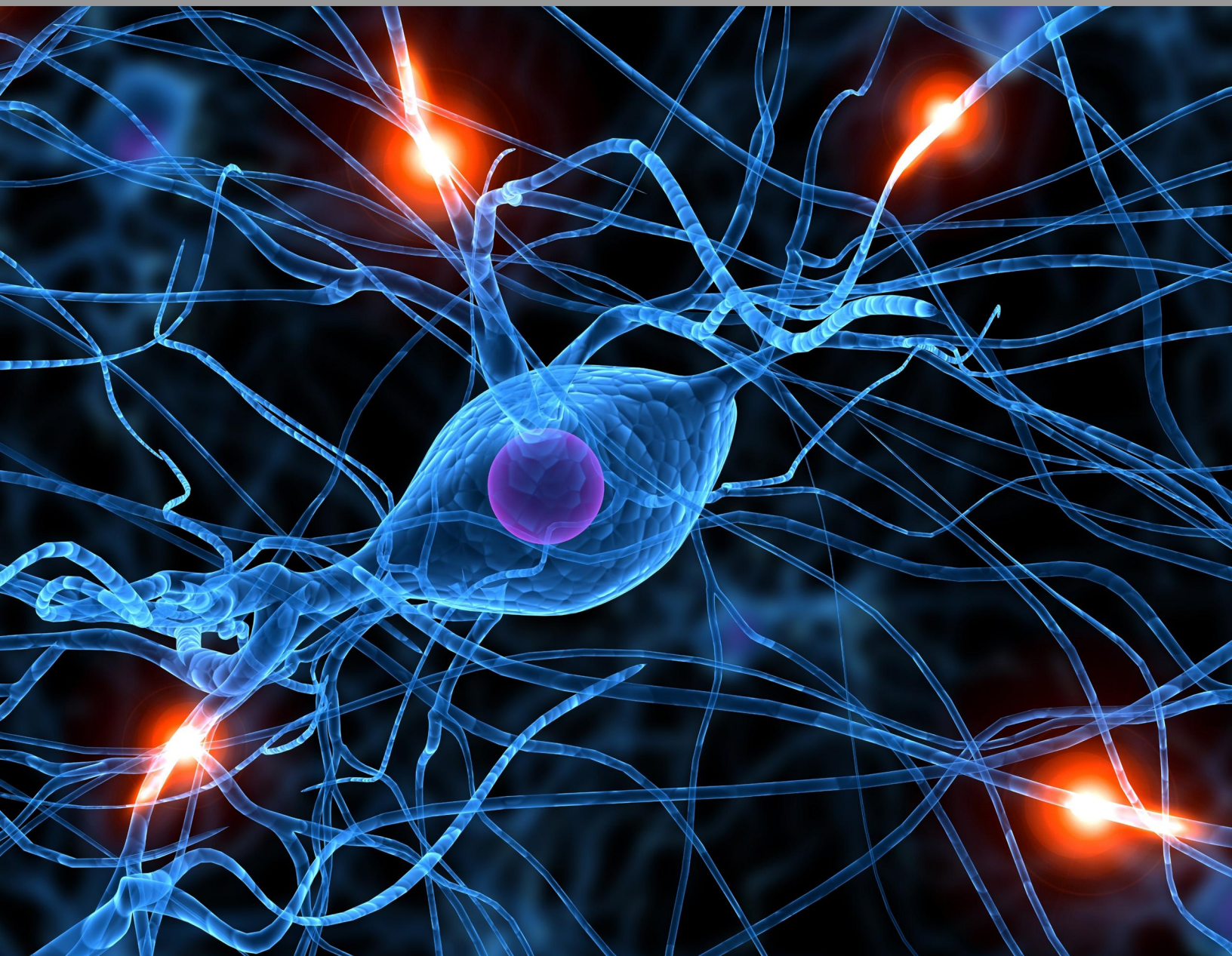
Human Biology - Nervous System

Teacher's Guide



Human Biology Nervous System Teacher's Guide

The Program in Human Biology,
Stanford University, (HumBio)

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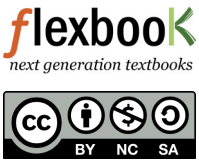

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Stanford University, (HumBio)

CHAPTER 1 Introduction to Nervous System - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

1.1 Overview

Human Biology: An inquiry-based guide for the middle school student.

Developed by the Program in Human Biology at Stanford University and

EVERYDAY LEARNING®

Contents

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Dedication

The faculty, staff, and teachers of Stanford University's Human Biology Middle Grades Life Science Curriculum Project dedicate the publication of the HumBio Curriculum in memory of our colleagues and friends, Mrs. Donna Harrison and Dr. Mary Budd Rowe. Donna was the lead science teacher at Dozier Middle School, the project test site school in Newport News, Virginia. She was an outstanding teacher, a community leader, a devoted wife and mother, and a wonderful human being. Her involvement in the HumBio Project enriched the curriculum materials and brought great joy to our lives. Although her life ended suddenly and tragically, the inspiration she gave to all who knew her will live on in what we do to improve the education of children and youth. Mary Budd Rowe was our most distinguished science education colleague and our dear friend. She guided the early organizational stages of the project as a group of university scientists attempted to address issues of middle level science education. Her unbridled enthusiasm for the education of children always reminded us of the important purpose of our work. Mary continued her unwavering support of the HumBio curriculum until her passing in June of 1996.

1.3 Preface

Stanford University's Middle Grades Life Science Project began in 1986 with the vision of David A. Hamburg, M.D., then President of Carnegie Corporation of New York. A new wave of science education reform was gathering momentum following the release of *A Nation at Risk* by the United States Department of Education and *Educating Americans for the Twenty-First Century* by the National Science Board. Dr. Hamburg brought together the concerns of scientists and science educators over the watered down, vocabulary-laden life science curricula that were typical of middle level science courses at that time with broader public concern over large and increasing numbers of adolescents who engaged in high-risk behaviors leading to school failure, teen pregnancy, and other health problems. Because of his leadership in developing Stanford's undergraduate Program in Human Biology and his interests as a physician and scientist in the major physiological and behavioral transitions in the lives of children, Dr. Hamburg believed that a rigorous middle grades life science curriculum focused on human biology, and where possible on the adolescent, not only would greatly improve the science taught at this level, but through its relevance would capture the interest of this age group.

Initial work on the Human Biology (HumBio) Middle Grades Life Science Curriculum brought together faculty, staff, and students from Stanford's Program in Human Biology and its School of Education with local middle and high school teachers. The curriculum development team was enriched in 1991 by twelve interdisciplinary teams of middle level teachers from diverse test site schools across the country. These teams became our most valued collaborators. The teachers attended annual two week summer institutes at Stanford between 1991 and 1994 and used the draft curriculum units in their classes between 1991 and 1995. The teachers and their students provided extensive formative evaluation data on the field-test materials, which has shaped the final student and teacher versions of the units that comprise the HumBio Curriculum. Using HumBio units as a starting point, many teams also created their own innovative, interdisciplinary materials, which they taught across the middle level curricula in their schools.

The Project's Advisory Board provided insightful advice on the development of the curriculum from the unique perspectives of the professional associations, the institutions, and the fields its members represented. We are grateful to all of those who served for periods of time during the past seven years. We also would like to express our appreciation to the education consultants from universities, the National Middle School Association, and the California State Department of Education who made presentations and worked with the teacher teams during the summer institutes at Stanford. C. Stuart Brewster served with great distinction as our adviser on publication. We are indebted to him for his keen insights and good advice.

The Project faculty, the staff, and the teachers contributed more to the development of the HumBio Curriculum than anyone could have imagined before this work began. Their expertise, determination, and dedication to improving the education of young adolescents were inspirational. Supporting the curriculum development team and the test-site teachers were wonderful groups of Stanford undergraduates from the Program in Human Biology. They helped to ensure a productive and pleasurable working environment, which was an essential part of the success of the summer institutes.

To be sure, none of this work would have been possible without funding from Carnegie Corporation of New York, the National Science Foundation, and most recently The David and Lucile Packard Foundation. On behalf of the entire Project team we would like to thank these foundations and the program officers who have worked with us over the years for their support. As always, the final content of this curriculum is the sole responsibility of the Stanford University Middle Grades Life Science Curriculum Project and does not necessarily reflect the views of Carnegie Corporation of New York, the National Science Foundation, or The David and Lucile Packard Foundation.

H. Craig Heller, *Principal Investigator*

Mary L. Kiely, *Project Director*

January, 1998. Stanford, California

1.4 Letter to the Teacher

Dear Teacher:

Welcome to *Nervous System*. I am a neurobiologist, so this is my favorite unit in the HumBio curriculum. The subject of this unit, the nervous system, is of great interest to students. When students are asked what part of the body they would like to learn about, the most common answer is "the brain". This is not so surprising considering as is pointed out in this unit, that your brain is you, Your brain defines who you are, what you know, how you behave, and what you think. If it were medically possible, you could imagine transplanting any part of your body except your brain and still be you. But, if you received a brain transplant, you would be the person who donated the brain. Isn't that an interesting thought? The human brain is the most complex matter in the known universe, so it is fascinating to scientists as well as to your students. Knowledge about the brain is expanding rapidly. Almost daily there are articles in the popular press reporting new discoveries about the brain and nervous system. After completing this unit, your students will be able to read and understand any of these articles.

Neurobiology can get complex fast, but I don't think you and your students will find this unit difficult. We begin with a structural focus to give students a conceptual road map to build on. We then get students to use that road map by working through simple reflexes. Thus, they can experience directly what they are studying. We then go to the building blocks of the nervous system, neurons, and explain how these cells work to receive and communicate information.

At this point in the unit, you will have a choice. You can teach the entire unit by referring only to nerve signals or nerve impulses. Or, you can take some extra time and explain the physics and membrane biology involved in nerve impulses. This is a good opportunity to team with your physical science colleagues, but you can also do it alone. We have tried to offer very basic explanations of electricity and membrane biology necessary to explain how nerve impulses are generated and conducted down the long processes of neurons. Although you might think this information is too advanced for your class, don't be afraid to try it. Also, don't be afraid of students asking questions you cannot answer. It happens to me all of the time. Perhaps the richest teaching and learning experiences I have had have started "I don't know, but let's find out." The most important thing students can learn from this curriculum is the habit of asking good questions and how to find the answers.

As with all HumBio units, the activities are extremely valuable components of the learning experience. They are not difficult, and they do not require sophisticated equipment. Most only require common household items. The "Thinking Cap" activity is a wonderful way to teach students to think about the brain as a three-dimensional structure. It requires only grocery store bags, crayons, and scissors, yet students who have done this activity have a better grasp on the layout of the brain than do many beginning medical students.

Please let us know about your experience with this *Nervous System*.

Best Wishes,

H. Craig Heller

Chair, Department of Biological Sciences, Stanford University

1.5 Unit Planning

Content Overview

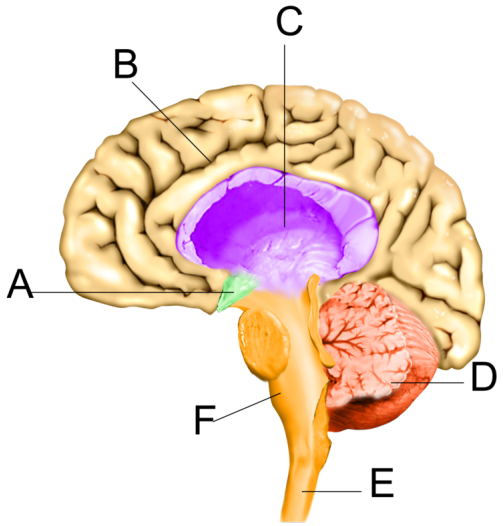
As unique as a fingerprint, your brain determines who you are. This unit introduces students to the workings of the human nervous system-its structure and basic components, its relationship to the world around us, and some of its problems. *Nervous System* reviews how the brain functions as control center for coordinating essential body processes and responding to sensory feedback. Students are encouraged to use this knowledge in making good personal decisions, in protecting and making the most of their nervous system function. Students build structural models representing the brain and spinal cord, the regions of the brain, and the connecting network of nerves. The unit's main points include the following.

- The brain is the most complex matter in the universe.
- The brain's capacity for conscious thought, making connections between events, and reflecting about emotional responses distinguishes humans from other species.
- The nervous system works in circuits. The human body's sensory systems are designed to collect information, bring information to the brain and/or spinal cord, and respond to that information.
- The neuron is the basic functional unit of the nervous system. It is involved in everything you do, from breathing to sleeping to sports or dancing.
- The nervous system exists in a delicate balance. Many factors in the environment affect nervous system functions.

How is the unit structured?

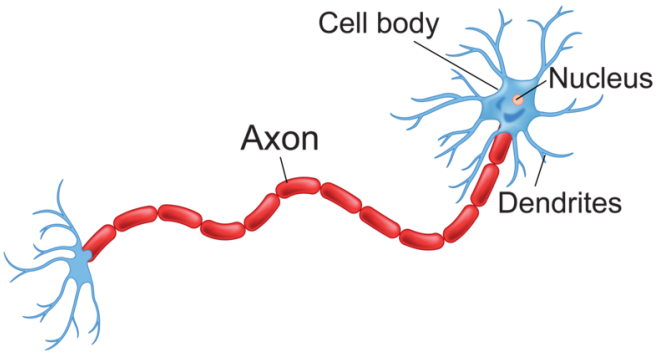
Section 1: Thinking about the Nervous System

Section 2: A Closer Look at the Brain



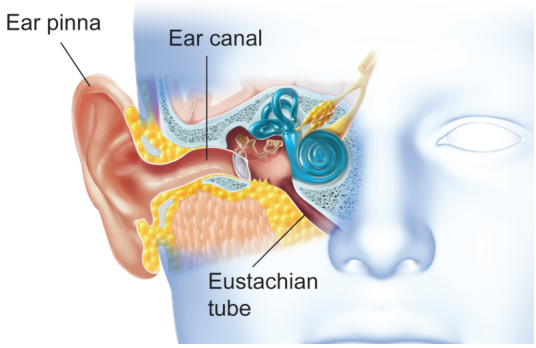
Section 3: Neurons: The Building Blocks of the Nervous System

Section 4: Reflexes: Neurons in Action



PE Figure 3.1 A neuron (nerve cell) is usually microscopic.

Section 5: Sensation



PE Figure 5.7 The pinna and ear canal are parts of the outer ear.

How is the unit structured?

Sections 1 and 2 introduce students to the nervous system through an exploration of the structure and functions of the brain. The text and activities help students identify and learn the functions of the brain's major parts.

Sections 3 and 4 focus on neurons. Section 3 describes what a neuron is and how it sends messages. Section 4 reviews reflex arcs as a model for how the nervous system functions.

Section 5 examines the neural structure of the eyes and ears to show students how the body translates sensory information into nerve impulses that travel to the brain.

Section 6 reviews the output messages from the brain to the muscles. Students learn that in order to perform a new activity, the brain must establish new neural connections.

Section 7 reviews some of the diseases and disorders that can affect normal nervous system function.

Why teach this unit? Connections to the Real World

- Neurological illnesses affect more than 50 million Americans each year, costing 120 billion in health care.
- Every year, 22% of the population experiences some form of mental health disorder. (National Institute of Mental Health)
- More than 144,000 children in the United States suffer from head injuries in bicycle accidents. (Public Health Reports; NIH)
- 300 bicyclists under age 14 die each year, 80% of whom die of head injuries. (Public Health Reports; NIH)
- Drug and alcohol abuse costs the nation over $215 billion in prevention programs, treatment, lost wages, and violence.

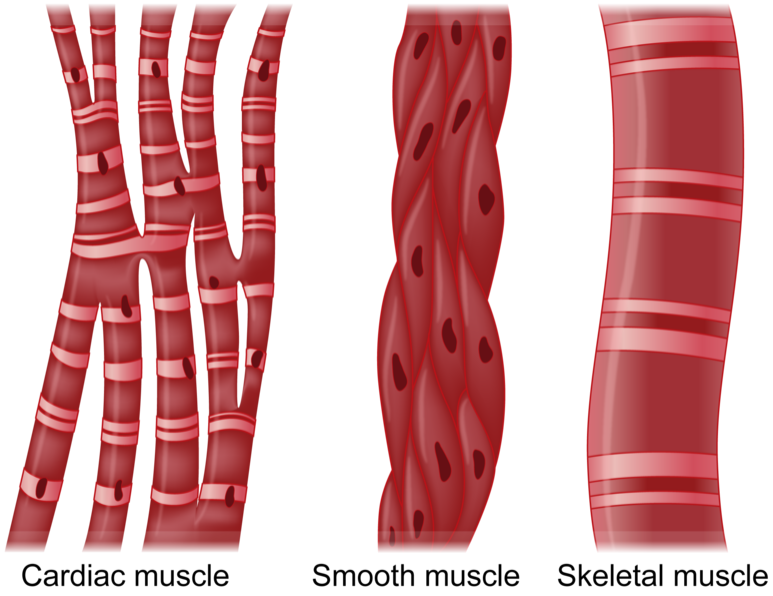
- Adolescents appreciate the opportunity to make their own decisions. In order to make good decisions, they need information. This unit provides students with information about one of its primary body systems-a system that, through their choice of actions, affects how they feel moment to moment.

Questions to Consider throughout the Unit

What elements in your environment that affect your nervous system can you control, and which are more difficult to control?

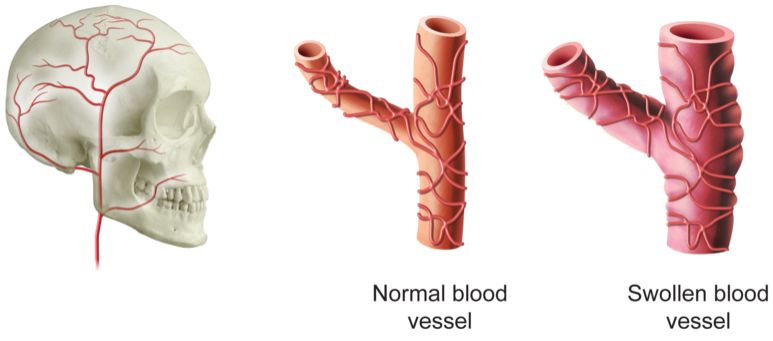
How much of whom we are is a function of the environment, and how much is a function of biology?

Section 6: Moving Muscles



PE Figure 6.1 Three types of muscle fibers: cardiac, smooth, and skeletal (striated).

Section 7: Maintaining a Healthy Nervous System



PE Figure 7.1 A migraine headache is a debilitating disorder of the nervous system. This figure illustrates how a migraine may be caused.

TABLE 1.1: Unit Activities and Key Ideas

Section	Key Ideas	Activity
1 Thinking about the Nervous System Your brain is amazing.	• The nervous system is made up of the brain, the spinal cord, and a network of nerves connecting to all parts of your body. • Your brain acts as "Mission Control" to coordinate nerve messages throughout the body. • The skull, cerebrospinal fluid, and blood-brain barrier protect the brain's delicate nerve tissue.	**Mini Activity:** Billions and Billions **Mini Activity:** Egghead **Activity 1-1:** The Blood-Brain Barrier (BBB) **Mini Activity:** Self-Portraits
2 A Closer Look at the Brain How does the brain work?	• Brain structures such as the brain stem and cerebellum control the basic functions of the body, such as breathing and balance. The cerebral cortex is responsible for thinking, making connections between cause and effect, and the processing, storing and recall of information. • While each portion or lobe of the cerebral cortex of the brain is responsible for a different function, there is close communication among these parts. • Internal balance, or homeostasis, is a result of the integration of nerve cell messages to and from the brain, the spinal cord, and the body.	**Mini Activity:** Brain Study **Activity 2-1:** Big Brain on a Stick **Mini Activity:** Brain on Your Hand **Activity 2-2:** Thinking Cap

TABLE 1.1: (continued)

Section	Key Ideas	Activity
3 Neurons: The Building Blocks of the Nervous System How do neurons work?	• The neuron is the basic building block of the nervous system. There are three types of neurons: sensory, motor, and interneurons. • Sensory neurons transmit information to the brain. Motor neurons transmit information from the brain to various parts of the body. Interneurons transmit information from sensory to motor neurons. • The structure of the neuron differs from other cells in the body. Neuron design facilitates the transmission of electrical messages in one direction only.	**Mini Activity:** Building a 3-D Model of a Neuron **Activity 3-1:** Picture a Nerve Cell **Activity 3-2:** Drug Effects on Neurons
4 Reflexes: Neurons in Action What is a reflex?	• A reflex is the simplest circuit in the nervous system. • Once triggered by a stimulus, a reflex goes to completion and causes a response, such as a muscle reaction. Some reflexes are easier to control than others. • The five parts of a reflex arc are sensor, sensory nerve, control center, motor nerve, and muscle.	**Mini Activity:** The Knee Jerk Reflex **Mini Activity:** Identifying Parts of a Reflex **Mini Activity:** React First, Think Later **Activity 4-1:** How Fast Is Your Reaction Time?

TABLE 1.1: (continued)

Section	Key Ideas	Activity
5 Sensation How do you sense the world around you?	• Sensory organs such as eyes and ears act as windows to the world that bring information into the nervous system. • Sensory neurons connect with certain areas of the brain. All neurons fire impulses, but where they go in the brain determines the nature of the sensation. • The eye and ear represent two different and highly specialized organs connected to the nervous system.	**Activity 5-1:** Using Your Sensors **Mini Activity:** Use Your Sensors **Activity 5-2:** Designing and Building a Model of the Eye **Mini Activity:** Pupils in a Different Light **Mini Activity:** What Are The Advantages of Two Eyes? **Mini Activity:** Eye Dominance **Activity 5-3:** Exploring a Mammalian Eye (Dissection) **Enrichment 5-1:** Building a Model of the Ear
6 Moving Muscles What makes your muscles move?	• The nervous system triggers movement of many muscles for normal activities and to help with survival in the environment. • Some muscles move automatically to help maintain your body functions. Other muscles involve conscious coordination by the nervous system of many muscle groups at once. • Learning new movements requires practice to develop new connections between neurons in the brain.	**Activity 6-1:** Connecting Your Brain and Muscles **Activity 6-2:** Moving Muscles **Activity 6-3:** The Nervous System and Muscles Working Together

TABLE 1.1: (continued)

Section	Key Ideas	Activity
7 Maintaining a Healthy Nervous System What can you do to keep your nervous system healthy?	• The primary job of the nervous system is to coordinate normal body functions. • Scientists continue to learn more about brain functions through the study of diseases and disorders of the nervous system. • There are some simple things that can be done to keep the nervous system healthy.	**Activity 7-1:** Cortical Experiences **Mini Activity:** Learning More about Nervous System Disorders **Mini Activity:** How Much Sleep Do You Need? **Activity 7-2:** Improving Your Memory **Activity 7-3:** Your Nervous System in Action

Teacher's Guide Overview

This *Nervous System* unit is built around a variety of student activities. Text material can be used to introduce, reinforce, and extend the concepts developed in the activities. The activities are the foundation of this unit, so the unit's success depends on students' involvement in the activities. Embedded activities are interrelated, since the concepts developed in one may be applied in another.

Section Planning

For each section, you'll find extensive advance planning for the student activities and the section topic. Key ideas, section objectives, background information, suggestions for introducing activities, and the materials needed for each activity are listed on the Section Planning page. Review this information ahead of time to ensure that materials for each activity are available when you need them.

Support for Embedded Activities

Embedded activities are those activities contained or "embedded" in the Student Edition. Procedures for each embedded activity are contained in the Student Edition. In the Teacher's Guide, you'll find activity planning information, activity assessment, and student reproducible pages for each embedded activity.

Enrichment Activities

Enrichment activities are activities found in the Teacher's Guide. These activities are designed to extend and enrich students' learning experiences. Complete Enrichment activities, including Teacher Activity Notes and the student procedures and reproducible pages, are located at the end of each appropriate section of the Teacher's Guide.

GroupWork Activities

Learning science is a process that is both individual and social. Students in science classrooms often need to interact with their peers to develop a knowledge of scientific concepts and ideas, just as researchers, engineers, mathematicians, and physicians who are working in teams do to answer questions and to solve problems. The GroupWork activities of the HumBio Curriculum for Middle Grades have been developed to foster a collaborative environment for groups of students. Students plan experiments, collect and review data, ask questions and offer solutions, use data to explain and justify their arguments, discuss ideas and negotiate conflicting interpretations, summarize and present findings, and explore the societal implications of the scientific enterprise. In short, GroupWork activities provide an environment in which students are "doing science" as a team.

For more information, refer to "Using GroupWork Activities" on TE page 132. The specific GroupWork activities for this unit can be found on TE pages 135-161.

Projects

The research and action projects in HumBio are varied and provide students with time to explore a particular topic in depth. With Projects, students have the opportunity to take a position based on knowledge gained through research, debate an issue, and devise a plan of action. In this way, students can apply what they are learning to larger issues in the world around them.

Projects for this unit include

- Research Questions
- Mind and Body
- Sleep and Dreams

Assessment Overview

Within each section of the unit there are suggestions for assessment that can be used individually or in combination to develop a complete assessment package. The list below describes the variety of assessment tools provided.

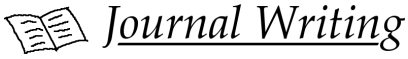
Apply Your Knowledge Questions appear throughout each section. They can be used as homework assignments and as ways to initiate a class discussion. These questions are designed to assess

- communication skills
- depth of thought and preparation
- problem-solving skills
- ability to apply concepts to related or big ideas
- how well students relate their new knowledge to different problems

What Do You Think

These questions appear in each section. They provide students with opportunities to think and write about the concepts they are learning in a larger context. You can use these Questions to assess

- writing skills
- problem-solving abilities
- creativity and depth of thought
- the ability to analyze and summarize



Journal Writing prompts are suggested throughout the unit. These prompts provide opportunities for students to write critically and creatively about concepts and issues. The writing products can be used to assess

- writing skills
- depth of thought

- the ability to explain and expand on concepts and issues

Review Questions

Review Questions are located at the end of each section. These Questions can be used for written responses or as the basis for class discussion. These questions are designed to assess content knowledge and whether students can explain the concepts explored in the section.

Activity-Based Assessment

Inquiry-base student-centered activities are the foundation of the, *Human Biology* Program. The unit is rich with relevant and exciting activities that introduce, support, or reinforce concepts students are exploring. Within the Teacher's Guide, you'll find extensive teacher information, including assessment strategies, for each type of activity:

- Embedded Activities
- Enrichment Activities
- Mini Activities
- GroupWork
- Projects

You can use students' products to assess their progress. These products include models, simulations, reports of laboratory investigations, role-plays, written responses to questions and written observations, student-designed explorations and procedures, poster presentations, and classroom presentations.

PORTFOLIO ASSESSMENT

You may want to have your students develop a portfolio of the unit. A sample assessment portfolio of the unit might contain the following items:

- Written responses to three *What Do You Think? questions.*
- Written responses to one *Apply Your Knowledge* question from each section.
- An analysis of their two favorite activities and how those activities helped them learn an important concept.
- Reports from three laboratory investigation such as the following.

  Activity 2-2: Thinking Cap Activity 3-2: Drug Effects on Neurons Activity 6-1: Connecting Your Brain and Muscles

- A model from *Activity 5-2: Designing and Building a Model of the Eye*
- An example of calculations from *Activity 4-1: How Fast Is Your Reaction Time?*

Getting Started

Keep Students Interested. Encourage students to read the text: It is the story line that ties all of the content together. Every effort has been made to make the text interesting to students and appropriate to their reading level. Text material can be used to introduce, reinforce, and extend the concepts addressed within the activities.

The success of the unit depends on the completion of at least the Embedded activities. And keep in mind that some activities are related since the data obtained in one may be used in another.

Plan Ahead. The unit is activity-based, and you can select the activities that will best meet your class' needs. The activities are listed in the Unit Matrix on pages xiv-xv and in the Activity Index on page 171. Mini Activities are shorter and can be done with minimal teacher input; they are located in the margin of the student edition. The Embedded activities in the student text are investigations that require some planning and setup time; these are the essential activities within the unit. Other investigations called Enrichment activities are located at the end of each

section in the Teacher's Guide. Enrichment activities expand student knowledge of the concepts explored in the given section.

A variety of projects were designed to extend the content of the unit. These include ongoing class projects, school projects, and/or community projects. Projects are located at the end of the Teacher's Guide, beginning on page 162.

Customize the Unit. Each section of this unit builds upon knowledge gained in the previous sections. Teaching timelines are provided on TE pages xxii-xxiii. The first timeline demonstrates how to complete this unit within a three-week schedule. The second timeline demonstrates how to complete this unit within a five-week schedule. Both of these timelines highlight the essential activities. If your class has time to study the unit over a longer period of time, many additional activities are available.

Allow Time for Projects. Consider having students start projects at the beginning of the unit and then prepare those projects for presentation as a culminating event.

Use Current Events. Ask students to bring in newspaper and magazine articles that relate to what they are studying each week. Relating the unit content to current events helps students see that what they are doing in class is, in fact, relevant to their lives outside of school. Students can use current events to make group scrapbooks, bulletin boards, and posters or to develop class presentations.

Make a "question box" available. Have students write down questions they have about what they are investigating and put them in the box, At appropriate times select questions and read them to the class to generate discussion. These questions can also be used to initiate class research projects.

Use a Variety of Resources. We encourage you and your students to use a wide variety of sources for information. The activities provide rich opportunities for students to explore a variety of concepts. The more students incorporate information from resources outside the classroom, the richer their learning experiences will be. Use computer services for gathering student and teacher information, for networking with students in different schools and with community resources, and for contacting experts in the field under study. A list of resources can be found on page 168 of this Teacher's Guide.

Make Career Connections. Encourage students to investigate careers related to the content of the unit. Invite scientists, physicians, and technologists working in the field to come to your classroom to discuss career opportunities, their research, and specific topics of interest.

Plan for Field Trips. Field trips to local hospitals, industrial sites, or universities need, of course, to be arranged well in advance. Contact the public affairs offices of these institutions for assistance.

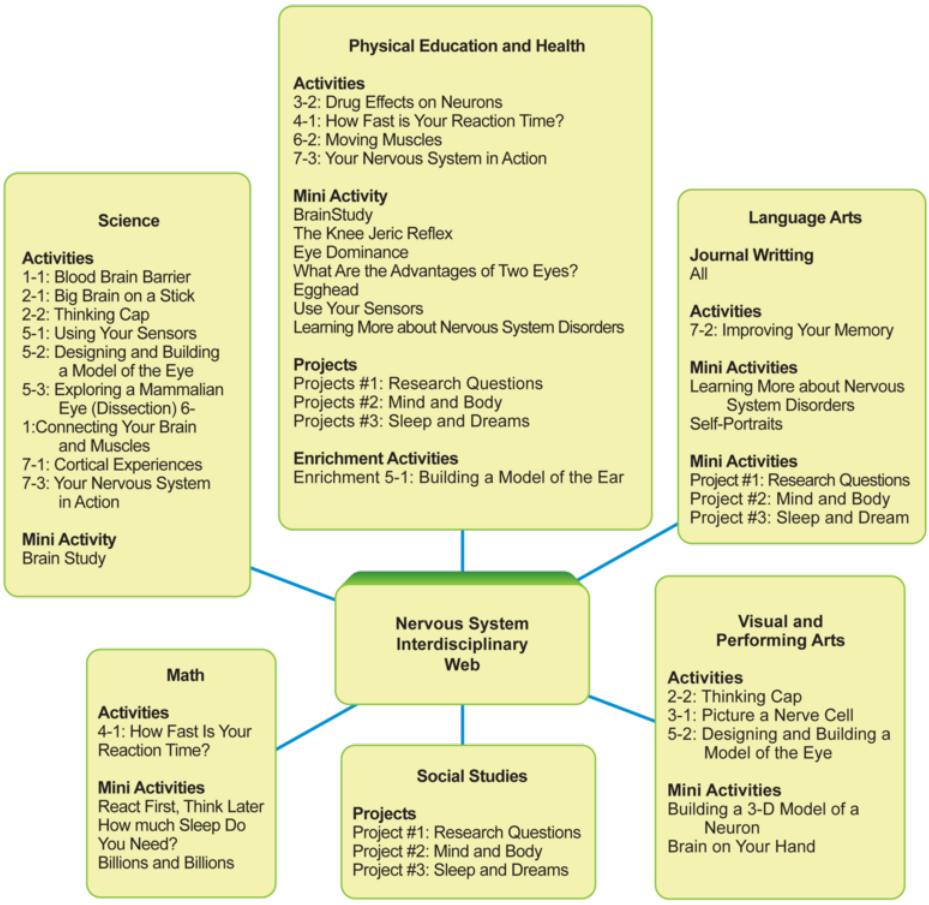
Address Health Concerns. Be aware of any special health problems your students may have, Some students may have health conditions that would make it uncomfortable for them to participate in certain activities, such as those that require exercise or that relate directly to their particular health problems. For students unable to participate fully in these activities you may wish to create an alternative assignment or have them use data from another group. If the class is appropriately prepared, the affected students may want to share information about their special circumstances with the class in order to increase empathy and knowledge of all students.

Connect with Other HumBio Units. The units covering human physiological systems, cell biology, and genetics are related. There are many opportunities to make connections among the concepts taught in these units. Similarly, the three units covering the biological, behavioral, and social aspects of adolescent development can be taught in sequence.

Connect with Other Disciplines. The interdisciplinary web provided is a guide for planning if your school uses an interdisciplinary team approach. The web classifies the unit's activities and projects by related discipline-language arts, math, social studies, physical education, health/nutrition, and visual/performing arts, and science. For interdisciplinary planning, schedule meetings with your team early. You are encouraged to tap the talents and interests of your team members as well as of your unique school and community resources in developing other suitable activities for this unit.

Connect with the Home. Give special attention to the unit activities as a means of involving family and community

members. Also, encourage your students to take selected Apply Your Knowledge questions and Mini Activities home for further exploration.



Teaching Timelines

You can use these timelines as a place to start in designing your own timelines, or you can use them as they are laid out. If you're planning your own timeline, consider the inclusion of the Embedded activities first. The "Embedded activities" are included in the student edition. The Enrichment activities, GroupWork activities, and Projects can then be included, depending on your time restrictions. The timelines are guides that can vary if some activities are done at home or in other classes in addition to science class.

We realize it may not be possible to do all the activities shown on these timelines. If you need to remove activities, be careful not to remove any activities critical to the content of the unit. You may want to divide the activities among interdisciplinary members of your teaching team.

Page references in this chart refer to the student edition, except when Enrichments are suggested. The page references for Enrichments refer to this Teacher's Guide.

TABLE 1.2: Option 1: Three Week Timeline

	Monday	Tuesday	Wednesday	Thursday	Friday
Week 1	Introduce Section 1 **Activity 1-1:** The Blood-Brian Barrier	**Mini Activity:** Egghead **Mini Activity:** Self-Portraits	Introduce Section 2 **Activity 2-1:** Big Brian on a Stick **Mini Activity:** Brain Study	conclude Activity 2-1: Big Brian on a Stick	**Activity 2-2:** Thinking Cap Review Section 1 & 2
Week 2	Introduce Section 3 **Mini Activity:** Building a 3-D Model of a Neuron **Activity 3-1:** Picture a Nerve Cell	**Activity 3-2:** Drug Effects on Neurons	Introduce Section 4 **Mini Activity:** The Knee Jerk Reflex	**Activity 4-1:** How Fast Is Your Reaction Time? **Mini Activity:** React First, Think Later	Review Section 3 & 4
Week 3	Introduce Section 5 **Activity 5-1:** Using Your Sensors Assign **Mini Activity:** Pupils In a Different Light	**Activity 5-2:** Designing and Building a Model of the Eye or **Activity 5-3:** Exploring a Mammalian Eye (Dissection)	Introduce Section 6 **Activity 6-1:** Connection Your Brain and Muscles or **Activity 6-2:** Moving Muscles	**Activity 6-3:** The Nervous System and Muscles Working Together Introduce Section 7 **Activity 7-1:** Cortical Experiences **Activity 7-2:** Improving Your Memory	Summarize and review Sections 5, 6, and 7 Unit assessment

TABLE 1.3: Option 2: Five Week Timeline

	Monday	Tuesday	Wednesday	Thursday	Friday
Week 1	Introduce Section 1 **Mini Activity:** Billions and Billions **Activity 1-1:** The Blood-Brian Barrier	**Mini Activity:** Egghead **Mini Activity:** Self-Portraits	Introduce Section 2 **Mini Activity:** Brain Study **Activity 2-1:** Big Brian on a Stick	Conclude **Activity 2-1:** Big brain on a Stick **Mini Activity:** Brain on Your Hand	**Activity 2-2:** Thinking Cap
Week 2	Review Section 1 & 2 **Mini Activity:** Building a 3-D Model of a Neuron	Introduce Section 3 **Activity 3-1:** Picture a Nerve Cell	**Activity 3-2:** Drug Effects on Neurons	Share 3-D Models of a Neuron Review Section 3	Introduce Section 4 **Mini Activity:** The Knee Jerk Reflex

TABLE 1.3: (continued)

	Monday	Tuesday	Wednesday	Thursday	Friday
Week 3	**Activity 4-1:** How Fast is Your Reaction Time? **Mini Activity:** React First, Think Later	Review Section 4	Introduce Section 5	**Activity 5-1:** Using Your Sensors **Mini Activity:** How Much Sleep Do You Need?	Introduce **Activity 5-2:** Designing and Building a Model of the Eye
Week 4	**Mini Activities:** Pupils in a Different Light Use Your Sensors	**Mini Activities:** What Are the Advantages of Two Eyes? Eye Dominance	**Activity 5-3:** Exploring a Mammalian Eye (Dissection)	Conclude **Activity 5-3:** Exploring a Mammalian Eye (Dissection)	Summarize Section 5. Assign **Mini Activity:** Learning More about Nervous System Disorders
Week 5	Introduce Section 6 **Activity 6-1:** Connecting Your Brain and Muscles	**Activity 6-2:** Moving Muscles Review Section 6	Introduce Section 7 **Activity 7-1:** Cortical Experiences **Activity 7-2:** Improving Your Memory	Begin **Activity 7-3:** Your Nervous System in Action	Discuss **Mini Activity:** How Much Sleep Do You Need? Unit Review and Assessment

Safety for Teachers

- Always perform an experiment or demonstration on your own before allowing students to perform the activity. Look for possible hazards. Alert students to possible dangers. Safety instructions should be given each time an experiment is begun.
- Wear glasses, not contact lenses. Make sure you and your students wear safety goggles in the lab when performing any experiments.
- Do not tolerate horseplay or practical jokes of any kind.
- Do not allow students to perform any unauthorized experiments.
- Never use mouth suction in filling pipettes with chemical reagents.
- Never "force" glass tubing into rubber stoppers.
- Use equipment that is heat resistant.
- Set good safety examples when conducting demonstrations and experiments.
- Turn off all hot plates and open burners when they are not in use and when leaving the lab.
- When students are working with open flames, remind them to tie back long hair and to be aware of loose clothing in order to avoid contact with flames.
- Make sure you and your students know the location of and how to use fire extinguishers, eyewash fountains, safety showers, fire blankets, and first-aid kits.
- Students and student aides should be fully aware of potential hazards and know how to deal with accidents. Establish and educate students on first-aid procedures.
- Teach students the safety precautions regarding the use of electricity in everyday situations. Make sure students understand that the human body is a conductor of electricity. Never handle electrical equipment with

wet hands or when standing in damp areas. Never overload electrical circuits. Use 3-prong service outlets.
- Make sure that electrical equipment is properly grounded. A ground-fault circuit breaker is desirable for all laboratory AC circuits. A master switch to cut off electricity to all stations is desirable for all laboratory AC circuits.
- Make sure you and your students are familiar with how to leave the lab safely in an emergency. Be sure you know a safe exit route in the event of a fire or an explosion.

For Student Safety

Safety in the Classroom

- Wear safety goggles in the lab when performing any experiments. Tie back long hair and tuck in loose clothing while performing experiments, especially when working near or with an open flame.
- Never eat or drink anything while working in the science classroom. Only lab manuals, notebooks, and writing instruments should be in the work area.
- Do not taste any chemicals for any reason, including identification.
- Carefully dispose of waste materials as instructed by your teacher. Wash your hands thoroughly.
- Do not use cracked, chipped, or deeply scratched glassware, and never handle broken glass with your bare hands.
- Lubricate glass tubing and thermometers with water or glycerin before inserting them into a rubber stopper. Do not apply force when inserting or removing a stopper from glassware while using a twisting motion.
- Allow hot glass to cool before touching it. Hot glass shows no visible signs of its temperature and can cause painful burns. Do not allow the open end of a heated test tube to be pointed toward another person.
- Do not use reflected sunlight for illuminating microscopes. Reflected sunlight can damage your eyes.
- Tell your teacher if you have any medical problems that may affect your safety in doing lab work. These problems may include allergies, asthma, sensitivity to certain chemicals, epilepsy, or any heart condition.
- Report all accidents and problems to your teacher immediately.

HANDLING DISSECTING INSTRUMENTS and PRESERVED SPECIMENS

- Preserved specimens showing signs of de cay should not be used for lab observation or dissection. Alert your teacher to any problem with the specimen.
- Dissecting instruments, such as scissors and scalpels, are sharp. Use a cutting motion directed away from yourself and your lab partner.
- Be sure the specimen is pinned down firmly in a dissecting tray before starting a dissection.
- In most cases very little force is necessary for making incisions. Excess force can damage delicate, preserved tissues.
- Do not touch your eyes while handling preserved specimens. First wash your hands thoroughly with warm water and soap. Also wash your hands thoroughly with warm water and soap when you are finished with the dissection.

CHAPTER 2 Thinking about the Nervous System - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

2.1 Planning

Key Ideas

- The nervous system is made up of the brain, the spinal cord, and a network of nerves connecting to all parts of your body.
- Your brain acts as "mission control" to coordinate nerve messages throughout the body.
- The skull, cerebrospinal fluid, and blood-brain barrier protect the brain's delicate nerve tissue.

Overview

The nervous system is introduced by inviting students to think about the brain. The brain is compared to a "super computer" and a "mission control." It receives and transmits information from the environment through the sensory organs in order to maintain internal balance-homeostasis. Students investigate how the brain is protected by its own structure, by the skull, by the surrounding cerebrospinal fluid, and by the blood-brain barrier.

Objectives

Students:

✓ identify the components of the nervous system.

✓ describe how the brain is the center for information transfer.

✓ explain the relationship between the brain and sensory organs.

✓ identify and evaluate the effectiveness of the structures that protect the brain.

✓ explain the concept of homeostasis.

Vocabulary

blood-brain barrier, brain, capillaries, central nervous system (CNS), cerebral cortex, cerebrospinal fluid, concussion, glial cells, homeostasis, meninges, nerve fibers, neuron, peripheral nervous system (PNS), spinal cord

Student Materials

Activity 1-1: The Blood-Brain Barrier (BBB)

- Activity Report
- Safety goggles
- 6 test tubes with stoppers and a test-tube rack
- Marking pen
- Masking tape
- Clear cooking oil to represent the membranes of the BBB
- Sesame or motor oil to represent a fat soluble substance
- Water with a little red food coloring to represent blood
- Blue food coloring to represent a water-soluble substance
- Alcohol
- 3 eyedroppers
- Paper towels
- Colored pencils (red and blue)

Teacher Materials

Activity 1-1: The Blood-Brain Barrier (BBB)

- Activity Report Answer Key
- Diagram of brain in skull
- Diagram/model of the Blood-Brain Barrier

Advance Preparation

See Activity 1-1 in the Student Edition

You may want to begin *Activity 2-1: Big Brain on a Stick* so that the completed models will be available when discussing Section 2.

Arrange to have some examples of protective headgear such as bicycle helmets and hard hats for students to refer to throughout this section.

Interdisciplinary Connections

Physical Education Compare a variety of sports safety helmets and discuss how their design helps protect the skull and brain.

Health Investigate which drugs cross the blood-brain barrier

Language Arts Write a persuasive essay about the laws regulating the wearing of protective helmets.

Social Studies Debate laws that regulate the wearing of protective helmets.

Visual Arts Create a drawing that shows how the blood-brain barrier protects the brain.

Math and Social Studies Investigate insurance, hospitalization, and rehabilitation costs for accidents related to head injuries due to not wearing head protection.

Background Information

The complexity of the human brain is greater than any other known matter. The brain constantly receives, integrates, and interprets information from the environment and then sends information to the muscles and major organs of the body. Some of the actions controlled by the brain are voluntary, while others are involuntary. Examples of involuntary responses are the functions of the heart, the lungs, and the digestive system. The brain is the central part of a much larger nervous system, which provides communication among cells in the body.

The nervous system uses sensors, such as the eyes and the ears, to convert the information it receives from them into messages it can process and then send to other parts of the body, such as the muscles, which respond. The brain and the spinal cord make up the central nervous system. The network of nerve cells that carry the messages to and from the central nervous system form the peripheral nervous system.

2.2 Using Thinking about the Nervous System – Student Edition (Human Biology)

Discuss the role of models in science-specifically, the models of the brain that students use in this unit.

Draw students' attention to the Key Ideas using means such as posters and overhead transparencies.

Introduce the section with the Journal Writing prompt to invite students to think about their brains.

Engage students in a discussion about the brain, using comparisons such as "mission control."

Introduce the term *homeostasis,* or "balancing the steady internal environment of the body with the changing external environment." Use the seesaw analogy.

Discuss the importance of the structure of the brain and its connection to the sensory organs.

The *Mini Activity: Egghead* emphasizes the role of the skull in protecting the brain.

Discuss the role of bike helmets and hard hats as they relate to protecting the brain from injury.

Discuss the function of the blood-brain barrier when students do *Activity 1-1: The Blood-Brain Barrier*.

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

Suppose for a minute that brain transplants were possible, as in a science fiction movie. If you had a brain transplant, would you be you, or would you be the person who donated the brain? Why?

Apply Your KNOWLEDGE

The study of the nervous system is called neurobiology. What do you call someone who studies neurobiology? What subjects do you think a person would have to study to become a scientist who studies neurobiology?

Mini-Activity

Billions and Billions

Students count kernels of corn contained in a cup to calculate one billion.

What Do You think?

Think about what you have learned about the brain so far. Now think about the bike helmet laws in effect in many areas. These laws, which are sometimes controversial, require anyone riding a bicycle to wear a helmet. Do you think a bike helmet law is a good idea? Is such a law fair? Explain your responses.

Mini-Activity

Egghead This activity can be used as a student project for demonstration to the class. It is important that the jar is completely filled with water and without any space or air. Teachers need to check jars to be sure they do not leak. When students give the air-filled jar a slight shake, the egg in the jar will break. However, even with vigorous shaking, the egg in the water filled jar will not break. Refer to *Activity 2-1: Big Brain on a Stick* to discuss how using a bike helmet protects the brain.

Ask Students How is the egg in the jar of water protected?

The water cannot move out of the way when the jar is jolted. This is why the egg doesn't hit the side of the jar and break.

What would happen if the glass jar containing the raw egg and water fell onto the ground? (Do NOT test their hypotheses!)

The jar would shatter and the egg would probably break.

Activity Extension Remove eggshell with vinegar before placing it in the jar (This takes about 24 hours.) The membrane around the egg can represent the meninges, the tough outer membrane protecting the brain. The uncooked egg representing the brain is more like the consistency of a real brain. Infection of the meninges is called "meningitis."

Have students design a protective covering for the egg in a jar of water model so that the jar would not break after being dropped from a height of 6 feet, maximum.

Suggestions: Use contest format, document with photos or videotape. Make connections with use of bike helmets to protect the skull (jar) and brain (egg) from damage. Ask students to suggest methods of protecting the brain portion (the egg) of the model only. Some suggestions could include wrapping it in a soft material to cushion against shock or covering it with a hard material to protect against blows. Solicit student suggestions for examples of materials that could be used for this protection. Have students compare their methods of protection for the brain to the skull and cerebrospinal fluid.

2.3 Activities and Answer Keys

Activity 1-1: The Blood-Brain Barrier (BBB)

PLAN

Summary Students explore the relationship between the solubility properties of molecules and their ability to cross the blood-brain barrier. They investigate separation and mixing of like and unlike liquids to learn how "like" liquids will mix and "unlike" liquids will remain separate from each other.

Objectives

Students:

✓ distinguish between water-soluble and oil-soluble liquids.

✓ describe the relationship between a substance's solubility and protecting the brain.

✓ explain the role of the blood-brain barrier in protecting the brain.

✓ demonstrate and explain the effects on the BBB of an injury to the head.

Student Materials

Per student

- Activity Report

Per group

- Safety goggles
- 6 test tubes with stoppers
- Test-tube rack
- Marking pen
- Masking tape
- Clear cooking oil (to represent the membranes of the BBB)
- Sesame or motor oil (to represent a fat-soluble substance)
- Water with a little red food coloring (to represent blood)
- Blue food coloring (to represent a water-soluble substance)
- Alcohol
- 3 eyedroppers
- Paper towels
- Colored pencils (red and blue)

Teacher Materials

- Diagram of brain in skull
- Diagram/model of the Blood-Brain Barrier
- Activity Report Answer Key

Advance Preparation

Collect materials for demonstration or for each student team.

Diagrams of the brain in the skull can be at each lab table or displayed in the front of the room.

Have student texts available.

Set up waste containers for the disposal of liquids.

Estimated Time Approximately one 50-minute class period

Interdisciplinary Connections

Language Arts Students can use expository writing or poetry to explain how the BBB protects the brain.

Prerequisites and Background Information

Students should have completed the *Mini Activity: Egghead.*

Students should have some knowledge of what happens to chemicals in the body: where they go, how they work, and how they are excreted. They need to have some knowledge of how drug receptors work. They should have some knowledge of how the actual effects of drugs are related to the route or entry into the body, prior exposure to the drug, age, health, as well as dose. They also need to know that toxicity differs from the usual drug effect.

The blood-brain barrier, which is a hurdle interposed between brain capillaries and nerve and glial cells, keeps most harmful substances out of the brain while keeping brain chemicals in. For a drug to traverse the barrier and activate brain receptors, the drug needs to be small (low molecular weight) and nonpolar, i.e., lipid soluble. This activity demonstrates partition coefficients and reveals that water-soluble substances stay in the water phase and go where water goes, and that lipid-soluble substances remain in the oil and go across the lipid blood-brain barrier better and stick in the fatty tissue of the brain better.

Other processes can be demonstrated. For example, use liquid dish-washing detergent to demonstrate detergent action on the oil-water interface-i.e., bile salt action and micelle formation. Interpose a semipermeable membrane and discuss the relation between transport of a substance and its concentration (osmotic) gradient.

As students explore solubility properties of different molecules and relate them to the BBB, some may ask if there are molecules that are soluble in both oil and water. The answer to this question is "yes." An example of this type of molecule is a detergent or alcohol. Soap can function as an acid or base and has emulsifying properties. In answering why these materials do not break down the BBB, point to the difference between this activity and the actual BBB, which consists of membranes.

IMPLEMENT

Introduce Activity 1-1 by reviewing the definition of *solubility properties*.

Include this activity at least as a demonstration, but preferably as a student activity.

CAUTIONS:

Plastic containers are safer. However, if you use glass, remind students of the care necessary in working with glass containers. Wear goggles. Display the safety rules. Make sure students wear safety goggles during all lab activities. Review procedures for eye safety and washing if accidental splashes occur. Caution students not to rub their eyes during the lab and to wash hands thoroughly after the lab.

Steps 1-3 Set up waste containers for disposing liquids. Make sure the test tubes are labeled correctly. Act as a model for students by wearing goggles.

Steps 4-5 Discuss student predictions. Compare predictions with actual results.

Step 6 Test tubes E and F are set up to demonstrate that some molecules are soluble in both water and oil.

Step 7 Discuss the findings recorded on the Activity Reports and the answers to the Activity Report questions.

Extend Activity 1-1 by having students conduct research. They can learn more about the blood-brain barrier and how it is affected by drug use or brain injury. This activity is an excellent "bridge" activity to connect with the *Circulation* unit and *Lives of Cells* unit.

Helpful Hints

Water colored red with food coloring: use enough food coloring to create a red color to represent the blood.

Cooking oil: a generic brand is sufficient.

Review with students what each of these materials represents before they begin.

ASSESS

Use the model of the brain and the written responses to the Activity Report to assess if students can

✓ explain the meaning of the word *soluble*.

✓ describe how to classify liquids as water soluble or oil soluble.

✓ identify which types of liquids "mix" and which liquids remain separated.

✓ demonstrate how the blood-brain barrier transports nutrients to the brain cells and prevents harmful substances from reaching the brain cells.

✓ explain how an injury to the head can disrupt the effectiveness of the BBB.

Mini-Activity

Self-Portraits Your nervous system is as unique as your fingerprints. Your brain makes you who you are. Think about the following questions and write a few responses to share with your class. Who are you? What makes you unique? Do the things that make you unique involve your brain?

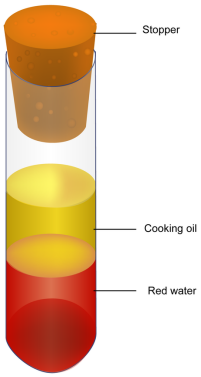
Journal Writing

What aspects of yourself and your brain interest you the most? Do you ever surprise yourself? Have you ever heard yourself say something and wonder where the thoughts came from? Explain your responses.

Activity 1-1: The Blood-Brain Barrier (BBB) – Activity Report Answer Key

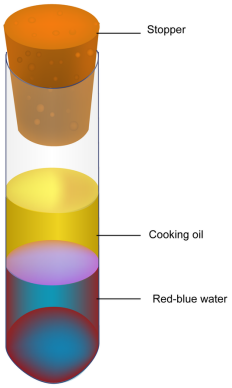
- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Observe Test Tube A. Make a labeled drawing in color of the test tube and its contents.

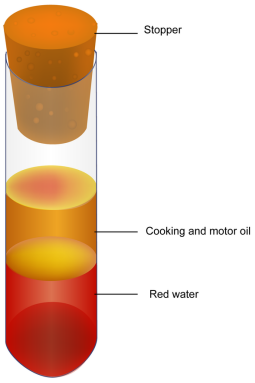


(a) Do the water and oil mix?
(b) What happens when you shake the test tube?

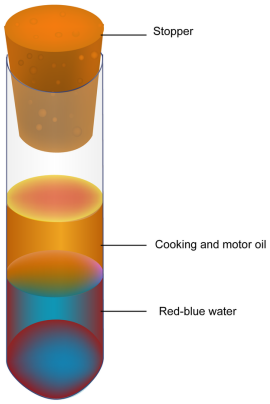
2. Observe Test Tube B. Make a labeled drawing of the test tube and its contents before and after adding the drops of blue food color. If the blue color is a water-soluble chemical, where would it go if it reached the brain in the bloodstream?



3. Observe Test Tube C. Make a labeled drawing of the test tube and its contents before and after adding the motor or sesame oil. If the colored oil is a fat-soluble chemical, where would it go if it reached the brain in the bloodstream?



(a) Predictions of shaking Test Tube D for 10 seconds. Answers will vary.



(b) Results of shaking Test Tube D for 10 seconds.
(c) Explain any differences between your predictions and your observed results.
(d) If there are water-soluble and fat-soluble chemicals circulating in your blood, which is more likely to cross your BBB? Why?

(a) Describe your results from the experiment with Test Tubes E and F.
(b) How do these results differ from your observations on Test Tubes Band C?
(c) Do you think it is easy for alcohol to cross the BBB?

4. What is the importance of fat (lipids) and water solubility with respect to the BBB?
5. Use what you have learned to explain how the cells of the brain are protected by the BBB. Why do you think alcohol has such a rapid and extreme effect on behavior?

Review Questions/Answers

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. What are the three major divisions of the nervous system?
2. In general, what does the nervous system do?
3. List three aspects of the nervous system and brain you find remarkable. Explain why they are remarkable.
4. How is the brain protected from damage?
5. Why is wearing a bicycle helmet important?
6. What substances does the blood-brain barrier not keep out? Why?
7. Why can drugs or alcohol affect behavior so quickly?

Activity 1-1 Report: The Blood-Brain Barrier (BBB) (Student Reproducible)

1. Observe Test Tube A. Make a labeled drawing in color of the test tube and its contents.

a. Do the water and oil mix?

b. What happens when you shake the test tubes?

2. Observe Test Tube B. Make a labeled drawing of the test tube and its contents before and after adding the drops of blue food color. If the blue color is a water-soluble chemical, where would it go if it reached the brain in the bloodstream?

3. Observe Test Tube C. Make a labeled drawing of the test tube and its contents before and after adding the colored oil. If the colored oil is a fat-soluble chemical, where would it go if it reached the brain in the bloodstream?

4. a. Predictions for shaking Test Tube D for 10 seconds.

b. Results of shaking Test Tube D for 10 seconds.

c. Explain any differences between your predictions and your observed results.

d. If there are water-soluble and fat-soluble chemicals circulating in your blood, which is more likely to cross your BBB? Why?

5. a. Describe your results from the experiment with Test Tubes E and F.

b. How do these results differ from your observations on Test Tubes B and C?

c. Do you think it is easy for alcohol to cross the BBB?

6. What is the importance of fat (lipids) and water solubility with respect to the BBB?

7. Use what you have learned to explain how the cells of the brain are protected by the BBB. Why do you think alcohol has such a rapid and extreme effect on behavior?

CHAPTER 3 A Closer look at the Brain - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

3.1 Planning

Key Ideas

- Brain structures such as the brain stem and cerebellum control basic functions of the body, such as breathing and balance. The cerebral cortex is responsible for thinking; making connections between cause and effect; and the processing, storing, and recalling of information.
- While each portion or lobe of the cerebral cortex of the brain is responsible for a different function, there is close communication among these parts.
- Internal balance, or homeostasis, is a result of the integration of nerve cell messages to and from the brain, the spinal cord, and the body.

Overview

Building on the overview of the brain in the first section, students investigate the structure and function of the brain. They learn about "brain geography" by focusing on each part of the brain and its functions. They compare the structural relationship between the brain and spinal cord to the design of a car gearshift. Students build and use several different kinds of models to help demonstrate how the brain works.

Objectives

Students:

✓ identify and describe the major parts of the brain including the cerebrum, cerebellum, medulla, thalamus, hypothalamus, and spinal cord.

✓ describe the special features designed to protect the human brain.

✓ explain the function of the different parts of the brain.

✓ distinguish between the parts of the brain that control body function and the parts of the brain that control thinking/information processing.

Vocabulary

electrodes, electroencephalogram (EEG)

Lobes of the cerebral hemispheres:

frontal lobe, occipital lobe, parietal lobe, temporal lobe, magnetic resonance imaging (MRI), neurobiologist

Parts of the brain:

brain stem, cerebellum, cerebral cortex, cerebral hemispheres, or cerebrum, thalamus, hypothalamus

Student Materials

Activity 2-1: Big Brain on a Stick

- Resource
- Activity Report
- Illustration of brain and spinal cord
- Soft wood, such as pine or fir:

a. 2 pieces, $8'' \times 5'' \times 2''$ (for cerebral hemispheres)

b. 1 piece: $2\ \frac{1}{2}'' \times 2'' \times 1''$ (for hypothalamus and thalamus)

c. 1 piece, $1\ \frac{1}{2}'' \times 1'' \times 20''$ (for spinal cord)

d. 1 piece, $2'' \times 2'' \times 4''$ (for cerebellum)

(If possible, use a different type/color of wood for A-D to help students distinguish the different parts of the completed model.)

- Template indicating shapes of parts of nervous system
- Saws and sandpaper
- Safety goggles
- Glue and/or nut-bolt assembly
- Paper
- $\frac{3}{4}''$ masking tape
- Colored pencils
- Black marker, fine point
- Bike helmet (optional)

Activity 2-2: Thinking Cap

- Resource
- Activity Report
- Large paper grocery bag; scissors; transparent tape; colored pencils and/or marking pens; clear plastic wrap; mirror

Teacher Materials

Activity 2-1: Big Brain on a Stick

- Activity Report Answer Key
- A completed "Brain on a Stick" model is useful in helping students visualize the end product as they prepare and assemble the "Big Brain on a Stick" model.
- Bike helmet, different styles if possible
- Additional anatomy/ physiology texts or a CD-ROM and charts showing brain structure and function.

Activity 2-2: Thinking Cap

Activity Report Answer Key

- Extra supply of student materials

Advance Preparation

See Activities 2-1 and 2-2 in the Student Edition.

Activity 2-1: Big Brain on a Stick

- Allow sufficient time for advance construction of the model parts.
- Invite others to help prepare model parts. An industrial arts teacher, older students, a scout troop, parents, and/or a lumberyard could provide preparation of models.
- The description on the Resource can be given to the person(s) who will prepare model parts.
- If it is impossible to make multiple models, it is strongly recommended that one model be made for demonstration purposes. Construct a model as a class or student project. Models can be retained for future use.

Activity 2-2: Thinking Cap

- Collect large paper grocery bags-one per student. Large grocery bags can often be obtained or purchased inexpensively from the supermarket.

Interdisciplinary Connections

Math Investigate metric system units such as microns by relating them to the size of the sensory and motor neurons.

3.2 Using A Closer Look at the Brain – Student Edition (Human Biology)

Discuss the role of models in science, in particular, the different models of the brain students use in this unit.

Draw students' attention to the Key Ideas using means such as posters and overhead transparencies.

Have students complete *Activity 2-1: Big Brain on a Stick.* The construction of the model is time consuming but is worthwhile, and it is used throughout the unit. The model enables students to learn about the structure of the brain and the spinal cord.

Complete *Activity 2-2: Thinking Cap* to help students relate the different parts of the brain to their functions.

Time permitting select from unit projects.

Throughout and at the end of the section refocus students' attention on the Key Ideas.

Mini-Activity

Brain Study Students do library research about MRI scans, CAT scans, and PET scans and write a report about their findings.

3.3 Activities and Answer Keys

Activity 2-1: Big Brain on a Stick

PLAN

Summary Students build a model of the central nervous system (the brain and spinal cord) to learn how the different parts relate to each other. Building the model provides the opportunity for students to visualize the main structures of the central nervous system and think about how the different parts communicate with one another. Students will continue to use their "Brain on a Stick" model as a reference throughout the unit.

Objectives

Students:

✓ locate the major parts of the brain.

✓ demonstrate and explain the importance of protecting the brain from injury.

Student Materials

- Resource
- Activity Report
- Illustration of brain and spinal cord
- Soft wood, such as pine or fir:

a. 2 pieces, $8'' \times 5'' \times 2''$ (for cerebral hemispheres)

b. 1 piece, $2\ \frac{1}{2}'' \times 2'' \times 1''$ (for hypothalamus and thalamus)

c. 1 piece, $1\ \frac{1}{2}'' \times 1'' \times 20''$ (for spinal cord)

d. 1 piece, $2'' \times 2'' \times 4''$ (for cerebellum)

(If possible, use a different type/color of wood for A-D, to help students distinguish the different parts of the completed model.)

- Template indicating shapes of parts of nervous system
- Saws and sandpaper
- Safety goggles
- Glue and/or nut-bolt assembly
- Paper
- $\frac{3}{4}''$ masking tape
- Colored pencils
- Black marker, fine point
- Bike helmet (optional)

Teacher Materials

- A completed "Big Brain on a Stick" model is useful in helping students visualize the end product as they prepare and assemble the "Big Brain on a Stick" model.

- Bike helmet, different styles if possible
- Additional anatomy/physiology texts or a CD-ROM and charts showing brain structure and function.
- Activity Report Answer Key

Advance Preparation

Allow sufficient time for advance construction of the model parts. Invite others to help prepare model parts. An industrial arts teacher, older students, a scout troop, parents, and/or a lumberyard could help with the preparation of models. The description on the Resource can be given to the person(s) who will prepare model parts. If it is impossible to make multiple models, it is strongly recommended that one model be made for demonstration purposes. Construct a model as a class or student project. Models can be retained for future use.

Estimated Time

Time will vary depending on whether brain model parts are precut-one to two 50-minute class periods, or model parts are not precut-two to four 50-minute class periods.

Helpful Hints

Bolt Parts A1 and A2 (Left and Right hemispheres) through Part B(Thalamus and Hypothalamus) so they can be detached.

Use the "Big Brain on a Stick" model as a reference throughout this unit and any drug education studies.

Use the "Big Brain on a Stick" model as a reference in the *Breathing* unit to show where breathing (pons/medulla) and temperature (hypothalamus) are controlled.

Encourage students to make their own replica of the wooden model using clay or paper, in either full scale or reduced scale.

Students can use their "Big Brain on a Stick" models to evaluate different helmets used in their community and relate their designs to areas of the brain protected and the effectiveness of that protection, giving reasons for their conclusions.

Students can conduct community surveys to find out more about bike helmets such as what types of bike helmets are available, their comparative costs, and numbers of people who use helmets. They can share these results using posters, graphs, and class presentations.

Interdisciplinary Connections

Visual or Industrial Arts Plan, prepare, and assemble wooden models for use in science classes.

Math Prepare model patterns by marking cutting lines for the art or industrial arts classes.

Physical Education Discuss use of bike and sports helmets.

Physical Science Discuss mass, forces, and acceleration in physical science.

Prerequisites and Background Information

None required

IMPLEMENT

Introduce Activity 2-1 by reviewing the relationship of brain to spinal cord, using a sample "Big Brain on A Stick."

Steps 1- 2 Set out materials for student lab groups, depending upon how students will use the parts: materials to construct and make the models or previously assembled models. The amount of materials required for models (Resource) will depend upon how many models will be assembled in the classroom.

Step 3 Students also can color-code brain regions.

Step 4 Have students complete the Activity Report and label the parts of the brain.

ASSESS

Use the model of the brain and the written responses to the Activity Report to assess if students can

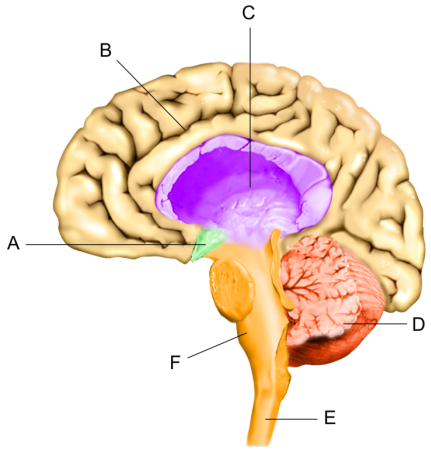
✓ locate the major parts of the brain (cerebrum, cerebellum, medulla, thalamus, and hypothalamus) and the spinal cord.

✓ demonstrate and explain the importance of protecting the brain from blows and subsequent damage.

Activity 2-1: Big Brain on a Stick – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. On your drawing of the central nervous system, label and color the cerebrum, cerebellum, medulla, thalamus, hypothalamus, and spinal cord.



2. Look carefully at your model. Hold it up next to your lab partner to see where each part fits on the body.
3. If a bike helmet is available, place it on your "Brain on a Stick" model. What purpose does the helmet serve? Explain.
4. Make a sketch of your model wearing a bike helmet. Describe why you think this particular helmet is safe or not.
5. Now you can write a paragraph in which you give several reasons why a person should protect the brain by wearing a bike helmet.
6. Think of some ways in which you can use your "Brain on a Stick" model. Describe those uses.

Journal Writing

Memories What is your earliest memory? Describe the memory and pay close attention to the role your senses play in this memory. For example, can you smell or hear or see something as part of the memory? Why do you think this memory has stuck with you for so long?

Helpful Hints

Make a fist with your right hand, thumb over your fingertips. As you view your fist your knuckles will be to your right and your thumb to your left. Your hand and fingers represent the cerebrum. The thumb represents the cerebellum. The area of your hand just above your wrist represents the medulla. Your wrist and arm represent the spinal cord.

Brain on Your Hand Students use their fists as a model of a brain, labeling the parts of the brain on their hand. They explain to at least three people what the parts are and what they do.

What Do You Think?

How do you think the cerebral cortex could control our behavior? How do you think the cerebral cortex could control o personalities? How do all those cells make us what we are? What is intelligence?

Activity 2-2: Thinking Cap

PLAN

Summary Students design and label a paper model to help them learn about the functions of the different regions of the brain. Students use the thinking cap when locating where organs, such as the eyes and the ears have nerve connections in the brain.

Objectives

Students:

✓ identify and describe the major regions of the brain (cerebrum, cerebellum, and medulla).

✓ describe the regions of the cerebrum (frontal, parietal, temporal, and occipital lobes).

Student Materials

- Resource
- Activity Report
- Large paper grocery bag; Scissors; Transparent tape; Colored pencils and/or marking pens; Clear plastic wrap; Mirror

Teacher Materials

- Activity Report Answer Key
- Extra supply of student materials

Helpful Hints

- If grocery bags have advertisements/ writing on the outside, have students turn them inside out and do their marking on the unprinted side.
- To save time, have student helpers complete some precutting of bags before class.
- As another option, have a demonstration model of the "Brain on a stick" for students to use during this activity.
- Butcher paper or construction paper can be substituted for a paper bag.
- A large mirror is not required but is recommended so students can observe themselves wearing their "Thinking Caps."

Advance Preparation

Collect large paper grocery bags, one per student. Large grocery bags can often be obtained or purchased inexpensively from the supermarket.

Estimated Time

Approximately two to three 50-minute class periods

Interdisciplinary Connections

Math Measure and mark paper bags for cutting in math class.

Visual Arts After brain parts have been drawn and labeled, students can color in and embellish diagrams in art classes.

Prerequisites and Background Information

Students need to that left and right are referenced to the part of the brain being studied, not students' left and right.

Students should have completed *Activity 2-1: Big Brain on a Stick.*

Helpful Hints

- In Completing item #4 of the Activity Report, give your students some cues(e.g, names, shape, size and location in the body.)
- As an optional activity, consider the game "Musical Brains." As music plays, students point to different regions of the brain on the "Thinking Cap." When the music stops, students name the region of the brain on which their fingers rest and tell what it does.
- If students have already completed *Activity 2-1: Big Brain on a Stick,* they can place their paper model on the wooden model to help them visualize the boundaries of brain parts and regions. Have students write in the names of brain parts and regions of the cerebrum on the wooden model. Be sure to follow up these activities with *Activity 7-1: Cortical Experiences and Activity 7-3: Your Nervous System in Action.*

IMPLEMENT

Introduce Activity 2-2 by reviewing the different parts of the brain.

Step 1 It may be helpful to prepare a sample Thinking Cap to use as a reference after students complete the activity. Or you may find it helpful to have some students do this activity ahead of time so they can help other students.

Steps 2-6 Stress safety precautions necessary for using pencils and scissors to construct the model, especially when the bag is covering the head. Caution students to be sure they can see properly through the holes they have cut when they are moving around with bags on their head.

ASSESS

Use the construction and proper labeling of the "Thinking Cap" and the written responses to the Activity Report to assess if students can

✓ construct a model of a "Thinking Cap" to represent the brain.

✓ label and describe the major regions of the brain (cerebrum cerebellum, and medulla) as well as the spinal cord.

✓ locate the regions of the cerebrum (frontal, parietal, temporal, and occipital lobes).

Activity 2-2: Thinking Cap – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. For the drawing of the brain below, color-code the parts of the brain. Label *cerebrum, cerebellum, medulla,* and *spinal cord.* In addition, label left, right, top, bottom, front and back.
2. On the following drawing of a cerebral hemisphere, color-code the regions of the cerebrum: *frontal, parietal, temporal,* and *occipital lobes.*
3. What are the functions of the brain regions recorded on your paper bag model of the "Thinking Cap"?
4. How do the meninges help protect the brain? Describe meningitis is and its effects on brain functions.
5. Communicate what you have learned about the brain to someone else. You may wish to write a letter, create a poem, draw some pictures, have a conversation, use the computer, or use another method approved by your teacher.
6. How does this description of the brain and its functions differ from your thoughts about the brain before you started this activity?

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

What might you guess is the difference between a species of mammal that has a large temporal cortex compared to one with a large occipital cortex?

What Do You Think?

The cerebral cortices of other mammals are smaller and less complex than ours are. Do you think animals have feelings? Do they think? Do you think some animals, such as dolphins and chimpanzees, are intelligent? Explain.

What Do You Think?

Technology has made it possible to keep people's hearts and lungs alive even when their brains are dead. When do you think a person is really dead? When he or she stops breathing? When the heart stops beating? When the brain stops functioning?

Apply Your KNOWLEDGE

What parts of the brain do you think are essential when a person dances?

Apply Your KNOWLEDGE

Imagine you are a doctor. Patient A comes to you and says that he is "seeing stars." What part of the brain would you investigate? Patient B comes to you and says that she smells strange smells everywhere she goes. What part of the brain would you investigate?

Review Questions/Answers

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. What part of the brain is responsible fer thinking?
2. Describe four major parts of the brain and explain what they do.
3. If a surgeon stimulated the neurons for your big toe in the right sensory cortex, what would happen? Why? What if the surgeon stimulated "toe" neurons in your right frontal cortex?
4. Describe several methods scientists use to learn how the brain works.

Activity 2-1 Resource: Big Brain on a Stick (Student Reproducible)

Directions for making the parts to build your "Big Brain on a Stick"

Soft wood, such as pine or fir:

a. 2 pieces: $8'' \times 5'' \times 2''$ (for cerebral hemispheres)

b. 1 piece: $2\ \frac{1}{2}'' \times 2'' \times 1''$ (for hypothalamus and thalamus)

c. 1 piece $1\ \frac{1}{2}'' \times 1'' \times 20''$ (for medulla and spinal cord)

d. 1 piece $2'' \times 2'' \times 4''$ (for cerebellum)

If possible, use a different type/color of wood for A-D, to help students distinguish the different parts of the completed model.

Template indicating shapes of parts of nervous system

Saws and sandpaper

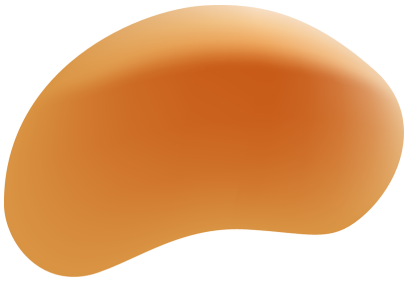
Safety goggles

Remember to consider how parts will be secured. If the model is to be reused, fastening devices can be included (e.g., wooden pegs, Velcro, or other means.)

a. Cerebral hemispheres (two: one right hemisphere and one left hemisphere)

Use two pieces of wood, $8'' \times 5'' \times 2''$.

Be sure you end up with a right and a left hemisphere.



Part A (cerebral hemisphere)

b. Hypothalamus and Thalamus

Find the piece of wood that is $2\ \frac{1}{2}'' \times 2'' \times 1''$. It does not need to be cut any more.

Part B (thalamus and hypothalamus)

This piece is the upper brain stem and will represent the hypothalamus and the thalamus. In the completed model, it will separate the two cerebral hemispheres.

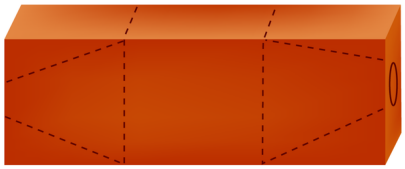
c. Medulla and Spinal Cord

The long piece of wood $(1\ \frac{1}{2}'' \times 1'' \times 20'')$ becomes the medulla and spinal cord in this model. It does not need to be cut any more.

Part C (medulla and spinal cord)

d. Cerebellum

The last piece of wood $(2'' \times 2'' \times 4'')$ will represent the cerebellum. Cut this piece to taper both ends, about $1\ \frac{1}{2}''$ from either end, as shown in the diagram below.



Part D (cerebellum)

Directions for assembly of parts

a. Glue B (Thalamus and Hypothalamus) onto the inside of part A1, (right cerebral hemisphere). Let dry. Tell your teacher if your model does not agree with Figure 2.5.

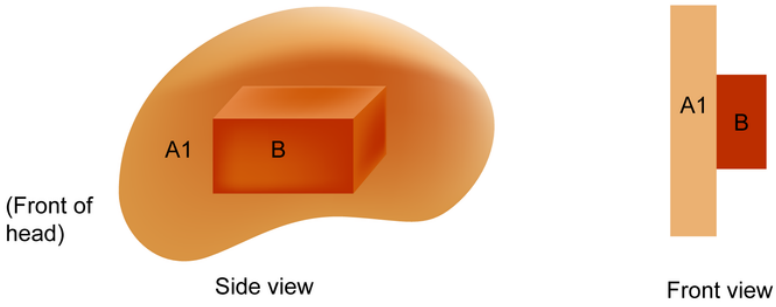


Figure 2.5 Assembly diagrams for parts A and B

b. Now glue C (medulla and spinal cord) onto the bottom of piece B (thalamus and hypothalamus). Let the glue dry. Tell your teacher if your model does not agree with Figure 2.6.

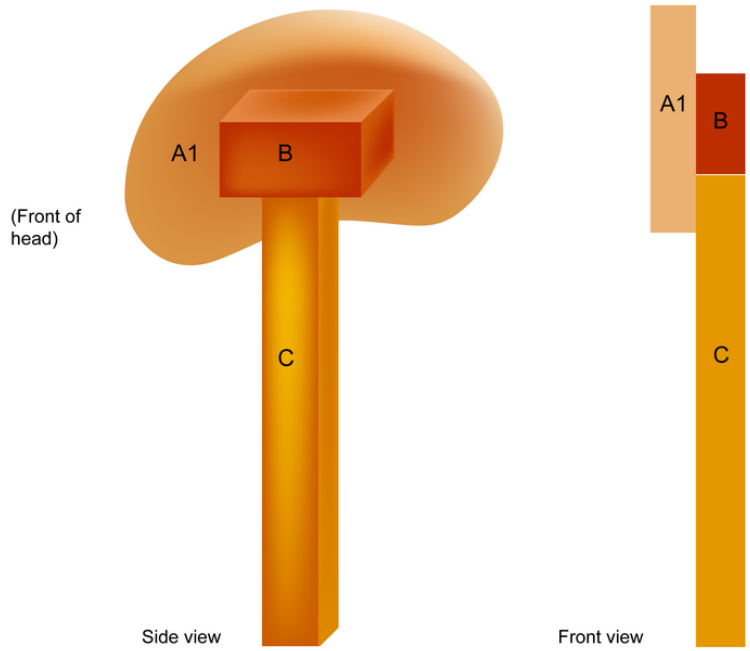


Figure 2.6 Assembly diagrams for parts A, B, and C

c. Glue piece A2 (left cerebral hemisphere) like a sandwich on top of piece B (thalamus and hypothalamus), just opposite piece A1 (right cerebral hemisphere). Tell your teacher if your model does not agree with Figure 2.7.

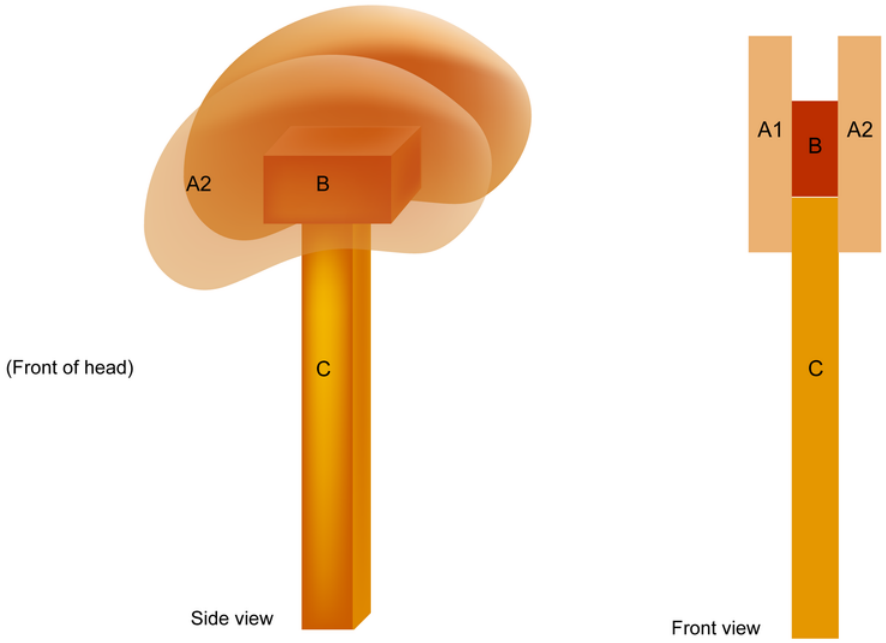


Figure 2.7

d. Now glue D (cerebellum) onto the back of the spinal cord, as shown in Figure 2.8.

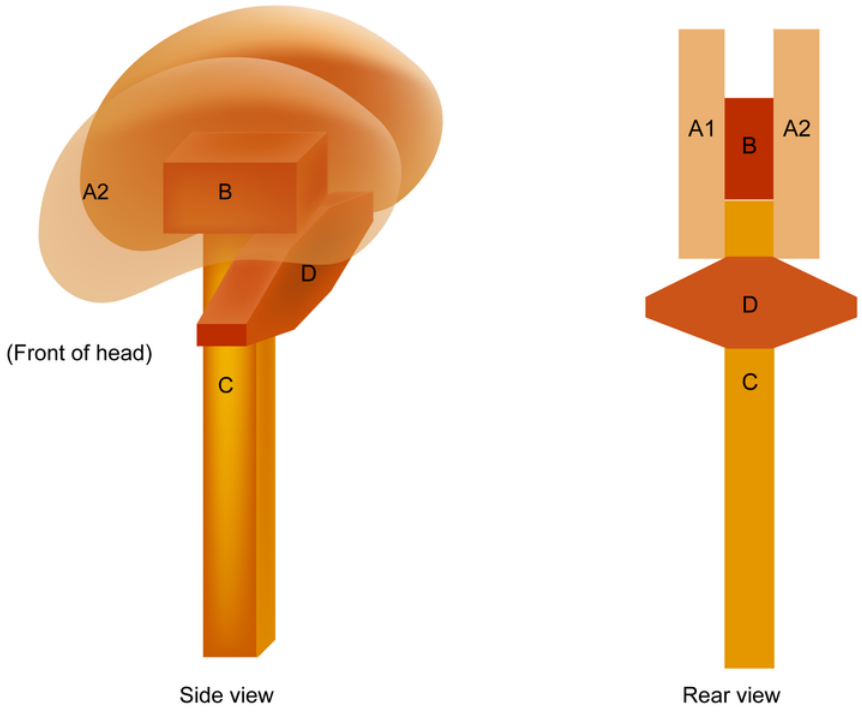


Figure 2.8

e. Finally, use a fine-point black marking pen to label (on masking tape) your model as indicated in Figure 2.9.

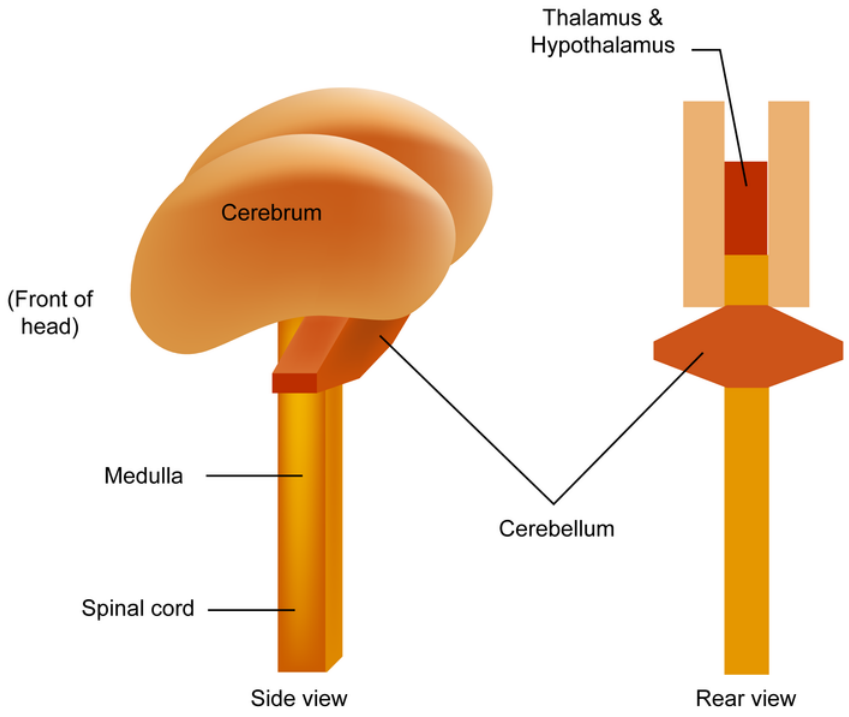
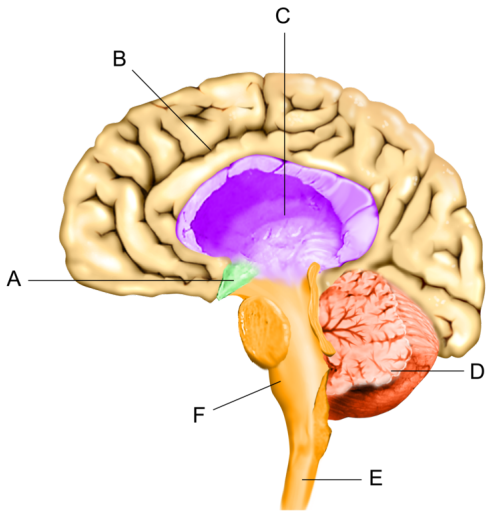


Figure 2.9

f. Ask the teacher how to identify your model (e.g., name of the lab group).

Activity 2-1 Report: Big Brain on a Stick (Student Reproducible)

1. On your drawing of the central nervous system, label and color the cerebrum, cerebellum, medulla, thalamus, hypothalamus, and spinal cord. Indicate parts below.



A. _____

B. _____

C. _____

D. _____

E. _____

F. _____

Now that you have completed your model, you can use it throughout the unit to show how the brain and nervous system function together to coordinate your body's activities.

2. Look carefully at your model. Hold it up to your lab partner to see where each part fits on the body.

3. If a bike helmet is available, place it on your "Brain on a Stick" model. What function does the helmet serve? Explain.

4. Make a sketch of your model wearing a bike helmet. Describe why you think this particular helmet is safe or not.

If you have time, try different styles of bike helmets on your model and see which one appears to give the best protection. Share this information with your class.

5. Now you can write a paragraph in which you give several reasons why a person should protect the brain by wearing a bike helmet.

6. Think of some ways in which you can use your "Brain on a Stick" model. Describe those uses.

Activity 2-2 Resource: Thinking Cap (Student Reproducible)

In this activity, you use a paper bag to design a map of the brain. Your finished "Thinking Cap " is a representation of the different regions of the brain.

1. Cut the bag so it will fit your head.

- Measure the distance from the top of your head to the bottom of your ear.
- Now use a ruler to mark a line around the front and two sides of the bag as indicated in Figure 1.

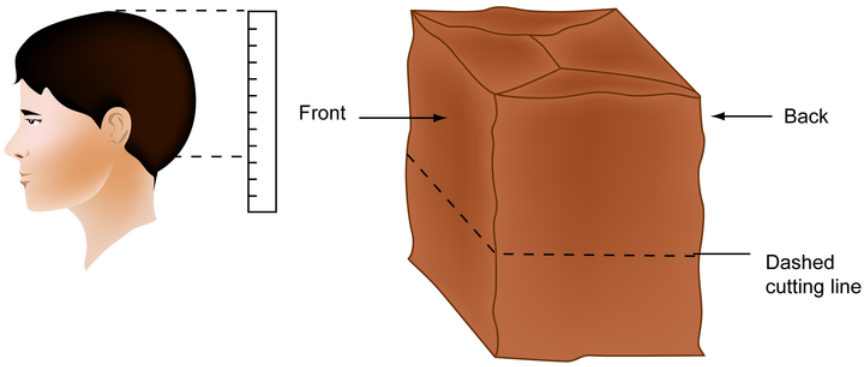


Figure 1

2. Taking care not to cut the back side, cut along the dashed cutting line you have marked, leaving the back flap long. when finished cutting, your bag should like Figure 2.

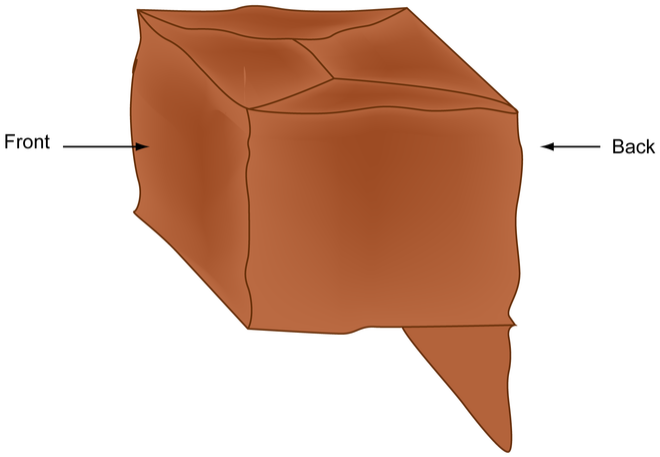


Figure 2

3. Put the bag over your head.

- Use your finger to locate on the bag where your eyes should be.
- Keeping your finger at these spots, remove the bag. Use a pencil to lightly mark these spots, labeling them A and B, and cut openings in the bag to represent the location of your eyes. Be sure to make them large enough so you can see when the bag is on your head.

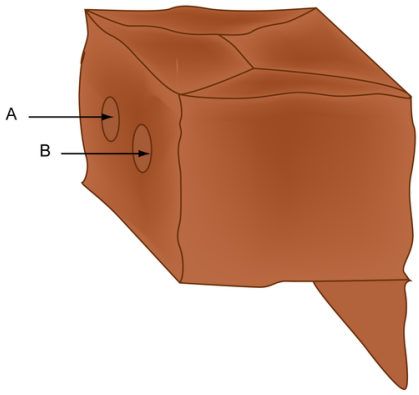


Figure 3

4. Try the bag on to see how it fits.

- Put the bag back on your head so that the eyeholes fit over the eyes.
- Have your partner mark where your head ends on the top of the bag.
- Label this line "C"
- Cut the folds along the dashed cutting lines in the back up to the corners and along the top fold to line C

- DO NOT cut line C.
- Fold the back flap down on line C (Figure 4).
- Cut, or fold in, any extra paper from each side (shaded area, Figure 5)
- The back flap should be hanging loosely, attached only by line C (Figure 5),

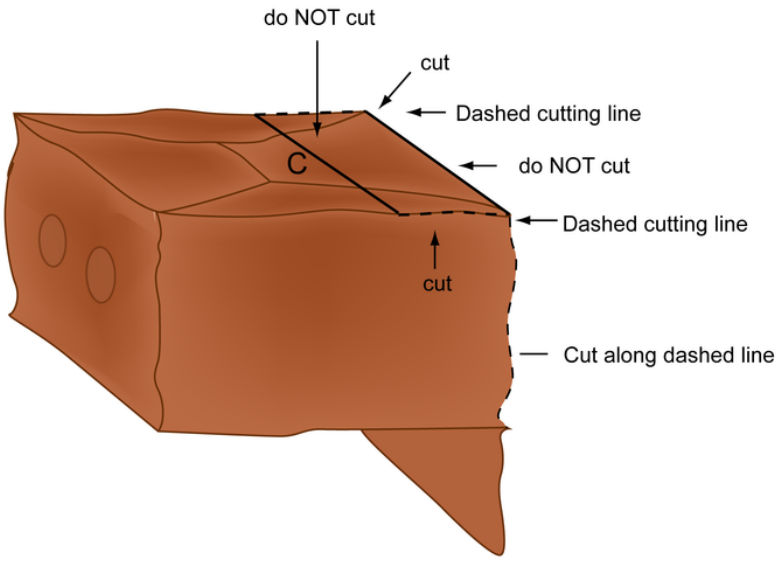
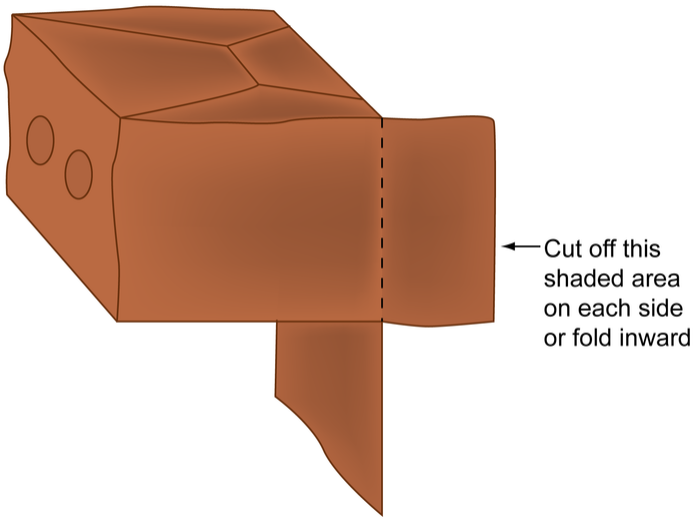


Figure 4

5. If no further adjustments are needed, flatten out the bag as illustrated below by cutting the two folds on each side of the eye holes (Figure 6).



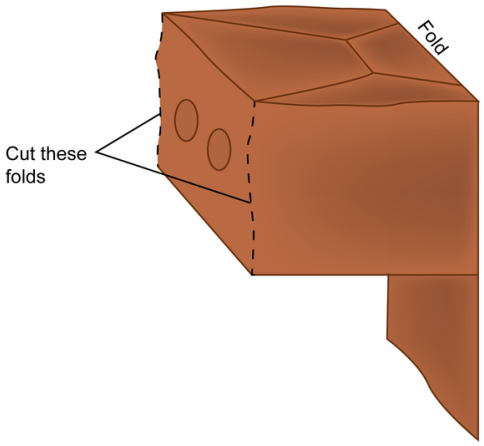


Figure 5

6. Use Figure 7 to outline the boundaries of the brain parts on the flattened bag ("Thinking Cap"). Be sure to select the side of the bag without advertising (or use the unmarked inside of the bag). Then write the names of the brain parts and regions of the cerebrum as indicated in Figure 7.

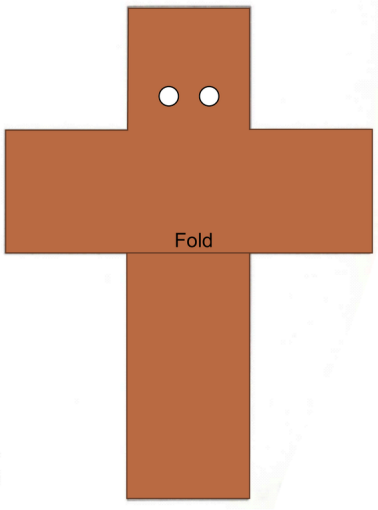


Figure 6

7. Follow the directions of your teacher for any further tasks (e.g., labeling parts of the brain and clean up).

3.3. ACTIVITIES AND ANSWER KEYS

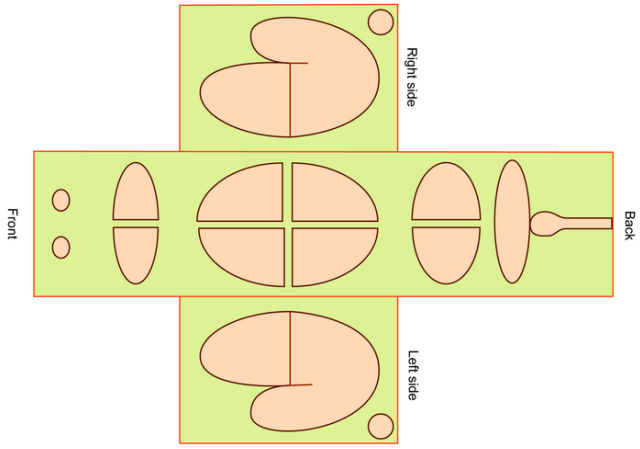
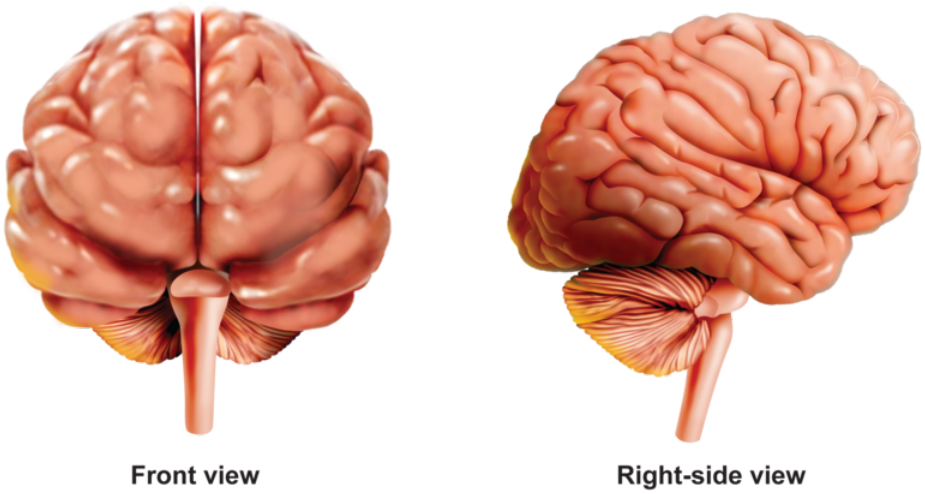


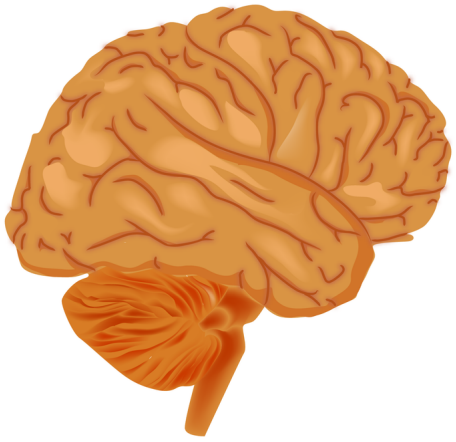
Figure 7 Illustration/template for paper bag model-boundaries of brain parts: top view.

Activity 2-2 Report: Thinking Cap (Student Reproducible)

1. For the drawing of the brain below, color-code the parts of the brain. Label *cerebrum, cerebellum, medulla,* and *spinal cord.* In addition, label left, right, top, bottom, front, and back.



2. On the following drawing, color-code the regions of the cerebrum *frontal, parietal, temporal,* and *occipital lobes.*



Right-side view

3. What are the functions of the brain regions recorded on your paper bag model of the "Thinking Cap"?

4. How do the meninges help to protect the brain? Describe meningitis and its effects on brain functions.

5. Communicate what you have learned about the brain to some else. you may wish to write a letter, create a poem, draw some pictures, have a conversation, use the computer, or use another method approved by your teacher.

6. How does this description of the brain and its functions differ from your thoughts about the brain before you started this activity?

CHAPTER 4 Neurons: The Building Blocks of the Nervous System - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

4.1 Planning

Key Ideas

- The neuron is the basic building block of the nervous system. There are three types of neurons: sensory, motor, and interneurons.
- Sensory neurons transmit information to the brain. Motor neurons transmit information from the brain to various parts of the body. Interneurons transmit information from sensory to motor neurons.
- The structure of the neuron differs from other cells in the body. Neuron design facilitates the transmission of electrical messages in one direction only.

Overview

In sections 1 and 2 students learned about the structure and function of the brain and the spinal cord. In this section they explore the structure and functions of neurons, the basic unit of the nervous system. Students design and build models of neurons showing dendrites, the axon, and cell body. They use these models to help explain how neurons carry messages in one direction only and how special chemicals called neurotransmitters carry information across the synapses (gaps between neurons.)

Objectives

Students:

✓ identify and describe the function of each part of a nerve cell.

✓ explain how nerve impulses move from one neuron to another.

✓ demonstrate neuron structure and function using the 3-D model of a neuron.

Vocabulary

axon, cell body, dendrites, glial cells, interneurons, motor neurons, neuron, neurotransmitter, sensory neurons, synapse

Student Materials

Activity 3-1: Picture a Nerve Cell

- Activity Report
- Markers, Crayons, Colored pencils, Construction paper

Activity 3-2: Drug Effects on Neurons

- Activity Report
- Resources 1, 2, and 3
- Signs that read:

Message Sender

Message Receiver

Dopamine Pump

Cocaine

- Two chairs
- 20 to 30 tennis balls
- Scissors; Yarn or string

Teacher Materials

Activity 3-1: Picture a Nerve Cell

- Activity Report Answer Key
- Sample pictures of neurons
- Microscope slide of neuron

Activity 3-2: Drug Effects on Neurons

- Activity Report Answer Key
- Resources 1, 4, 5, and 6
- Transparencies of Resources 2 and 3
- Charts and other visuals showing the synapse between two neurons

Advance Preparation

See Activities 3-1 and 3-2 in the Student Edition.

Activity 3-1: Picture a Nerve Cell

Prior to this activity, encourage students to draw a neuron and explain its cellular structure. For discussion, see the introduction to Section 3 in the Student Edition.

- Gather art materials or ask students to bring them.

Activity 3-2: Drug Effects on Neurons

- Prior to the activity, have students read Resource 1 and discuss the content in class.
- Gather materials and ask students to bring in tennis balls.

Interdisciplinary Connections

Physical Education and Health Discuss the effects of over-the-counter medications and illegal drugs on the brain. Investigate the effects of snakebites, chemical neurotoxins, and neurological diseases on the function of neurotransmitters in the brain.

Math Investigate metric system units such as microns by relating them to the size of the neurons.

4.2 Using Neurons: The Building Blocks of the Nervous System – Student Edition (Human Biology)

Discuss the role of models in science; in particular, the models of the brain students use in this unit.

Draw students' attention to the Key Ideas using means such as posters and overhead transparencies.

Begin section with *Activity 3-1: Picture a Nerve Cell* to introduce the structure and function of a neuron.

Explain how nerve impulses move from one neuron to another by connecting neuron diagrams to create synapses.

Explore the structure and function of the neuron by having students use their neuron diagram to complete the *Mini Activity: Building a 3-D Model of a Neuron*.

Emphasize that neurons carry messages in one direction only.

Do *Activity 3-2: Drug Effects on Neurons* to illustrate how information is carried through the synapse by neurotransmitters.

Provide the opportunity for students to share the models of the neuron with the class.

Emphasize that the nerve impulse is electrical as it passes along the dendrite, cell body, and axon of the neuron, and chemical as a neurotransmitter crosses the synapse.

Time permitting select from unit projects.

Throughout and at the end of the section refocus students' attention on the Key Ideas.

Journal Writing

You have read about neurons being like a big bedroom with tentacles and a nerve impulse being like an electrical signal. These explanations are analogies and they help us picture the activities of these parts of the nervous system. What other analogies can you think of to help you learn more about neurons? What analogies can you think of to describe a nerve impulse? Draw pictures to illustrate your analogies.

Mini-Activity

Building a 3-D Model of a Neuron Suggestions for materials include markers, crayons, colored pencils, scissors, colored paper, tape, glue, clay, oranges, apples, balloons (to represent cell bodies), wire, string, and yarn (to represent axon and dendrites). Have students place 2 or 3 neurons close to each other, but not touching, to create a reflex arc. Identify the synapse (space between neurons) where the neurotransmitter helps carry the impulse across the gap to the next neuron. When finished, display neuron models by hanging them (on string or tape) from the classroom ceiling or on the wall. The nerve impulse can be simulated by using a string of holiday lights (in sequence mode) to represent the electrical part of the message traveling down the axon. Food coloring added to a vial of water positioned between neurons can represent the chemical part of the impulse. Invite a guest speaker to address topics such as surgery, headaches, slipped disk, whiplash, or seasonal affective disorder.

4.3 Activities and Answer Keys

Activity 3-1: Picture a Nerve Cell

PLAN

Summary Students design drawings of neurons, which they join in chains or networks. The model nerve network helps them visualize and learn that information flows in one direction from dendrites to the cell body, along the axon to dendrites on the next neuron, and through synapses.

Objectives

Students:

✓ identify the parts of the neuron: axon, dendrites, and cell body.

✓ explain the relationship between the structure and function of a neuron.

✓ explain the function of neurotransmitters.

✓ demonstrate how neurons transmit messages from one place to another in the human body.

Student Materials

- Activity Report
- Markers, Crayons, Colored pencils, Construction paper

Teacher Materials

- Activity Report Answer Key
- Sample pictures of neurons
- Microscope slide of neuron
- Resource 1 from *Activity 3-2: Drug Effects on Neurons.*

Advance Preparation

Prior to this activity, encourage students to draw a neuron and explain their design. Gather art materials or ask students to bring them.

Estimated Time Approximately one or two 50-minute class periods, depending on what work is assigned as homework

Interdisciplinary

Visual and Performing Arts Students can create and/or embellish their neuron diagrams in art classes.

Home Education/Art Use fabric decorating paint to paint neuron designs on T-shirts.

Helpful Hints

Prepare a display area for completed neuron pictures. Discuss the structure of neurons with students.

Use the "holes" from punched paper to represent the neurotransmitter at the synapse, as it carries the chemical message from neuron A to neuron B.

Use some student drawings when learning about the reflex arc.

IMPLEMENT

Introduce Activity 3-1 by referring students to Figure 3.1 in the student text as a guide.

Steps 1-3 This activity can be done individually, in pairs, or with small groups. Make sure students have their texts for reference.

Step 4 Make sure students keep a space between their neurons to represent a synapse. Refer students to Figure 3.3. Discuss the structure of neurons with students.

Extensions

Use computer graphics to create a two-dimensional model of a neuron. Invite students to research neurotransmitters and health, with respect to depression and suicide. Possible resources include community hospitals, health clinics, and hotlines, as well as libraries, local medical experts, and computer information searches, e.g., Web sites for the National Institutes of Health (NIH) and the Society for Neurobiology.

ASSESS

Use the model of a neuron and the written responses on the Activity Report to assess if students can

✓ identify the location of the specific parts of a neuron (axon, dendrites, and cell body).

✓ explain how each part of a neuron functions, using diagrams.

✓ demonstrate what a neurotransmitter is and how it works.

✓ describe how a message is transferred through a synapse between two neurons.

✓ show how the transfer of a message along a chain of neurons allows the nervous system to function properly.

Activity 3-1: Picture a Nerve Cell – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Describe the path a nerve impulse takes. Include the pathway taken within a neuron and the way an impulse travels between neurons. Add a sketch, with labels and arrows, to indicate the direction of the impulse or message.
2. What is the role of the neurotransmitter?
3. What effects would certain drugs have on the function of a neuron? (You may want to read the information on Resource 1 of *Activity 3-2: Drug Effects on Neurons* to answer this question.)
4. What questions do you have about how nerve cells work to carry messages throughout your body?

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

- **Some poisonous snakes have venom that can paralyze a person. How do you think the venom affects the nervous system?**
- **What kinds of symptoms do you think a person would have if the axons of his or her nerve cells were damaged?**

Activity 3-2: Drug Effects on Neurons

PLAN

Summary Students demonstrate the normal transmission of dopamine across a synapse in the brain and then the effects of the drug cocaine on neurons. These activities help students visualize and learn how drugs disturb the normal function of nerve cells and, in this case, the neurotransmitter dopamine.

Objectives

Students:

✓ demonstrate and explain the transmission of the neurotransmitter dopamine across a synapse.

✓ demonstrate the effects of cocaine on the normal function of neurons.

✓ explain the effects of cocaine on neurons.

Student Materials

- Resources 1, 2, 3
- Activity Report

Signs that read:

Message Sender

Message Receiver

Dopamine Pump

Cocaine

- Tennis balls (about 20 to 30)
- 2 chairs
- Scissors
- Yarn or string

Teacher Materials

- Activity Report Answer Key
- Resources 1, 4, 5, and 6
- Transparencies of Resources 2 and 3
- Charts and other visuals showing the synapse between two neurons

Advance Preparation

Prior to the activity, have students read Resource 1 and discuss the content in class.

Gather materials and ask students to bring in tennis balls.

Interdisciplinary

Physical Education Students discuss drug testing for bus and train drivers, pilots, physicians, and participants in competitive sports.

Prerequisites

Students should review the structure and function of neurons, synapses, and how neurotransmitters work.

You may want students to review or learn about the effects of stimulant and depressant drugs.

IMPLEMENT

Introduce Activity 3-2 by discussing the structure and function of neurons, synapses, and how neurotransmitters work. Review the effects of stimulant and depressant drugs.

Step 1 Have students read Resource 1. You may want to make a transparency of Resource 1 and discuss the resource as students read along.

Step 2 Explain the process shown in Resource 2 titled *Normal Transmission of Dopamine* to students. Ask students to explain how dopamine is transferred from one neuron to another neuron across the synapse in order to determine how much they know about the process.

Step 3 Explain the process shown in Resource 3 titled *Cocaine's Effect on Neurons* to students.

Steps 4-5 Assign specific classification of drugs (stimulant or depressant) to groups of students. Use Resource 6 to record observations of the presentation.

Extend Activity 3-2 by having students research the use of drugs in medicine and the possible long-term effects of illicit drugs on the body.

ASSESS

Use observations of student's performance and written responses on the Activity Report to assess if students can

✓ demonstrate and explain the transmission of the neurotransmitter dopamine across a synapse in the brain.

✓ demonstrate and explain the effects of cocaine on the normal transmission of dopamine across the synapse.

✓ explain the effects of stimulants and depressants on a neuron.

✓ create a presentation on the effects of stimulants and depressants on the nervous system.

Activity 3-2: Drug Effects on Neurons – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Discuss the role of dopamine in the transmission of a nerve impulse.
2. Describe the effects of cocaine on neurons.
3. Distinguish between a stimulant and a depressant.
4. How do stimulants and depressants affect nerve cell function?
5. What was the most interesting thing you learned from this activity?

Review Questions/Answers

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Name and describe the three basic parts of a neuron.
2. What is a synapse?
3. Why are neurotransmitters important?
4. Why are nerve impulses like a "human wave in a sports stadium"?

Activity 3-1: Report Picture a Nerve Cell (Student Reproducible)

1. Describe the path a nerve impulse takes. Include the pathway taken within a neuron and the way an impulse travels between neurons. Add a sketch, with labels and arrows, to indicate the direction of the impulse or message.

2. What is the role of the neurotransmitter? (Hint: see Procedure Step 3)

3. What effects would certain drugs have on the function of a neuron? (You may want to read the information on Resource 1 of *Activity 3-2: Drug Effects on Neurons* to answer this question.)

4. What questions do you have about how nerve cells work to carry messages throughout your body?

Activity 3-2 Resource 1: Drug Effects on Neurons (Student Reproducible)

Science News Report

Drugs affect the body by influencing the regulation of cellular processes. In many cases, the cellular processes that are most disrupted by drugs are those carried out by neurons. Drugs affect nerve cells by interfering with their ability to receive and transmit signals. The synaptic phase of nerve signal transmission depends on the release of neurotransmitter molecules, the diffusion of these molecules across the synaptic space, and the way a given neurotransmitter is able to structurally "fit into" and later "drop out of" a receptor. Some drugs might affect nerve signal transmission by increasing or decreasing the amount of neurotransmitters in the synaptic space. Other drugs might even "take the place" of neurotransmitters on the receptors located on a synaptic membrane. These drug actions occur at synapses and can make nerve signals more intense, less intense, or completely prevent the signal's transmission. The influence of these drugs on thought, mood, and behavior results from the drugs' effects on nerve cells.

Drugs that affect the nervous system include stimulants and depressants.

Stimulants

The stimulants are a group of drugs that speed up cellular processes causing an increase in heart rate, blood pressure, body temperature, and rate of breathing. Stimulants increase signal transmission at synapses that in turn stimulate nervous system activity. Normally, your nervous system does a good job of correctly balancing excitation and inhibition. However, the balance is disrupted by stimulants in a way that leads to anxiety, restlessness, dizziness, headaches, inability to sleep, and tremors. Examples of stimulants include caffeine, nicotine, and amphetamines.

Depressants

The depressants are a group of drugs that slow down or decrease the actions of the nervous system. They enhance the activity of inhibitory nerve signal pathways in the brain. There are two types of depressants-sedatives and analgesics. Sedatives are drugs that have a generalized effect on the function of the nervous system and produce relaxation. Analgesics, such as aspirin, have a "painkilling" effect on nerve pathways. Some of the depressants, such as opioids and alcohol, have both sedative and analgesic effects. Depressants lower blood pressure and body temperature and decrease muscle action and heart rate. All depressants are addictive. Examples include barbiturates and alcohol.

Dopamine

Numerous substances are known neurotransmitters in the brain. Many of these are amino acids or derivatives of amino acids. They serve as chemical messengers between nerve cells. Neurons containing the neurotransmitter dopamine are clustered in the midbrain.

Cocaine

Cocaine comes from the cocoa plant found in South America. It is used in medicine as an anesthetic for eye, ear, nose, and throat surgery. Cocaine obtained illegally is known on the streets as "Coke" "C" "snow," "blow," "toot," "rock," or "crack." It can be smoked, snorted, or injected. "Freebasing" is the smoking of cocaine that has been converted to a pure base. Crack, which is extremely addictive, is a rocklike mixture of cocaine and baking soda that is smoked.

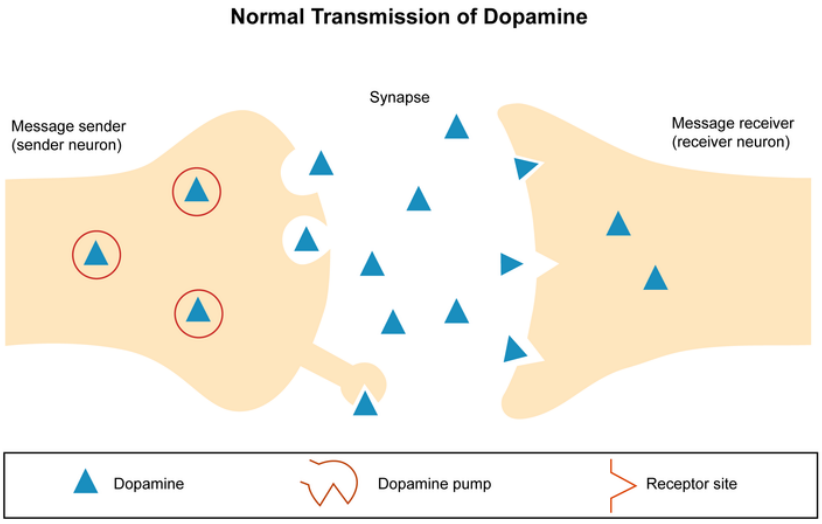
Cocaine is a powerful central nervous system stimulant. While cocaine's effects are very similar to amphetamines', they usually are more intense and tend to magnify feelings of self-confidence and mental alertness. Cocaine can cause a powerful heightened state of pleasure. This euphoria or feeling of being high lasts only a short time depending on how the cocaine is taken. When the drug's effect wears off, the person is left feeling let down and depressed. The "let down" is so powerful that it leads to a strong desire to take the next dose of cocaine to feel good again. Cocaine is an extremely addictive drug.

Cocaine, like amphetamines, affects the synaptic terminals of neurons that release dopamine. Cocaine increases the amount of dopamine released from neurons. However, unlike amphetamines, cocaine also interferes with the body's normal mechanism for removing dopamine molecules.

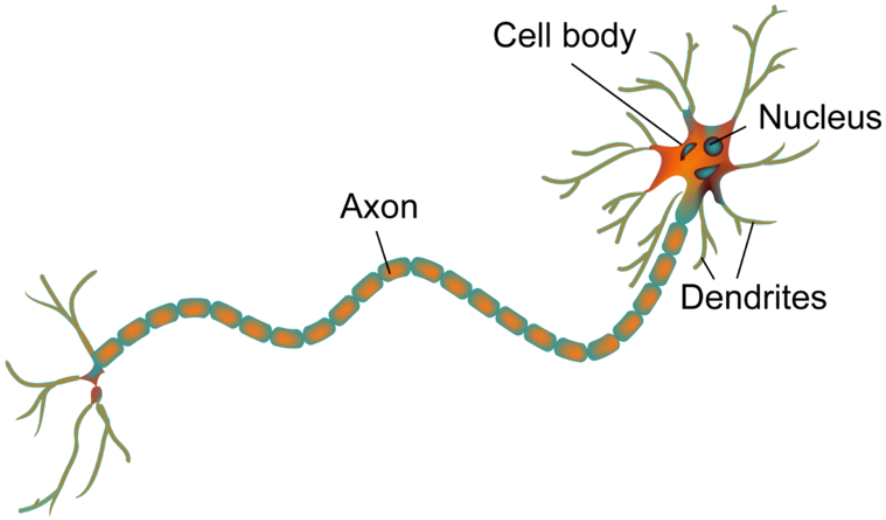
Cocaine is among the most dangerous of illegal drugs. A single use of cocaine can cause the heartbeat to become irregular and the coronary arteries (which nourish the heart muscle cells) to constrict. In extreme cases cocaine use can lead to a heart attack and sudden death. Repeated snorting of cocaine can do serious damage to the nasal passages. Abusers may feel paranoid, suffer shaking and convulsions, and have unpredictable behavior.

Pregnant mothers who use cocaine endanger their babies' health. Cocaine constricts the blood vessels carrying nutrients to a developing baby in the womb. At birth, the infant can be addicted to cocaine just like the mother.

Activity 3-2 Resource 2: Drug Effects on Neurons (Student Reproducible)



Activity 3-2 Resource 3: Drug Effects on Neurons (Student Reproducible)



Activity 3-2 Resource 4: Drug Effects on Neurons (Student Reproducible)

Part 1

Demonstrate for your class the normal transmission of dopamine. Three students volunteer for the demonstration.

Setup-

- Dopamine is represented by tennis balls.
- "Message sender" sits on a chair on the left.
- "Message receiver" sits on a chair about 3 feet to the right.
- "Dopamine pump" stands near the "neuron message sender."

Using an overhead transparency of the diagram, discuss the process for the normal transmission of dopamine. A possible narrative for this discussion:

1. The **neuron message sender** releases **dopamine** in little packets. The "neuron message sender" shows the class a tennis ball.
2. The **neuron message sender** releases dopamine into the **synapse.** The **neuron message receiver** absorbs the dopamine at the **receptor site.** The "neuron message sender" tosses one tennis ball at a time to the "neuron message receiver."
3. As dopamine accumulates in the synapse, the **dopamine pump** recycles or takes the dopamine back into the neuron message sender. When the "neuron message receiver's" hands are full, the "neuron message receiver" tosses the ball up in the air, and it is caught by the "dopamine pump" and given back to the "neuron message sender."
4. Repeat this demonstration using a different group of students. Students explain this process to each other and then volunteer to present their explanations to the class.

Activity 3-2 Resource 5: Drug Effects on Neurons (Student Reproducible)

Part 2

Demonstrate for your class cocaine's effect on neurons. At least four student volunteers will help with the demonstration.

Setup-

- Dopamine is represented by tennis balls.
- "Message sender" sits on a chair on the left.
- "Message receiver" sits on a chair about 3 feet to the right.
- "Dopamine pump" sits on the floor next to the "neuron message sender."
- "Cocaine" is waiting in the wings.

1. The **neuron message sender** releases **dopamine** in little packets. The "neuron message sender" shows the class a tennis ball.
2. The **neuron message sender** releases dopamine into the **synapse.** The **neuron message receiver** absorbs the dopamine at the **receptor site.** The "neuron message sender" tosses one tennis ball at a time to the "neuron message receiver."
3. As dopamine accumulates in the synapse, the **dopamine pump** recycles or takes the dopamine back into the neuron message sender. When the "neuron message receiver's" hands are full, the "neuron message receiver" tosses the ball up in the air, and it is caught by the "dopamine pump" and given back to the "neuron message sender."
4. When cocaine is introduced into the body, it blocks the dopamine pump and prevents the recycling of dopamine into the message sender. The "cocaine" holds the hands of the "dopamine pump" so that they cannot catch the extra balls or hand them to the "neuron message sender."
5. When the extra dopamine cannot be pumped back to the neuron message sender, an excess of dopamine is absorbed by the receptor sites on the neuron message receiver. The result of this excess is that you feel really high. "Neuron Message Receiver" throws all the tennis balls up in the air. The balls are not caught by the "Dopamine Pump." They stay with the "Neuron Message Receiver." The accumulating balls and chaos represent the "high."
6. Repeat this demonstration using a different group of students. Students explain this process to each other and then volunteer to present their explanations to the class.

Activity 3-2 Resource 6: Drug Effects on Neurons (Student Reproducible)

Names _____ Tasks _____

_____ _____

_____ _____

_____ _____

_____ _____

Presentation Guidelines: Drug Classification _____

1. **Content** Points _____

drug classification: stimulant or depressant effects of drug on neuron effects of drug on dopamine transmission

2. Accuracy/Completeness of Content Points _____

neat, clear, accurate serve to guide viewer toward improved knowledge of drug effects aesthetically pleasing

3. Presentation Points _____

good eye contact and voice projection all group members contribute equally clear, organized presentation engaging, interesting

4. Creativity/originality Points _____

presentation reflects thoughtful design effective and appropriate use of visual tools such as diagrams, pictures, and graphs

Activity 3-2 Report: Drug Effects on Neurons (Student Reproducible)

1. Discuss the role of dopamine in the transmission of a nerve impulse.
2. Describe the effects of cocaine on neurons.
3. Distinguish between a stimulant and a depressant.
4. How do stimulants and depressants affect nerve cell function?
5. What was the most interesting thing you learned from this activity?

CHAPTER 5 Reflexes: Neurons in Action - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

5.1 Planning

Key Ideas

- A reflex is the simplest circuit in the nervous system.
- Once triggered by a stimulus, a reflex goes to completion and causes a response, such as a muscle reaction. Some reflexes are easier to control than others.
- The five parts of a reflex arc are the sensor, sensory neuron, control center, motor neuron, and muscle.

Overview

In the previous sections students learned about components of the nervous system. In this section they investigate a nerve circuit. They learn that reflexes are simple circuits in the nervous system that result in a response. Students identify reflexes, which are an important part of behavior and serve as protection from harm.

Objectives

Students:

✓ demonstrate and explain the five-part sequence of a reflex arc.

✓ distinguish between a motor neuron and a sensory neuron.

✓ explain the role of an inhibitory interneuron in a reflex.

Vocabulary

reflex, stimulus

Student Materials

Activity 4-1: How Fast Is Your Reaction Time?

- Activity Report
- 20 *cm* metric ruler

Teacher Materials

Activity 4-1: How Fast Is Your Reaction Time?

- Activity Report Answer Key

Advance Preparation

See Activity 4-1 in the Student Edition

Activity 4-1: How Fast Is Your Reaction Time

- Gather 20 *cm* rulers.

Interdisciplinary Connections

Math Use strings of holiday minilights set to sequence mode to illustrate the nerve impulse traveling down the axon.

5.2 Using Reflexes: Neurons in Action – Student Edition (Human Biology)

Discuss the role of models science-especially models of the brain and spinal cord.

Draw students' attention to the Key Ideas using means such as posters and transparencies.

Begin this section with *Mini Activity: The Knee Jerk Reflex* and relate to the first *Did You Know?*

Demonstrate and introduce the 5-part sequence of a reflex arc using your hand.

Do the *Activity 4-1: How Fast Is Your Reaction Time?*

Mini-Activity

The Knee Jerk Reflex If possible, borrow one or more physician's reflex hammers for students to try. Students elicit knee jerks by tapping on their own quadriceps tendons *below* the kneecap. Taps should be sharp and abrupt, but not too hard.

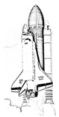
Questions and Answers

1. What makes it easy to get a knee jerk reflex?
2. Which muscles contract when your knee jerks?
3. How hard must you tap to get your knee to jerk?
4. What happens if you squeeze your hands together when someone else taps your knee?
5. Can you stop your foot before it swings, if you want to?
6. Name some other reflexes.
7. Why are reflexes important?
8. Have students draw a picture of the knee jerk reflex.

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

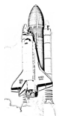
Apply Your KNOWLEDGE

How many reflexes can you think of? Work in small groups or in pairs to list as many as you can. Group them into categories that show how the reflexes protect you. Decide which are easier to control than others. Then share your list with the class.



Mini-Activity

Identifying Parts of a Reflex Students pick two reflexes from the list of reflexes they created in the Apply Your Knowledge question of page 32 and identify the five parts of those reflex arcs.



Mini-Activity

React First, Think Later Students calculate the time it takes for a nerve impulse to go from their big toe to their spinal cord and then from their spinal cord to their cortex.

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

Sometimes in addition to tapping your knee to make sure you have healthy reflexes, the doctor tickles the bottom of your foot. Why is that?

5.3 Activities and Answer Keys

Activity 4-1: How Fast Is Your Reaction Time?

PLAN

Summary In this activity students measure their reaction time and consider the mechanisms that allow for quick reactions.

Objectives

Students:

✓ measure the ir reaction time.

✓ explain the changes in their reaction time.

✓ describe the advantage of a fast reaction time.

Student Materials

- 20 – *cm* ruler
- Activity Report

Teacher Materials

- Activity Report Answer Key

Estimated Time

One 50-minute period

IMPLEMENT

Steps 1-2 You may want to have students repeat the procedure using their other hand. Students can record the time in seconds for each trial.

Step 3 Students should switch roles. Again, you may want to have students repeat the procedure using their other hand. Students can record the time in seconds for each trial.

Step 4 Have students graph their results.

> **Helpful Hints**
> Each student team needs a 20 *cm* metric ruler.
> Be sure students know how to construct a graph from their data.

Extend Activity 4-1 by having students determine their reaction times to various stimuli. Several ways to test reactions times are described below.

Hand Slap-Both members of student pair removes all jewelry from wrists/hands. One student holds the right hand out with the palm facing up. The partner rests his/her right hand on the partner's right hand with the palm facing

down. The first student (palm facing up) attempts to turn his or her hand over fast enough to slap the back of the partner's hand (palm facing down). The hand turning speed of one partner is tested against the partner's reaction time.

Penny Grab-Students hold their right arm out with the palm facing down. A penny is placed on the center of the back of the hand. Students slowly tilt their hands to the side so that the penny slides off. Students try to catch the penny before it hits the ground. The procedure is repeated and the number of catches is documented. Students should determine whether their reaction time gets better with practice. The same procedure can be repeated with the left hand.

Dollar Drop-One student holds a dollar bill (on its side) at arm's length above his/her head. Another student attempts to catch the dollar as it flutters to the ground. (Restrict student to one hand if this is too simple.) Have students predict whether it would be easier to catch a tennis ball or the dollar. Students should discover that it takes time for the eye to see that the dollar was released, time for the brain to tell the hand to grasp it, and more time for the hand muscles to respond. This activity illustrates that the brain and nervous system must have time to adjust before most movements can be accomplished.

ASSESS

Use the completion of the activity and the written responses to the Activity Report to assess if students can

✓ measure their reaction time.

✓ explain the changes in their observed reaction times.

✓ describe the advantage of a fast reaction time.

Activity 4-1: How Fast Is Your Reaction Time? – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Record in the table below the reading on the ruler for each trial.

TABLE 5.1:

Trial	Distance in centimeters
1	
2	
3	
4	
5	
6	

2. Graph your results recorded in the table above.
3. Using the data in your table and graph, what was the trend in reaction times recorded? Compare the times from the first to the last trials. What would you expect after ten trials?
4. How would you explain the changes in reaction time?
5. What are some advantages of fast reaction times?

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

What happens when someone throws a ball at you and you blink? Trace the path the message takes through your nervous system.

Review Questions/Answers

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. What is a reflex response to a stimulus? Give three examples, describing both the stimulus and the reflex.
2. Name the five parts of a reflex in order.
3. What is the difference between a sensory neuron and a motor neuron?
4. If you touch a hot stove, why do you pull your hand away before you feel pain?
5. What role does an inhibitory interneuron play in a reflex?

Activity Report 4-1: How Fast Is Your Reaction lime?

1. Record in the table below the reading on the ruler for each trial.

TABLE 5.2:

Trial	Distance in centimeters
1	
2	
3	
4	
5	
6	

2. Graph your results recorded in the table above.

3. Using the data in your table and graph, what was the trend in reaction times recorded? Compare the times from the first to the last trials. What would you expect after ten trials?

4. How would you explain the changes in your reaction time?

5. What are some advantages of fast reaction time?

CHAPTER 6 Sensation - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

6.1 Planning

Key Ideas

- Sensory organs such as eyes and ears act as windows to the world that bring information into the nervous system.
- Sensory neurons connect with certain areas of the brain. All neurons fire impulses, but where they go in the brain determines the nature of the sensation.
- The eye and ear represent two different and highly specialized organs connected to the nervous system.

Overview

Students build on their knowledge of the nervous system from previous sections by investigating sensors as "windows to the world." They actively explore what sensors are and how sensors help gather information about the environment. They learn about the structure and function of the eye and the ear by constructing models and by performing experiments to investigate their functions and limitations. Students can conduct a dissection of a mammalian eye by designing their own lab or by using the procedures provided.

Objectives

Students:

✓ describe the role sensors play in receiving and transmitting nerve impulses.

✓ identify the parts of the eye.

✓ distinguish between rods and cones in the eye.

✓ compare the functions of eyes with that of a camera.

✓ identify the parts of the ear.

✓ explain how the ears capture sound.

Vocabulary

Parts of the ear:

anvil, cochlea, eardrum, Eustachian tube, hammer, pinna, stirrup

Parts of the eye:

cornea, iris, lens, optic nerve, pupil, retina

Student Materials

Activity 5-1: Using Your Sensors

- Activity Report
- Activity Data Table
- Objects of a variety of shapes and sizes; Gloves; blindfold; clock

Activity 5-2: Designing and Building a Model of the Eye

- Resource
- Activity Report
- Construction materials (as requested by students) such as construction paper; scissors; colored marking pens; string or colored yarns (to represent nerves, muscles, or eyelashes); old tennis balls or other round, hollow objects; plastic covers from containers (for the lens)

Activity 5-3: Exploring a Mammalian Eye

- Activity Report
- Resource (If students will use prepared procedure)
- Goggles; Sheep or cow eye; Paper towels; Dissection pan; Scalpel (single-edged cutting tool); Forceps; Scissors; Needle or metal probe

Teacher Materials

Activity 5-1: Using Your Sensors

- Data Table Answer Key
- Activity Report Answer Key
- Sample Data Sheets on transparency
- Optional: extra items for students to sort

Activity 5-2: Designing and Building a Model of the Eye

- Activity Report Answer Key
- Large chart and/or model of the human eye
- Optional: Computer simulation showing the structure and function of the human eye

Activity 5-3: Exploring a Mammalian Eye

- Activity Report Answer Key
- Model or large diagram/chart of the eye
- Resource (If students use prepared procedure)

Advance Preparation

See Activities 5-1, 5-2, and 5-3 in the Student Edition.

Activity 5-1: Using Your Sensors

- Gather and organize optional materials so they are accessible to students.

Activity 5-2: Designing and Building a Model of the Eye

- Obtain large eye diagram and a selection of materials for constructing the models.

Activity 5-3: Exploring a Mammalian Eye

- Obtain all student and teacher materials.

Interdisciplinary

Music/Band Class Make connections between the structure and the function of the ear and how they relate to the perception of music. Explore tonal variations with different instruments.

Physical Education and Health Focus on how to protect hearing and eyesight as part of good health practices. Examine how corrective lenses and hearing aids can assist people whose vision and hearing needs to be augmented. Research ear protection required for certain occupations.

Language Arts Students use creative writing strategies to describe how sensory systems work.

Art Investigate how the brain perceives color and study examples of artwork that use depth perception and optical illusions.

Social Studies Investigate local regulations governing noise pollution.

Math Use variables and constants in setting up investigations. Study the properties of waves using formulas. Solve math problems relating to the speed of sound and the speed of light.

Enrichment Activity

Enrichment 5-1: Building a Model of the Ear

Background Information

Two kinds of information that are used to maintain balance are mentioned in the text. One primarily senses movement and the other position relative to gravity. The organ responsible for sensing movement is called the vestibular apparatus. It consists of two membranous sacs in which sensitive hair cells are embedded in a gelatinous mass. When you move or change direction of movement, the change in momentum of the mass bends the hair cells and sends nerve impulses to the brain. The organ responsible for sensing position is the semicircular canals. They are fluid-filled loops of tubules with different orientations. When the head changes position, the fluid moves through

these tubes in specific ways. At the base of the tubes are clusters of hair cells that are bent by the moving fluid. The hair cells that are bent send nerve impulses to the brain.

6.2 Using Sensation – Student Edition (Human Biology)

Discuss the role of models in science and relate it to the models of the eye and the ear that students design in this section.

Draw students' attention to the Key Ideas using means such as posters and overhead transparencies.

Assign *Mini Activity: How Much Sleep Do You Need?*, which requires making observations over a two-week period.

Begin the section by discussing the question, "How do you know about the world around you?"

Emphasize that all electrical messages transmitted by sensory neurons are the same. The sensation that is experienced is determined by where they go in the brain.

Introduce *Activity 5 -1: Using Your Sensors* by discussing the questions "What is sensation?" and "What are sensors?"

Discuss Activity 5-1 Report questions in class.

Use the student-constructed 3-D model of the eye to illustrate how the eye works similar to a camera.

Completion of eye model in Activity 5-2 helps students with the dissection of the eye in Activity 5-3.

Discuss Activity 5-3 Report questions.

Complete *Enrichment 5 -1: Building a Model of the Ear,* if time permits.

Emphasize good health practices as they relate to the senses, especially the eyes and ears.

Time permitting select from unit projects.

Throughout and at the end of the section refocus students' attention on the Key Ideas.

Journal Writing

Your brain associates a sensation with stored information in your brain memories. Write a journal entry about your favorite color. Include descriptions of how the color might feel, taste, smell, and sound. What association does your brain make with your favorite color?

6.3 Activities and Answer Keys

Activity 5-1: Using Your Sensors

PLAN

Summary Students conduct experiments to see what happens when they sort objects with and without the use of a sensor, specifically the sense of touch and the sense of vision.

Objectives

Students:

✓ design and conduct experiments on the senses of touch and vision.

✓ explain what happens when you lose the sense of touch or vision.

Student Materials

- Activity Data Table
- Activity Report
- Objects of a variety of shapes and sizes; gloves; blindfold; clock

Teacher Materials

- Data Table Answer Key
- Activity Report Answer Key
- Sample Data Sheet on transparency
- Optional: extra items for students to sort

Advance Preparation

Gather and organize optional materials so they are accessible to students.

Estimated Time Approximately one to two 50-minute periods

Interdisciplinary

Math Discussion of "variables" and "constants" as they relate to math and science.

Physical Education and Health Connect this activity to ways to keep the nervous system healthy.

IMPLEMENT

Introduce Activity 5-1 by discussing experimental design and the importance of the following: *variable,* the factor under investigation; *constants,* factors which remain the same throughout the experiment; *hypothesis*, a "best" guess, supported with reasons, for the outcome of the experiment; *data,* the results of the experiment obtained by observing and measuring; *and conclusions,* the analysis of the data that either supports or refutes the original hypothesis. It leads to a conclusion about what actually happened during the experiment and its significance. The conclusions also could include suggestions for further experiments to answer new questions arising out of this experiment.

Helpful Hints

Gloves or mittens provide an easy means for impeding the sense of touch.

A blindfold made from a scarf or towel is suitable for blocking the sense of vision.

Invite students to design another experiment investigating the loss of both sight and touch when sorting objects.

Students also can design another experiment investigating the sense of hearing. See item #4 on the Activity Report.

Steps 1-2 Groups of at least three students are best. This allows for teamwork among the sorter, timer, and recorder.

If time is limited, you can divide the class in half, with one half of the class carrying out the touch experiment and the other half carrying out the vision experiment.

You also could divide the class into thirds, with one third investigating touch, one third investigating vision, and one third investigating touch and vision combined.

Be prepared to help student groups with suggestions for the items to be counted, how to form a hypothesis, and experimental design. Hypothesis may vary but should include reasons.

Sample Hypotheses include

- I think that the sorter will sort fewer objects correctly without touch than with touch because touch receptors are the most important sense when using the fingers and hands.
- I think that there will be fewer objects sorted correctly in the dark than in the light because the sense of vision is important in helping us distinguish between shapes of objects.

Extend Activity 5-1 Brainstorm with students other ways to design this experiment. For example, students could continue sorting until all objects have been correctly sorted. Students would then record the time needed to complete sorting. Ask students to explain why this would or would not be a better approach for the investigation. During the discussion, remind students that there are many ways to approach experimental design and that collaboration, like brainstorming, is a helpful and an enjoyable part of the scientific process.

Steps 3-4 Encourage students to design their own data sheets. However, a sample data sheet is included for your reference or use. If desired, you can copy these data sheets for student use.

Steps 5-8 Check the designs and help students whose designs are approved to get started with their investigation. Make sure students record their results on their data sheets. Remind students that conclusions need to be supported by data. Conclusions also should include explanations for any discrepancies between original hypothesis and actual results.

ASSESS

Use the experimental design, implementation, analysis of results, and written responses to the Activity Report to assess if students can

✓ determine and implement the key components necessary for good experimental design (hypothesis, variable, control, data table design, making and recording accurate observations, interpreting data, and stating conclusions supported by data).

✓ compare conclusions with original hypothesis.

✓ change or repeat the experiment to explore other questions.

✓ explain the importance of touch and vision when sorting a collection of objects.

Activity 5-1: Using Your Sensors Data Table Answer Key

Title of Experiment: *Touch Experiment*

Hypothesis:

Hypotheses may vary. If the sense of touch is important in helping to distinguish between shapes and objects, then there will be fewer objects sorted correctly when wearing gloves than when not wearing gloves.

Results:

Time allowed for sorting: *30 seconds* (seconds, minutes)

TABLE 6.1:

Name of objects to be sorted	Number of objects sorted	
	Without sensor	With sensor

Draw a graph to summarize your data.

Graphs will vary but could be a bar graph showing the number of objects correctly sorted in 30 seconds. In general, a lower number of objects will be sorted correctly without the sensor than with the sensor.

Title of Experiment: *Vision Experiment*

Hypothesis:

Hypothesis may vary. If the sense of vision is important in helping distinguish between shapes of objects, then there will be fewer objects sorted correctly in the dark than there will be in the light.

Results:

Time allowed for sorting: *30 seconds* (seconds, minutes)

TABLE 6.2:

Name of objects to be sorted	Number of objects sorted	
	Without sensor	With sensor

Draw a graph to summarize your data.

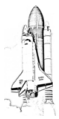
Graphs will vary but could be a bar graph showing the number of objects correctly sorted in 30 seconds. In general, a lower number of objects will be sorted correctly with the blindfold on than when students can see.

Activity 5-1: Using Your Sensors – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. What was the variable in each experiment? What was the constant?
2. Was your hypothesis correct for each of the experiments? Give reasons for your answers.
   (a) Touch Experiment
   (b) Vision Experiment
3. In your own words, summarize the results of each of the experiments.

4. How could you design an experiment to learn more about how your senses help you respond to the environment?
5. Think about the experiments you have just completed and complete the following sentences to summarize the value of each sense in helping you communicate with your environment. My sense of touch is like _____ that helps me to _____ My sense of vision is like _____ that helps me to _____



Mini-Activity

Use Your Sensors Students sit silently with their eyes closed for a few minutes, which makes it easier to focus on the other senses. They then make a list of all the things they noticed during these few minutes.

Activity 5-2: Designing and Building a Model of the Eye

PLAN

Summary Students discuss and review the structures of the human eye and how it works to help us see. They design a model eye and use their plans to construct it. Students use their models to explain the structures of the eye and their functions. They discuss how to protect the eyes from injury and disease.

Objectives

Students:

✓ explain how the parts of the eye are organized.

✓ state the functions of the parts of the eye.

Student Materials

- Resource
- Activity Report
- Variable, depending on student requests. Some examples might include Construction materials (as requested by students) such as construction paper; scissors; colored marking pens; string or colored yarns (to represent nerves, muscles, or eyelashes); old tennis balls or other round, hollow objects; plastic covers for margarine containers (for the lens)

Helpful Hints

Invite a guest speaker to talk to students about proper care of eyes. Consider an ophthalmologist, optometrist, nurse, or community health resource person. Your students may have a parent or friend who works in this area and could be helpful in arranging such a visit. Obtain a Snellen Chart to show students one method for checking vision.

Teacher Materials

- Activity Report Answer Key
- Large chart and/or model of the human eye
- Optional: Computer simulation showing the structure and function of the human eye

Advance Preparation

Obtain large eye diagram and a selection of materials for constructing the models.

Interdisciplinary Connection

Physical Education and Health Students discuss and identify eye protection gear for different sports. They also discuss common diseases of the eye and how they can be prevented.

Estimated Time Approximately one to three 50-minute periods

Prerequisites and Background Information

Students should have some knowledge of the structure of the human eye and how it works.

IMPLEMENT

Introduce Activity 5-2 by discussing the chart of the eye and other computer or text references about the structure and function of the eye. You may want to have some materials available to give students starting ideas for making a materials list for their eye models.

Steps 1-5 Once students have given you designs and lists of materials, decide who will provide these materials. Even if you decide that students are responsible for their own materials, you probably will want to have some generic materials available for classroom use. (See Student Materials.)

- Construction of the model eye can take place in class, or at home, depending on your time restrictions.

Step 6 When models are complete, students can share them with the class.

- Allow time for groups to give the presentations on their models to the class, to other classes, or at home. If students share at home, invite parent feedback in the form of a written note explaining what was done, how much time was spent, and any additional comments.
- You may want to have students display their models in the classroom and/or save them for future use.

Helpful Hints
Can students modify the model in order to improve the design of the eye?
Students might conduct research and use their models to discuss

- eye diseases
- eye injuries
- corrective medical procedures
- how drugs affect vision
- corrective lenses
- protective lenses

Encourage students to improve on existing designs for protective lenses, corrective lenses, and even the human eye.

ASSESS

Use the human eye model and written responses on the Activity Report to assess if students can

✓ select and use materials effectively to create a realistic model of the human eye.

✓ locate correctly the important parts of the eye (sclera, retina, cornea, ciliary muscles, iris, optic nerve, lens, fovea, vitreous humor, and aqueous humor).

✓ use the eye model to demonstrate how the function of the different parts of the eye enables humans to see.

Activity 5-2: Designing and Building a Model of the Eye – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. What is the function of the human eye?
2. Describe your model of the human eye. You may want to include labeled diagrams.
3. Trace a ray of light from the time it enters the eye until it is received by the brain. Include in your answer the parts of your model as they correspond to the parts of the human eye.
4. What are two ways your model accurately represents a human eye? What are two ways your model does not?
5. If you were to repeat this activity how would you design and construct the eye model differently.
6. Could the eye continue to function properly if one of its parts were damaged or missing? Provide one example to support your answer.
7. Using your model, explain three important actions you could take to keep your eyes healthy and safe.

Pupils in a Different Light Students observe the pupil under varying light conditions for changes in size.

What Are the Advantages of Two Eyes? Students tape a piece of paper over one eye and then play catch with a ball to illustrate the importance of two eyes in depth perception.

Eye Dominance Students check to see which eye is dominant.

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Owls are completely color-blind. What does this imply about the structure of the eyes of owls?

If you can read all the letters in the smallest line of letters on an eye chart at a distance of 20 feet, you have $\frac{20}{20}$ vision. What does $\frac{20}{40}$ vision mean?

Activity 5-3: Exploring a Mammalian Eye (Dissection)

PLAN

Summary Students use their knowledge of the structure and function of the mammalian eye to design a dissection lab (page 46 in the student edition). Alternatively students can follow a prescribed procedure for the dissection of

the eye (Resource). Students compare the similarities and differences between the human eye and a sheep or cow eye.

Objectives

Students:

✓ design a dissection lab for the mammalian eye.

✓ carry out an accurate dissection of a mammalian eye.

✓ identify the parts of a mammalian eye on a preserved specimen.

✓ state the function of each part of the eye and how the parts work together to facilitate sight.

Student Materials

- Activity Report
- Resource (If students use procedure provided)
- These will vary, depending upon experimental design and materials available. In general, each lab team will need the following items:

Goggles; sheep or cow eye; paper towels; Dissection pan; Scalpel (single-edged cutting tool); Forceps; Scissors; Needle or metal probe;

Teacher Materials

- Activity Report Answer Key
- Resource (If students use procedure provided)
- Model of an eye or large diagram! chart of the eye

Advance Preparation

Determine whether students will design their own procedure or use the one provided (Resource). Order specimens in advance. Obtain fresh specimens from a butcher. Fresh specimens can be frozen. Order preserved specimens from a biological supply house, such as

Carolina Biological Supply Company, 2700 York Rd., Burlington, NC, 27215. Call 1-800-334-5551.

Delta Biological, P.O. Box 26666, Tucson, AZ, 85726. Call 1-800-821-2502

Wear gloves and rinse specimens just prior to use.

Confirm that all student materials are available and organized so they are accessible to students.

Obtain video camera, tape, and tripod if you plan to record the activity on videotape.

Estimated Time Three 50-minute periods if students design their own procedure

Two 50-minute periods if students follow the procedure on the Resource

Interdisciplinary

Physical Education and Health Discuss the importance of eye protection during contact sports.

Social Studies Students can do research to find out about eye diseases in other countries and how they are treated.

Prerequisites and Background Information

Students should complete *Activity 5-2: Designing and Building a Model of the Eye.*

Students need to have knowledge of the structures of the human eye and how these structures function together to help us see.

Helpful Hints

Invite a guest speaker (ophthalmologist or optometrist) to talk about diseases of the eyes and proper care of the eyes. The talk could also include information about how glasses and contact lenses help improve vision.

Invite a nurse to explain about and/or give eye exams.

IMPLEMENT

You might want to dissect a cow eye on your own following these procedures before your students perform their own dissections in class.

Remind students about appropriate lab behavior and respectful treatment of animal specimens during dissections.

CAUTIONS:

- **Remind students about wearing goggles and being careful with sharp dissection equipment.**
- **Remind students of safety rules when working with any cutting tool Remind them that scalpels and scissors are very sharp.**
- **Review procedures for treating bleeding cuts on the fingers or hands.**

Steps 1-3 Students will need varying amounts of help designing their dissection procedure. Students' dissection procedure should be submitted for teacher review and approval before they are allowed to proceed. You can use the more structured approach to this dissection that is found on the Resource to help guide students through the lab design process.

Steps 4-5 Team members can assume roles such as the following:

Reader (reads directions), Surgeon (makes incisions and does dissection), Assistant Surgeon (helps surgeon), Recorder (makes drawings and takes notes during dissection). Encourage students to rotate these roles to include all students in the group. Make sure students are identifying the parts of the eye correctly.

ASSESS

Use the eye dissection and completion of written responses to the Activity Report to assess if students can

✓ design and/or follow a procedure to complete a dissection of a mammalian eye.

✓ identify and describe the function of the major components of the eye.

✓ determine similarities and differences between the human eye and a sheep or cow eye.

✓ explain how the organization of the eye enables a human to see.

Activity 5-3: Exploring a Mammalian Eye (Dissection) – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Using colored pencils, record a labeled drawing of the eye.
2. What did you find to be the most interesting part of the eye? Explain.
3. What is the purpose of the eye?
4. Describe the pathway of light beginning with the cornea until the brain receives it. Indicate each part in the pathway on your specimen.

5. Could the eye continue to function properly if one of its parts were damaged or missing? Provide one example to support your answer.
6. What would happen if the optic nerve became diseased or was cut?

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

Why do deer and rabbits have such oversized ear flaps? Why do you cup your hands behind your ears when you want to hear better?

Apply Your KNOWLEDGE

How do you think the loudness of sound is communicated to the auditory cortex?

What Do You Think?

What is noise pollution? Give some examples of noise pollution in your environment, and rank them according to how much they affect you. Are all sources of noise pollution the same for everyone? What can be done in your community to reduce noise pollution?

Apply Your KNOWLEDGE

- **If you spin around in circles, you feel dizzy when you stop. Why?**
- **What is motion sickness? How does it relate to your ears?**

Journal Writing

When talking about the senses we typically think of the five senses: taste, smell, sight, hearing, and touch. Expand your thinking a little and see how many other senses you can think of. Do library research to find examples of animals that use different senses than we do. Write about how animals use different sources of information about the environment than we do.

Review Questions/Answers

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. What role do sensors play in experiencing sensations?
2. How do you know what type of sensation you're feeling?
3. What is the difference between rods and cones? What do they do?
4. In what ways does your eye work like a camera?
5. How does your ear capture sound?

Activity 5-1 Data Table: Using Your Sensors (Student Reproducible)

Title of Experiment _____

Hypothesis:

Results:

Time allowed for sorting: _____ (seconds, minutes)

TABLE 6.3:

Name of objects to be sorted	Number of objects sorted	
	Without sensor	With sensor

Draw a graph to summarize the results of your data.

Activity 5-1 Report: Using Your Sensors (Student Reproducible)

1. What was the variable in each experiment? What was the constant?

2. Was your hypothesis correct for each of the experiments? Give reasons for your answers.

a. Touch Experiment

b. Vision Experiment

3. In your own words, summarize the results of each of the experiments.

4. How could you design an experiment to learn more about how your senses help you respond to the environment?

5. Think about the experiments you have just completed and complete the following sentences to summarize the value of each sense in helping you communicate with your environment.

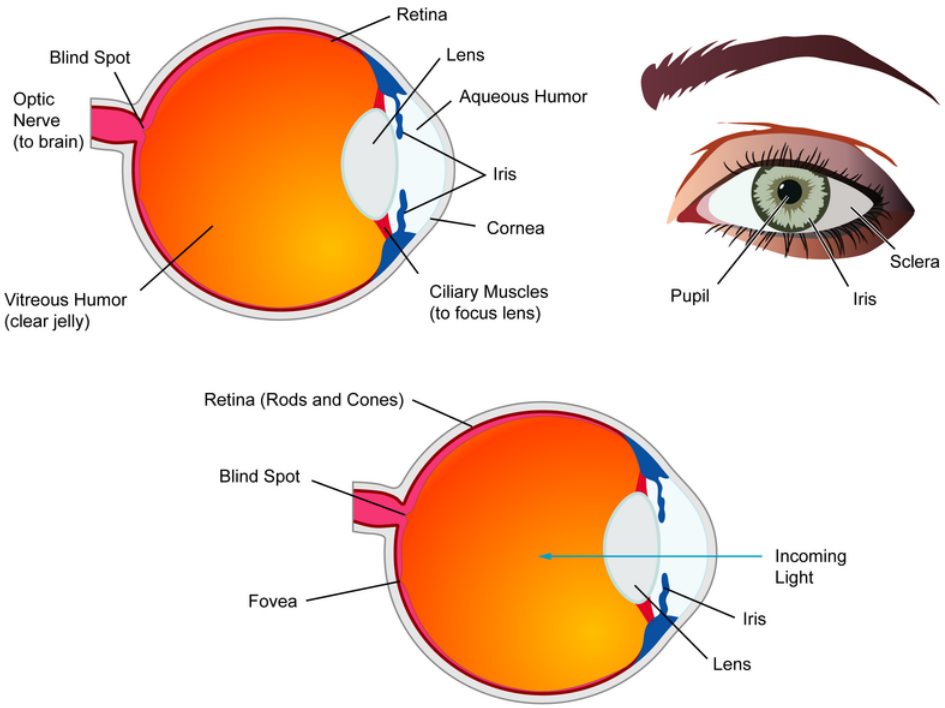
My sense of touch is like _____

that helps me to _____

My sense of vision is like _____

that helps me to _____

Activity 5-2 Resource: Designing and Building a Model of the Eye (Student Reproducible)



Activity 5-2 Report: Designing and Building a Model of the Eye (Student Reproducible)

1. What is the function of the human eye?

2. Describe your model of the human eye. You may want to include labeled diagrams.

3. Trace a ray of light from the time it enters the eye until it is received by the brain. Include in your answer the parts of your model as they correspond to the parts of the human eye.

4. What are two ways your model accurately represents a human eye? What are two ways your model does not?

5. If you were to repeat this activity how would you design and construct the eye model differently.

6. Could the eye continue to function properly if one of its parts were damaged or missing? Provide one example to support your answer.

7. Using your model, explain three important actions you could take to keep your eyes healthy and safe.

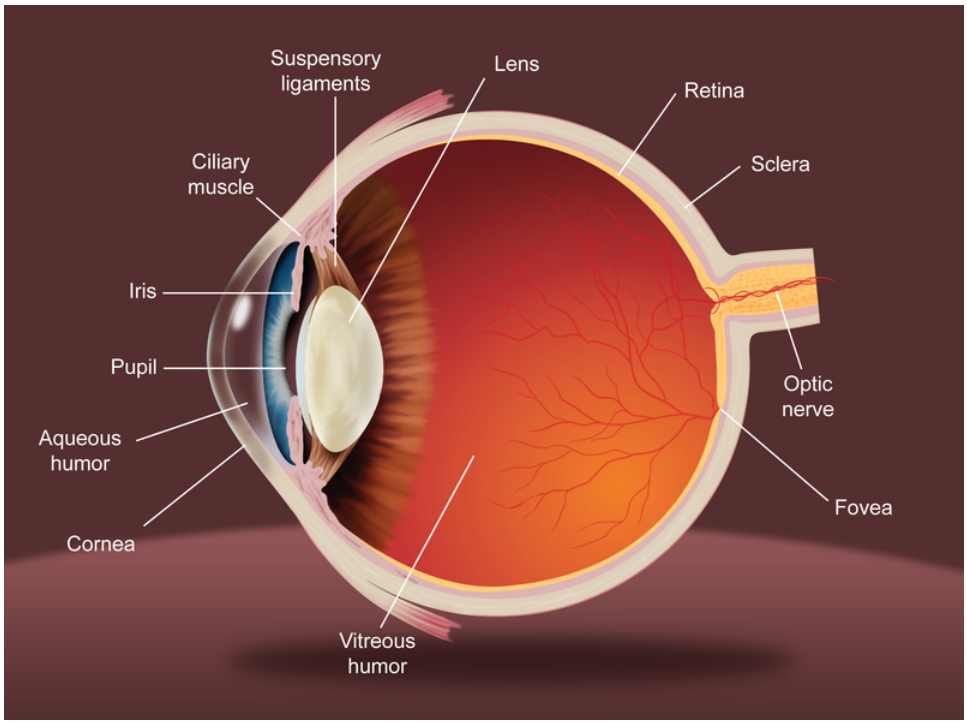
Activity 5-3 Resource: Exploring a Mammalian Eye (Procedure) (Student Reproducible)

Materials

- Sheep or cow eye
- Dissection pan
- Safety goggles
- Scalpel/razor blade (single edge)
- Paper towels
- Forceps and scissors
- Needle/metal probe

Procedure

Step 1 Refer to the diagram below for help throughout the dissection.



Step 2 Observe the yellowish fat covering the eye and the beige colored muscles.

Why is the eyeball covered in fat? Why does the eye have muscles attached?

Step 3 With scissors or a scalpel, remove most of the fat and muscles from the eyeball. **Be careful not to cut off the white stub (optic nerve) protruding from the rear of the eye.**

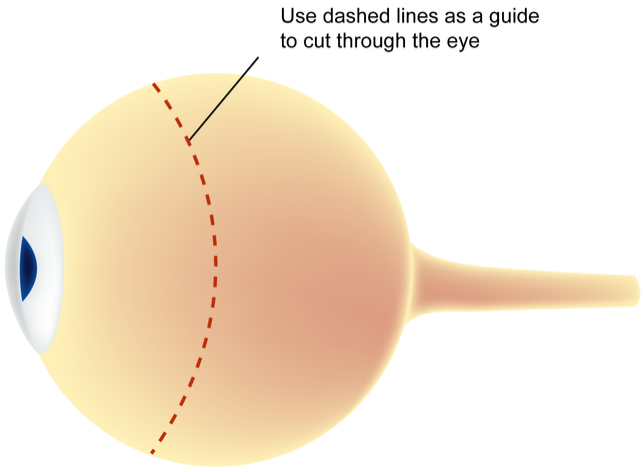
Step 4 Examine the white, outer layer of the eye.

This is the sclera. What is its purpose? How does it look and feel?

Step 5 In the front part of the eye, the white layer becomes colorless, transparent, and more sharply curved. (If you have a preserved eye, this area will appear blue.)

The cornea is the name of this transparent part of the eye. How does this structure help you to see?

Step 6 Next, using the scalpel or razor blade like a saw, carefully cut the eyeball in half to separate the front part from the rear part. **(Use the diagram below as a guide. Try not to let the liquid inside squirt out as you cut.)**



Step 7 Lift off the rear half. A jelly-like substance may ooze out or stick to the front half of the eye. Remove this jelly like material, called the vitreous humor.

Describe the substance. What function does it serve?

Step 8 Work with the front half of the eye. Carefully cut out the cornea. Lift it off. The space between the cornea and the lens is filled with a transparent, watery fluid called the aqueous humor. It may trickle out or it may no longer be present.

Compare the aqueous humor with the vitreous humor. What function do you think the watery fluid serves?

Step 9 Observe the colored, circular muscle with a hole in the middle.

What is the name of this muscle? What does it do? The hole in the center of the lens is called the pupil. What is the function of the pupil?

Step 10 Behind the iris, you can see the lens. Usually, the lens is colorless and transparent. However, in preserved eyes, it is cloudy. Examine the lens. Notice how it is attached to the eyeball by a circular band of fibers, the ciliary muscles. The lens thickens to bring images of near objects into focus. The lens becomes thin to bring more distant objects into focus.

Step 11 Carefully cut out the lens and place it on a piece of paper.

What does the lens feel and look like? Does it bounce or break when dropped? (Remember, in a living organism, the lens is colorless, transparent, and flexible.)

Step 12 Examine the rear half of the eyeball and notice the thin layer of light gray tissue. It may have folded in upon itself. This innermost layer of the eye is called the retina. It contains specialized nerve cells, including rods and cones.

What does the retina do? Where is this layer attached?

Step 13 The point at which the retina joins the optic nerve is called the “blind spot.” Why?

Activity 5-3 Report: Exploring a Mammalian Eye (Dissection) (Student Reproducible)

1. Using colored pencils, record a labeled drawing of the eye.

2. What did you find to be the most interesting part of the eye? Explain.

3. What is the function of the eye?

4. Describe the pathway of light beginning with the cornea until the brain receives it. Indicate each part in the pathway on your specimen.

5. Could the eye continue to function properly if one of its parts were damaged or missing? Provide one example to support your answer.

6. What would happen if the optic nerve became diseased or was cut?

6.4 Enrichment

Enrichment 5-1: Teacher Activity Notes

Building a Model of the Ear

PLAN

Summary Students review and discuss sound energy. Demonstrations of the movement of waves using a rope and water help students visualize sound waves. Students review and discuss the structures of the human ears and how they help us hear. They construct a model of the human ear and use it to explain how to care for and protect the ears.

Objectives

Students:

✓ identify the parts of the ear.

✓ state the function of each part of the ear.

✓ describe how loud noises can cause ear damage.

✓ describe how to care for and protect their ears from damage.

Student Materials

- Resources 1 and 2
- Activity Report
- 2 Water balloons or one balloon and a latex glove; Juice container (empty); Scissors; Cork; Balloon; String or rubber bands; Push pin or thumbtack; Plastic or rigid paper cup

Teacher Materials

- Resource 3
- Activity Report Answer Key
- Beaker (or petri dish bottom or glass pie plate); Water; Eyedropper; Overhead projector; Saber saw (variable speed electric); Rope; Resonator (refer to Resource 3 for materials and construction)

Advance Preparation

Make resonator

Obtain all student and teacher materials.

Allow ample time to collect necessary materials (i.e., juice bottles, saber saw, constructed resonator.)

Consider preparing an ear model in advance to use as a reference after students complete their models.

Remind students to use their brain models from previous activities to refresh their memories about the brain parts and their functions: *Activity 2-1: Big Brain on a Stick and Activity 2 -2: Thinking Cap.*

Fill the balloons with water while they are inside the juice container as follows: Find a water spigot on which you can place and hold the neck of the balloon. When the filled balloon *almost* reaches the bottom of the juice container, quickly pull off the neck of the balloon and tie it. Do this ahead of time. You might want to wear a plastic apron.

Estimated Time

Approximately one to two 50-minute class periods

Interdisciplinary

Music Explore tonal variations with different musical instruments.

Social Studies Investigate local regulations governing noise pollution.

Health Research hearing loss and compensations available for those physically challenged with hearing impairment. Research ear protections required for various careers.

Prerequisites and Background Information

Review the concept of sound energy with students.

IMPLEMENT

All materials should be available as listed on student Activity Guide.

Helpful Hints
Recommend juice bottle (16 oz.-refer to Resource 1).
Encourage students to investigate and report on animal hearing.
When doing this activity with more than one class, the first class can keep the "inner ear"-the juice bottle with the water balloon in it-for the classes that follow.

ASSESS

Use the model of the ear and written responses on the Activity Report to assess if students can

✓ identify the parts of the external ear, middle ear, and outer ear.

✓ explain how the function of each part of the ear enables humans to hear.

✓ demonstrate how sound travels through the different parts of the ear, how the cochlea acts as a resonator, and how the brain receives information from the ear.

✓ explain how to care for and protect their ears.

Enrichment Activity 5-1: Building a Model of the Ear – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. What is the function of the human ear?
2. Describe your ear model.
3. Can you think of other materials that you can substitute for materials used in this model?
4. Use your model to trace sound waves from their point of entry into the external ear until they are received by the brain. Include in your answer the parts of your model as they correspond to the parts of the human ear.

5. Could the ear function properly if one of its parts were damaged or missing? Provide an example to support your answer.
6. Describe two ways your ears could be damaged. How could you prevent this damage from happening?

Enrichment 5-1 Activity Guide: Building a Model of the Ear (Student Reproducible)

Introduction

Do you know how your ear works? In this activity you make a model showing how your ears work.

Materials

- Resources 1 and 2
- 2 water balloons or one balloon and a latex glove
- Juice container (empty)
- Scissors
- Cork
- Balloon
- String or rubber bands
- Push pin or thumbtack
- Plastic or rigid paper cup

Procedure

Step 1 Using Resource 1 as a guide, build a model of the outer ear. The outer ear includes the flap on the side of your head and a bony canal at the end of which is the eardrum. Your plastic cup represents the ear canal. Cut the bottom out of the cup. Then tie a cut balloon or a piece of latex glove over the cut end to represent the eardrum.

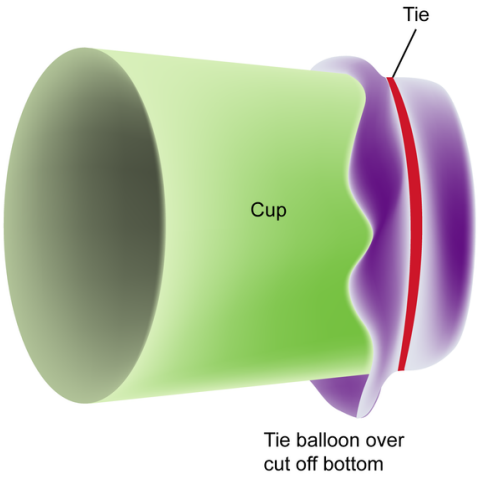
Step 2 Using Resource 1 as a guide, add to your model of the outer ear to include the middle ear. The middle ear includes the space behind the eardrum and the three small bones (hammer, anvil, and stirrup) that transmit eardrum movements to the oval window. In your model, the cork represents the bones of the middle ear.

Step 3 Using Resource 1 as a guide, modify your model to include the inner ear. The inner ear includes a spiral hole in the skull, which contains the cochlea. The juice container represents the canal in the bone. And the water balloon represents the fluid in the inner ear. Place your finger over a cut part of the juice container, resting against the water balloon, to represent the cochlea. Pressure-sensitive nerve endings in your fingertips represent hair cells. Sensory pathways to your sensory cortex represent the auditory nerve and temporal lobe. Compare your completed model of the ear with Resource 2.

Enrichment 5-1 Resource 1: Building a Model of the Ear (Student Reproducible)

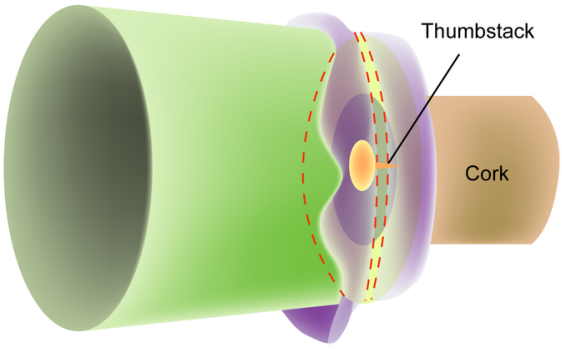
Building the external ear

Cut the bottom from the plastic cup and stretch a piece of balloon over it. Tie or tape a rubber band over the balloon to make the eardrum at the end of the external ear canal.



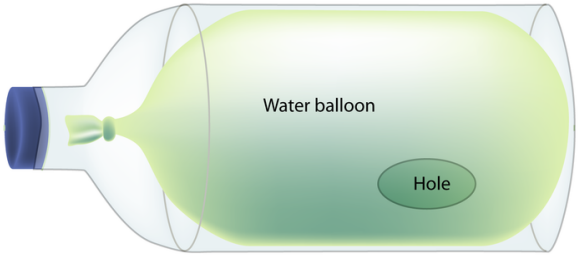
Building the middle ear

Push the thumbtack through the balloon from inside the cup into the cork. The cork moves in and out as the drum moves in and out. The cork represents the chain of three bones connecting the eardrum with the inner ear.



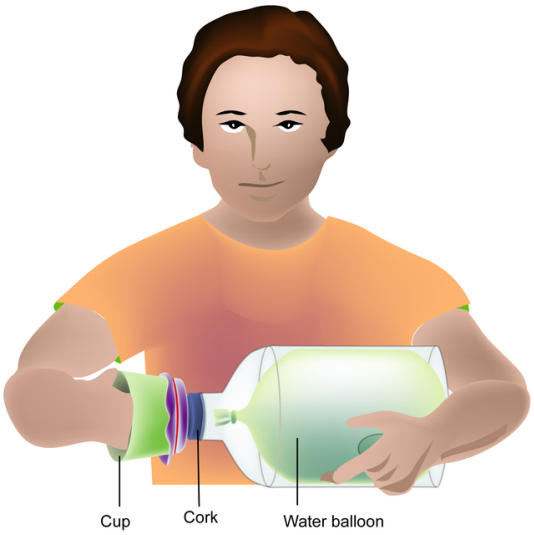
Building the inner ear

Cut a hole as big as your fingertip in the side of the plastic juice container. Put an empty balloon in the container and fill it with water from a faucet. Tie the balloon closed.



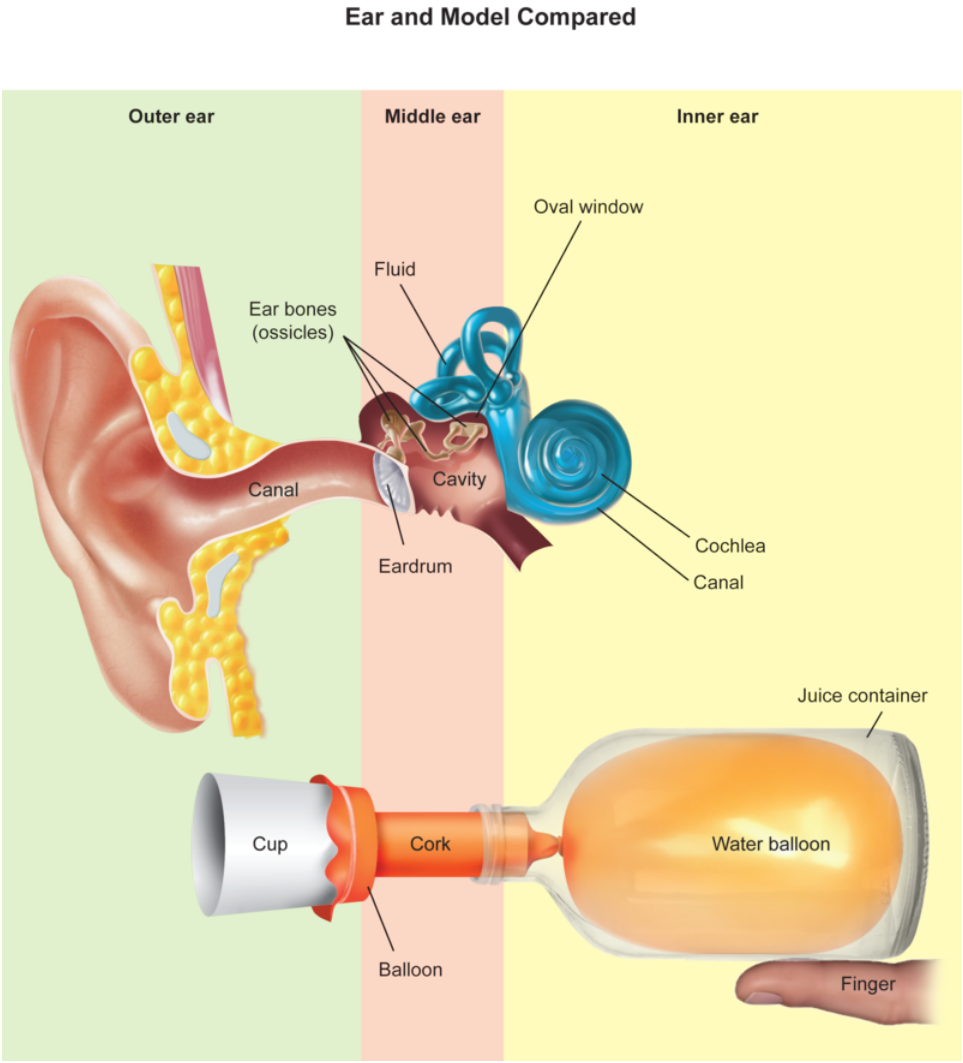
Seeing your ear working

Insert the cork through the mouth of the juice container and hold one finger against the water balloon.



Press the finger in the cup and feel the pressure in the water balloon. Pressure waves in the fluid are converted to impulses in the acoustic nerve. The impulses from your finger felt in your brain as a pressure are analogous to the impulses from your cochlea perceived by the temporal lobe as sound.

Enrichment 5-1 Resource 2: Building a Model of the Ear (Student Reproducible)



Enrichment 5-1 Resource 3: (Teacher Guide) - Building a Model of the Ear

1. **Making a Wave (Demonstration)**

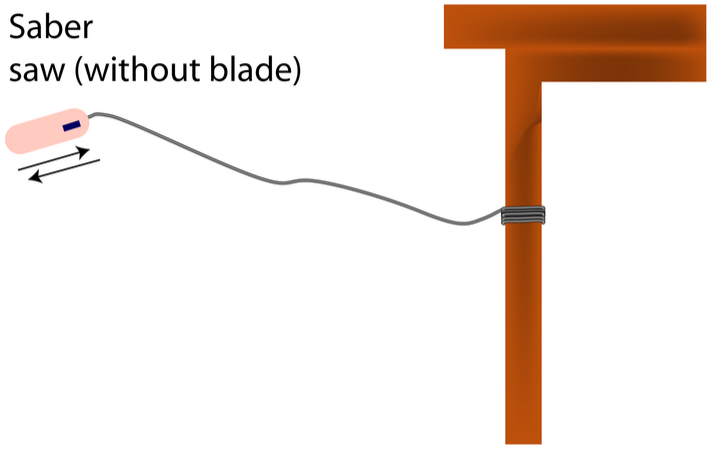
Place a beaker or petri plate bottom containing a small amount of water in it on an overhead projection. Using an eyedropper, add 1 or 2 drops of water into the center of the container. Notice the concentric rings (waves) start in the middle and reflect off the sides back toward the center. Use this demonstration to discuss sound reflections such as echoes and concert hall acoustics.

You also can use a slinky to show compression waves and reflection.

2. **Making a Wave with a Rope (Demonstration)**

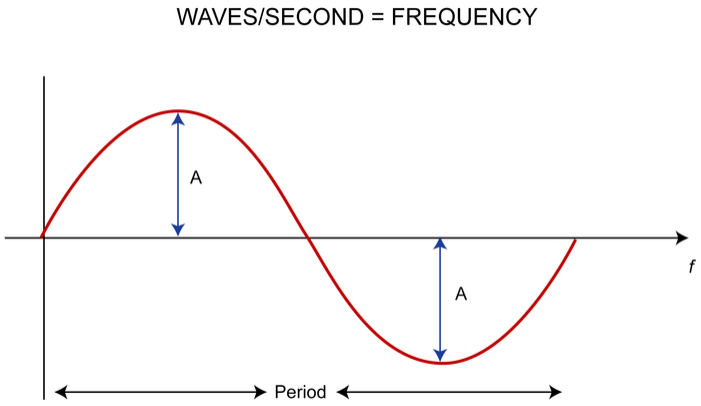
To see what a wave looks like, we'll make one stand still so you can see the parts using 15 feet of string or cord and a variable speed electric saber saw. Take the blade out and screw the blade-holding screw tight. Tie one end of the cord to the blade holder and tie the other end to a fixed object-a table leg will do. Turn on the saw and step back to tighten the string.

Each in and out movement of the saw starts a wave traveling down the cord. The wave reflects back on itself at the fixed point. The reflected wave returns to the saw and joins with newly formed waves to form a standing wave that seems not to move along the cord. How many waves can you form on the string at the same time? Some parts of the string appear to stand still. What are these points called? [Nodes]



Note :

- Speed of the wave along the cord depends on tension in the cord.
- A wave travels one wavelength in one period of the wave.
- The faster the in-and-out motion of the saw, the shorter the time between the waves (the greater the frequency) and the shorter the wave lengths.



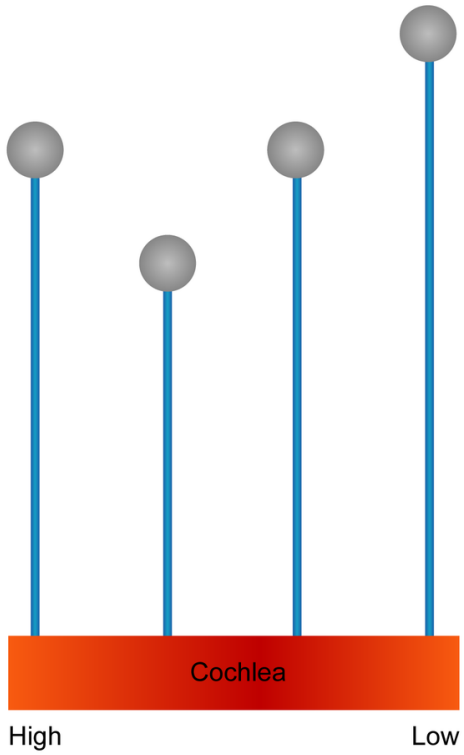
3. **The Cochlea as a Resonator**

Let us see a resonator working because the organ of Corti behaves a bit like one. Resonance is when a small repeated vibration causes a larger vibration in the resonating body.

Musical instruments, the cochlea of the ear, bridges in storms, and buildings in earthquakes act as resonators. If you vibrate an object near one of its natural frequencies, its motion may grow much larger. This demonstration shows again that waves carry energy.

To do this one yourself, you'll need three $\frac{1}{4}$ -inch wooden dowels, one 18 inches long, one 24 inches long, and one 30 inches long. You'll also need one $\frac{3}{8}$ -inch dowel about 2 feet long, 4 superballs, tennis balls, or lumps of clay, and one $2'' \times 4''$ piece of wood about 2 feet long, a drill, and some glue.

Drill 4 holes equidistant along the $2'' \times 4''$ piece of wood. Make the first hole slightly less than $\frac{3}{8}''$ and the other 3 slightly less than $\frac{1}{4}''$. Tap or glue the dowels in the holes. Drill holes in the superballs and stick them on the ends of the dowels.



Hold the $2'' \times 4''$ at each end and slide it back and forth on a table. What happens?

Sticks will sway back and forth in a wavelike motion.

It is like pushing a swing. Each push adds amplitude to the swing's natural frequency. Try a different frequency. What happens?

Each push changes how far and how fast the sticks sway.

Enrichment 5-1 Activity Report: Building a Model of the Ear (Student Reproducible)

Answer these questions:

1. What is the function of the human ear?

2. Describe your ear model.

3. Can you think of other materials that you can substitute for materials used in this model?

4. Use your model to trace sound waves from their point of entry into the external ear until they are received by the brain. Include in your answer the parts of your model as they correspond to the parts of the human ear.

5. Could the ear function properly if one of its parts were damaged or missing? Provide an example to support your answer.

6. Describe two ways your ears could be damaged. How could you prevent this damage from happening?

CHAPTER 7

Moving Muscles - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

7.1 Planning

Key Ideas

- The nervous system triggers movement of many muscles for normal activities and to help with survival in the environment.
- Some muscles move automatically to help maintain your body functions. Other muscles involve conscious coordination by the nervous system of many muscle groups at once.
- Learning new movements requires practice to develop new connections between neurons in the brain.

Overview

Students incorporate their study of the structure and function of the brain, spinal cord, and nerves to examine how the nervous system coordinates simple and complex movements of the body. They build a life-size map of the nervous system to explore how the brain, nerves, and muscles connect. They analyze the coordinated action of both walking and writing. Students perform experiments to explore the effects of practice on the coordinated movement of muscles.

Objectives

Students:

✓ identify sensory and motor nerve connections to the brain and spinal cord.

✓ distinguish between the three types of muscle cells (skeletal, striated, and cardiac) and their respective functions.

✓ compare voluntary and involuntary muscles regarding function and control.

✓ explain how the coordination of the brain and spinal cord controls muscle movement.

✓ trace the sequence of events performed by motor neurons and muscles that enables someone to walk

Vocabulary

cardiac muscles, involuntary, voluntary, skeletal muscles, smooth muscles

Student Materials

Activity 6-1: Connecting Your Brain and Muscles

Per student

- Activity Report
- Colored marking pens (black, yellow, green, and brown); Butcher paper; "Big Brain on a Stick" model (from Activity 2-1); Transparent tape; Colored yarn or string (green and yellow); Meter stick

Activity 6-2: Moving Muscles

- Activity Report
- "Thinking Cap" from Activity 2-2; Yellow and green yarn; Scissors

Activity 6-3: The Nervous System and Muscles Working Together

- Activity Report
- Writing paper; Tape; Marking pens

Teacher Materials

Activity 6-1: Connecting Your Brain and Muscles

- Activity Report Answer Key

Activity 6-2: Moving Muscles

- Activity Report Answer Key

Activity 6-3: The Nervous System and Muscles Working Together

- Activity Report Answer Key

Advance Preparation

See Activities 6-1, 6-2, and 6-3 in the Student Edition.

Activity 6-1: Connecting Your Brain and Muscles

- Be sure students have completed the text through Section 6.
- Provide ample floor space by rearranging furniture or using the gym or hallway.
- You may want to cut large pieces of butcher paper before class.

- Determine where to store or display completed maps of the nervous system.
- Gather marking pen sets (black, yellow, green, and brown).
- If you decide to videotape this activity, have camera and tape available.

Activity 6-2: Moving Muscles

- Be sure students have completed the text through Section 6.
- Suggest that students wear PE clothes for this activity.
- If you decide to videotape this activity, have camera and tape available.
- Consider and arrange for a guest speaker (or student) who is knowledgeable or able to demonstrate how a physically challenged person can show mastery of writing and drawing. Be sure to prepare your students thoroughly for this guest speaker's presentation.

Activity 6-3: The Nervous System and Muscles Working Together

- Be sure students have completed the text through Section 6. Suggest that students wear PE clothes for this activity. If you decide to videotape this activity, have camera and tape available. Consider and arrange for a guest speaker (or student) who is knowledgeable or able to demonstrate how a physically challenged person can show mastery of writing and drawing. Be sure to prepare your students thoroughly for this guest speaker's presentation.

Interdisciplinary Connection

Physical Education Students connect the nervous pathways on their maps with body motions used in running and walking. They can chart the effects of practice on improvement of a sport skill.

7.2 Using Moving Muscles – Student Edition (Human Biology)

Discuss the role of models in science.

Draw students' attention to the Key Ideas using means such as posters and transparencies.

Begin the section with *Activity 6-1: Connecting Your Brain and Muscles,* which answers the question, "How do Your Muscles Know What to Do?"

Point out the three types of muscles in Figure 6.1. Discuss examples and functions of each type.

Confirm that students can explain the differences between and involuntary and voluntary muscles and include examples for each.

Have the "Thinking Caps" from Activity 2-2 available when doing the *Activity 6-2: Moving Muscles.*

Review blood-brain barrier and *Activity 1-1: Blood-Brain Barrier* and the parts of the brain (Section 2) before discussing what parts of the brain coordinate body movements.

Activity 6-2: Moving Muscles reinforces the pathways of sensory and motor neurons.

Activity 6-3: The Nervous System and Muscles Working Together is a good follow-up activity for *Activity 6-2: Moving Muscles.*

Time permitting select from enrichment activities and unit projects.

Throughout and at the end of the section refocus students' attention on the Key Ideas.

7.3 Activities and Answer Keys

Activity 6-1: Connecting Your Brain and Muscles

PLAN

Summary Students use their own body as an outline for making a map of the nervous system, showing pathways of sensory and motor neurons. They use these maps to explore and identify nerve connections between the brain, spinal cord, and peripheral regions of the body. With this background, students investigate and determine how a spinal injury might affect the nervous system and body movement.

Objectives

Students:

✓ identify the sensory and motor areas of the brain responsible for walking and writing (brain, spinal cord, and nerves).

✓ trace pathways and direction of nerve impulses moving in sensory and motor nerves (neurons).

✓ describe the nerve connections between the brain, spinal cord, and muscles.

✓ explain the pathway of impulses through a simple reflex arc.

✓ explain how a spinal injury might affect the efficiency of the nervous system.

Student Materials

- Activity Report
- Colored marking pens (black, yellow, green, and brown); Butcher paper; "Big Brain on a Stick" model (from Activity 2-1); Transparent tape; Colored yarn or string (green and yellow); Meter stick; Text Figure 1.2 on p. 4.

Teacher Materials

- Activity Report Answer Key

Advance Preparation

Be sure students have completed the text through Section 6. Provide ample floor space by rearranging furniture or using the gym or hallway. You may want to cut large pieces of butcher paper before class. Determine where to store or display completed maps of the nervous system. Gather marking pen sets (black, yellow, green, and brown). If you decide to videotape this activity, have camera and tape available.

Estimated Time Approximately two 50-minute periods

Interdisciplinary

Visual Arts Students can draw and construct the map in art class.

Physical Education Students can connect the nerve pathways on their maps for muscles used in running and walking.

Health Investigate the effects of spinal cord injuries on movement.

Helpful Hints

Students can present their models to the class, adding explanations for locations and functions of sensory and motor neuron pathways.

Final presentations can be videotaped.

Students could present their finished models and explanations at home.

IMPLEMENT

Introduce Activity 6-1 by pointing out the role of nerve impulses in connecting muscles with the brain. Remind students to use their text as reference (Section 2 and Figure 5.1).

Step 1-5 This activity can be done in groups of 2 to 4 students. Students may want to check off each completed step on the instruction sheet. In Part B, make sure students write only on the paper. They have less control with their feet and can easily slip off the paper onto the wall.

ASSESS

Use the completed map of the nervous system and written responses on the Activity Report to assess if students can

✓ identify the sensory and motor areas of the brain responsible for walking and writing (brain, spinal cord, and nerves).

✓ trace the pathways and direction of nerve impulses moving in sensory and motor nerves (neurons).

✓ describe the nerve connections between the brain, spinal cord, and muscles.

✓ explain the pathway of impulses through a simple reflex arc.

✓ explain how a spinal injury might affect movement and the efficiency of the nervous system.

Activity 6-1: Connecting Your Brain and Muscles – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. What happens in the sensory areas of the brain to make it possible for you to walk and write?
2. What happens in the motor areas of the brain that are responsible for walking and writing?
3. What is represented by each piece of
   (a) yellow yarn
   (b) green yarn
4. In which direction are nerve impulses moving in the
   (a) sensory nerves:
   (b) motor nerves:
   (c) spinal cord:
5. Is it possible for you to move your lower leg without sensory nerve impulses first reaching your brain? Explain, using your model to demonstrate your answer.
6. Use your "road map of the nervous system" to demonstrate the pathway of nervous impulses involved in
   (a) touching a hot stove and suddenly pulling back your hand
   (b) feeling the pain of the hot stove and saying, "Ouch!"

7. A person has a spinal injury causing lack of sensation and paralysis in the legs. The person still has feeling and movement in the arms. Use your road map to explain how this is possible.
8. Carefully observe your "road map" connecting your brain, nerves, and muscles. How would your describe this "road map" to a friend?
9. Suggest another way of using your "road map" to help you learn more about how the brain, nerves, and muscles work together.

Activity 6-2: Moving Muscles

PLAN

Summary Students use their "Thinking Caps" from Activity 2-2 to show how their brain tells their muscles to move.

Objectives

Students:

✓ demonstrate which side of the brain is responsible for movements on each side of the body.

✓ distinguish between motor and sensory neuron pathways between the brain, spinal cord, and muscles.

✓ indicate where synapses occur in the neuron pathways.

Student Materials

- Activity Report
- "Thinking Cap" from Activity 2-2
- Yellow and green yarn
- Scissors

Teacher Materials

- Activity Report Answer Key
- Additional student materials
- "Thinking Cap" models

Advance Preparation

Gather "Thinking Cap" models and students materials.

Use Nervous System Maps from Activity 6-1 (Optional)

Estimated Time 30 minutes to one class period

Interdisciplinary

Health Investigate physical therapy and rehabilitation facilities for patients with nervous system impairment affecting muscles.

Math Contact a local health insurance group to gather information about insurance costs to support a patient with a particular nervous system impairments affecting muscles. Graph this information per month, over the period of typical rehabilitation time.

Social Studies Conduct research to find out about legislation for workplace requirements for employees with nervous system impairments affecting muscles.

Helpful Hints

Review the structure and function of a synapse, the gap between neurons over which neurotransmitters carry information from one neuron to the next neuron.

Have students review the five parts of a reflex.

IMPLEMENT

Introduce Activity 6-2 by reviewing with students the parts of the brain and their functions.

Steps 1-3 Have one student put on the "Thinking Cap". Have the other student point out each brain region and describe its function. Remind students that the "Thinking Cap" represents a map of the cerebrum.

ASSESS

Use the "Thinking Cap" models, the nerve connections, and written answers on the Activity Report to assess if students can

- demonstrate which side of the brain is responsible for movements on each side of the body.
- distinguish between motor and sensory neuron pathways between the brain, spinal cord, and muscles.
- indicate where synapses occur in the neuron pathways.

Activity 6-2: Moving Muscles – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Explain what happens when you touch the yellow yarn on one of your arms or legs.
2. Explain what happens when you touch the green yarn on one of your arms or legs.
3. Describe where synapses occur in the pathways you created with the yarn.
4. Imagine that your friend was not wearing a bike helmet when struck by a speeding car. The accident caused a severe head injury on the right side of the brain, including the ear region. You found out later that your friend has partial paralysis of the left side of the body. Based on what you have learned from this activity, how can you explain this outcome?

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

How would drinking alcohol affect your performance in the following activities? What are some things that might happen if you drank alcohol and tried to do these activities?

- taking a math test
- riding a bike
- playing baseball

Activity 6-3: The Nervous System and Muscles Working Together

PLAN

Summary Students explore how the nervous system coordinates the movement of muscles involved in walking and in writing. They relate their investigations to the importance of practice in fine tuning the motor skills involved in dancing and sports.

Objectives

Students:

✓ explain how the quadriceps and biceps muscles work together to make walking possible.

✓ describe how the nervous system regulates leg muscles to enable a person to walk.

✓ compare the ease and legibility of writing with the foot and with the hand.

✓ describe the importance of practice in improving performance and in compensating for missing capabilities.

Student Materials

- Activity Report
- Writing paper; Tape; Marking pens

Teacher Materials

- Activity Report Answer Key

Advance Preparation

Be sure students have completed the text through Section 6. Provide ample floor space by rearranging furniture or using the gym or hallway. You may want to cut large pieces of butcher paper before class. Determine where to store or display completed maps of the nervous system. Gather marking pen sets (black, yellow, green, and brown). If you decide to videotape this activity, have camera and tape available.

Estimated Time Approximately one 50-minute period

Interdisciplinary Connections

Visual Arts Practice drawing with hand and foot, comparing the results.

Physical Education Graph the effects of practice on improvement of a sports skill. Students can do this activity in PE.

Prerequisites and Background Information

Students should have completed the text through Section 6.

Helpful Hints

- In answering question 1 on the Activity Report, encourage students to make an animated sequence of walking movements using a computer. Students also can make a hand-drawn series using, for example, a package of "post-its" or $3'' \times 5''$ cards.
- In answering question 7 on the Activity Report, have students do research to learn how physically challenged individuals who, without use of arms or legs, have compensated successfully in writing, drawing, or other activities and sports.

IMPLEMENT

Introduce Activity 6-3 by pointing out the biceps and quadriceps muscles in the thigh. Use Figure 1.2 on p. 4 to demonstrate the location of quadriceps and biceps in the thigh.

Consider organizing class into teams of 2 to 4, with each student rotating through each part of the activity.

Demonstrate (or have a student help you demonstrate) writing on the wall with foot and hand.

Be sure the pieces of paper used for foot writing are large enough so students will not accidentally mark the wall.

If necessary, rearrange classroom furniture to create ample floor and wall space for student writing.

ASSESS

Use the written responses on the Activity Report to assess if students can

✓ explain why one muscle contracts (shortens) while the other muscle relaxes (lengthens) in order to make walking possible.

✓ demonstrate how the sequence of contracting and relaxing the quadriceps and biceps muscles enables a person to walk.

✓ discuss how the cerebrum, cerebellum, and spinal cord regulate the leg muscles to enable a person to walk.

✓ demonstrate and explain the differences between writing with a hand and with a foot.

✓ communicate the importance of practice to fine-tune motor skills to improve performance and to compensate for certain missing physical abilities.

Activity 6-3: The Nervous System and Muscles Working Together – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

Part A Walking Muscles

1. Make a series of three drawings to show how the quadriceps and biceps muscles work to help you take a step. Be sure to label the muscles.
2. How do the quadriceps and biceps work together to allow you to walk? You may want to refer to your numbered drawings above to help explain.
3. Which parts of the nervous system are involved in walking?

Part B Writing Muscles

4. Think about what happens when you write your name with your foot and compare it to writing with your hand. Which writing was easier to complete and read? Why?
5. How do you account for your ability to write with greater ease and more legibly now than when you were in the third grade?
6. How do you account for a person's skill in sports, dance, music, or art?
7. How can someone who is physically challenged compensate by using the mouth or feet?

Journal Writing

What activities are you really good at? Are you good because you have natural talent or because you've worked hard to make the connections between neurons that you need to be successful?

Review Questions/Answers

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. What causes muscles to contract?
2. How do we learn new movements, such as dance steps or a new piece on the piano?
3. What role does the cerebellum play in moving muscles?
4. Do all muscles have the same number of motor neurons? Explain.

Activity 6-1 Report: Connecting Your Brain and Muscles (Student Reproducible)

1. What happens in the sensory areas of the brain to make it possible for you to walk and write?

2. What happens in the motor areas of the brain that are responsible for walking and writing?

3. What is represented by each piece of

a. yellow yarn _____

b. green yarn _____

4. In which direction are nerve impulses moving in the

a. sensory nerves

b. motor nerves

c. spinal cord

5. Is it possible for you to move your lower leg without sensory nerve impulses first reaching your brain? Explain, using your model to demonstrate your answer.

6. Use your "road map of the nervous system" to demonstrate the pathway of nerve impulses involved in

a. touching a hot stove and suddenly pulling back your hand

b. feeling the pain of the hot stove and saying, "Ouch!"

7. A person has a spinal injury causing lack of sensation and paralysis in the legs. The person still has feeling and movement in the arms. Use your road map to explain how this is possible.

8. Carefully observe your "road map" connecting your brain, nerves, and muscles. How would you describe this "road map" to a friend?

9. Suggest another way of using your "road map" to help you learn more about how the brain, nerves, and muscles work together.

Activity 6-2 Report: Moving Muscles (Student Reproducible)

1. Explain what happens when you touch the yellow yarn on one of your arms or legs.

2. Explain what happens when you touch the green yarn on one of your arms or legs.

3. Describe where synapses occur in the pathways you created with the yarn.

4. Imagine that your friend was not wearing a bike helmet when struck by a speeding car. The accident caused a severe head injury on the right side of the brain, including the ear region. You found out later that your friend has partial paralysis of the left side of the body. Based on what you have learned from this activity, how can you explain this outcome?

Activity 6-3 Report: The Nervous System and Muscles Working Together (Student Reproducible)

Part A Walking Muscles

1. Make a series of three drawings to show how the quadriceps and biceps muscles work to help you take a step. Be sure to label the muscles.

1. 2. 3.

2. How do the quadriceps and biceps work together to allow you to walk? You may want to refer to your numbered drawings above to help explain.

3. Which parts of the nervous system are involved in walking?

Part B Writing Muscles

4. Think about what happens when you write your name with your foot and compare it to writing with your hand. Which writing was easier to complete and read? Why?

5. How do you account for your ability to write with greater ease and more legibly now than when you were in the third grade?

6. How do you account for a person's skill in sports, dance, music, or art?

7. How can someone who is physically challenged compensate by using the mouth or feet?

CHAPTER 8 Additional Resources Nervous System - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

8.1 Using GroupWork Activities

Learning science is a process that is both individual and social. Like researchers, engineers, mathematicians, and physicians who work in teams to answer questions and to solve problems, students in science classrooms often need to interact with their peers to develop deeper knowledge of scientific concepts and ideas. The GroupWork activities were developed to foster an environment in which groups of students work cooperatively to

- plan experiments,
- collect and review data,
- ask questions and offer solutions,
- use data to explain and justify their arguments,
- discuss ideas and negotiate conflicting interpretations,
- summarize and present findings,
- and explore the societal implications of the scientific enterprise.

The GroupWork environment is one in which students are "doing science" as a team. Suggestions about when to introduce these group activities are included in the Teacher Activity Notes.

Format and Organization of GroupWork Activities

Each GroupWork activity includes teacher activity notes, an activity guide, an individual report, resource materials, and at times, data sheets. The activity guide contains instructions for the group's task and questions to be discussed as students plan for and work on a group product. Resource materials are varied. They might include textual information, visual resources such as photos, drawings, graphs or diagrams, video, or audiotapes. Individual reports by students are an integral part of each activity to be completed in class or as part of a homework assignment. Planning information for the teacher is found on the Teacher Activity Notes page.

Sets of GroupWork activities are organized around a central concept or a basic scientific question-a "big idea." Ideally, as students rotate to complete these activities, they encounter this central idea, question, or concept in different scientific contexts or in different social settings. These rotations provide students with multiple opportunities to grapple with the material, explore related questions and dilemmas, look at different representations, and think of different applications. Figure 1 shows how students rotate from activity to activity around the "big idea."

The GroupWork activities were designed to be open-ended to foster the development of higher-order thinking skills. Such open-endedness allows students to decide as a group how to go about completing the task, as well as what the final group product might be. Open-ended group activities increase the need for interaction as students serve as resources for one another, draw upon each other's expertise and knowledge, and take advantage of their different problem- solving strategies. When groups are heterogeneous and include students with many different intellectual abilities, the repertoire of strategies and previous experiences is rich and diverse. As students interact with their peers, they learn how to communicate effectively, justify their arguments when challenged, and examine scientific problems from different perspectives. Such interaction scaffolds students' knowledge of scientific concepts and principles.

These GroupWork activities then are quite different from traditional lab activities that include more step-by-step procedures and are crowded with details. In addition to using reading, writing, and computing (the traditional academic abilities), students use many different intellectual abilities to complete their task. They make observations, pose questions, plan investigations; they use and create visual models, access and interpret scientific information from different sources and from different media, and convey scientific findings in diagrams, graphs, charts, or tables. The use of a wide array of resource materials provides students with additional ways to access and use information, as well as with additional opportunities to demonstrate their intellectual competence and be recognized for their

contributions. We have included in the Teacher Activity Notes a partial list of some of the multiple abilities students might be observed using in these group activities.

When group activities are open-ended, rich, and intellectually demanding, a Single student will not be able to complete the task in a timely fashion by himself or herself. Making students responsible as a group to interpret a challenging task and to design a common product or group presentation increases group interdependence. Teachers know, however, that it is also important to hold each student personally accountable for contributing to the group's success and for mastering the concepts or the big idea of the activity. To do so, students are required to complete individual written reports in which they respond in their own words to key discussion questions and summarize what they have learned in the group activity. These written responses can be useful for teachers in gauging and monitoring student knowledge and progress.

Role of the Teacher Planning ahead and organizing the classroom for GroupWork is important for the successful implementation of group activities. We suggest that you refer to Elizabeth Cohen's book, *Designing GroupWork: Strategies for Heterogeneous Classrooms,* published by Teachers College Press in 1994. (See also "Complex Instruction in the Science Classroom: The Human Biology Curriculum in Action" by R. A. Lotan, J. A. Bianchini, and N. C. Holthuis in *Cooperative Learning in Science: A Handbook for Teachers* edited by R. J. Stahl, published by Addison-Wesley Publishing Company.)

Many teachers have realized that when students work in groups, direct instruction is no longer practical. The teacher can't be everywhere at once, telling students exactly what to do and how to do it. Thus, teachers delegate authority to students and students take responsibility for their own behavior and their own learning. Rather than constantly turning to the teacher for help, students talk with each other to find out what they should be doing and to solve the challenging problems assigned to them. Teaching students to work collaboratively and to be responsible to one another as a group is an important prerequisite for successful GroupWork. Students also support the smooth operation of groups when they have learned to play different roles in their groups effectively. For example, the facilitator sees to it that everyone in the group knows what has to be done and gets help when necessary. The recorder keeps notes of the group's discussions and checks to see if individual reports have been completed. The materials manager sees to it that the group has all the equipment necessary and that the tables are cleared at the end of the lesson. The reporter presents the findings of the group during wrap-up time. When the activity involves hazardous materials, a safety officer might be needed. Every student must have a role to play, and roles rotate so students learn how to perform each role competently.

Delegating authority doesn't mean that the teacher withdraws from the class or completely stays out of the action. Instead of being the focal point of the classroom, the teacher carefully observes the students as they work in the groups, stimulates and extends their thinking, and provides specific feedback.

Equalizing Participation among Members of the Group Making sure that all members of the group have access to the materials and that one group member doesn't take over or dominate the group while another withdraws are among the principal challenges of GroupWork. Teachers can increase participation of students by explaining how the different intellectual abilities are relevant to the successful completion of the task. The teacher states that while no one group member has all the abilities, everyone in the group has some of the intellectual abilities necessary to complete the task successfully. Furthermore, after careful observation of the students' work in groups, the teacher can publicly acknowledge those students who have made relevant contributions and explain specifically how these contributions made the group move forward and become more successful. It is important that the teacher be able to notice the intellectual contributions of students who have low academic or peer status and who are frequently left out of group interactions. These strategies are particularly relevant in untracked classrooms, where students have a wide range of previous academic achievement (mainly in reading) or where significant proportions of students are English-language learners. Teachers, classmates, and the low-status students themselves need to understand that when many different intellectual abilities are necessary to complete a task successfully, everybody's contribution becomes critical to the success of the group. As more previously low-achieving students feel and are expected to be competent, their participation in the group increases, and subsequently their learning achievements increase as well.

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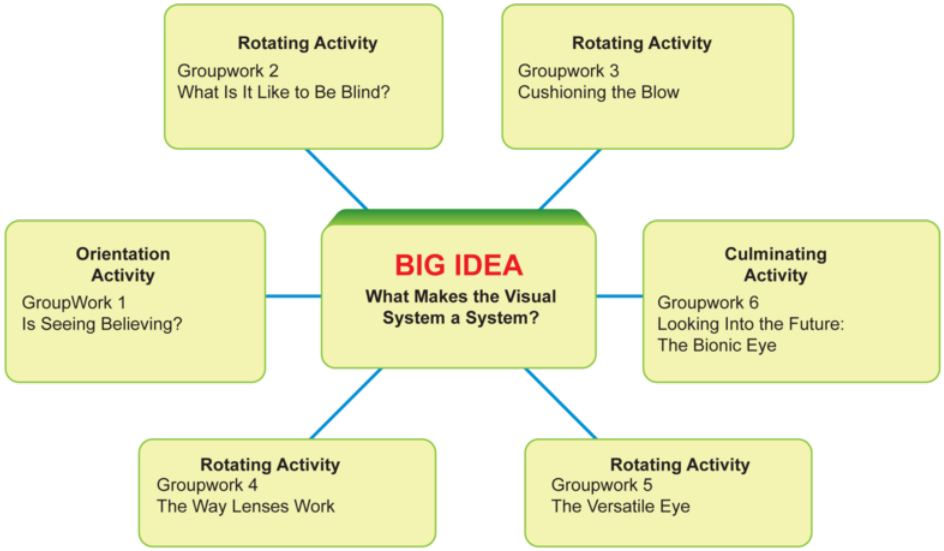


Figure 1 Activity Rotation in GroupWork

GroupWork Contents

TABLE 8.1:

Activity	Duration	Materials	Activity Summary
1. Orientation Activity: Is Seeing Believing?	30 minutes	TV, VCR, and videotape	As a class, students watch two video clips and record their observations. In groups, they explore similarities and differences in observations. They then write a scenario on the interaction of personal differences and perception.
2. What Is It Like to Be Blind?	40 minutes	Blindfold; a large box with common to unusual objects; and brochures, articles, or information packets about services for and special needs of blind	In this activity, students learn what it is like to be blind. They attempt to identify objects blind folded and create a plan to help a student adjust to life in their the blind classroom.

TABLE 8.1: (continued)

Activity	Duration	Materials	Activity Summary
3. Cushioning the Blow	40 minutes	Egg without shell and art supplies (cardboard, scissors, tape, cloth, cotton, string, wood, rubber, plastic tubing, and/or packing material)	Students explore how the eye is protected and how these different protective layers function. They then construct and test a structure to protect a shell-less egg. The compare their egg's protection to that of the eye.
4. The Way Lenses Work	50 minutes	Several converging and diverging lenses and a common object	Students learn how converging and diverging lenses help solve the problems of nearsightedness and farsightedness. They create a presentation for third graders on the benefits of glasses.
5. The Versatile Eye	40 minutes	Colored, white, and black squares of paper; dark sunglasses; a black felt pen; poster and art supplies	In this activity, students conducts an experiment to explore the relationship between the structure paper; and function of the retina. They then create a model of the retina to explain their findings to the class.
6. Culminating Activity: Looking into the Future: The Bionic Eye	40 minutes	Art supplies	In this activity, students study the eye as part of the visual system. They design a bionic eye and attempt to sell their design to company.

Groupwork 1: Teacher Activity Notes - Is Seeing Believing?

Big Idea: What Makes the Visual System a System?

PLAN

Summary As a class, students watch three video clips and record their observations. In groups, they explore similarities and differences in observations. They then write a scenario on the interaction of personal differences and perception.

Group Size 4 to 5 students

Objectives

Students:

- clearly describe what they have observed.
- compare and contrast what they have observed with their classmates.
- identify the type of things that influence what a person sees.

Student Materials

TV, VCR, and videotape. (Any selected videotape will work. Nature videos with the sound turned off work well.)

Multiple Abilities

- Reasoning ability (making connections between ideas/concepts, applying previous knowledge, examining an issue from various perspectives)
- Communication skills (explaining clearly and fully, using words precisely)
- Creativity (generating alternatives, imagining what it would be like to be someone else)

Estimated Time 30 minutes

Suggested Use

- This set of activities works well near the end of the unit.

IMPLEMENT

- Each student should use her or his journal to record her or his observations; each group, a team chart.
- Show two action scenes, each one to two minutes long, to the entire class.
- Do not introduce the clips. The scenes should not include sound. Ask students to refrain from writing while the video clips play. Pause after each to give students time to record in detail what they saw.
- After watching the video clips, break the class into groups. Have each group construct one chart. The chart should display similarities and differences in observations. In their discussions, have students consider the following questions: Who has seen the clips (the commercials or movies) before? Did that make a difference in what they saw compared to others? Did students know the actors? Did that influence what they wrote down? Did some find one clip interesting and another boring? Did that have an impact?

Conclude GroupWork Activity 1 by asking the following questions:

- If sound had been included in the video clips, would students have remembered things more clearly? How are the auditory and visual systems related?
- How are seeing and believing related?
- In this society, what influences people's ability to see and believe? (Examples include culture, education, interests, and emotional state.) What are possible outcomes of such differences?

(Examples include discrimination, violence, and social change.)

ASSESS

Use the journal entries, individual report, group chart, group discussion, and group product to assess if students can

- clearly describe what they have observed.
- explain how different people perceive different things.
- describe how mood, interests, and physical location influence what a person sees.

Extend GroupWork Activity 1 by exploring how new ways of seeing a phenomenon are crucial to new theories in science. Examples include Darwin's evolution, Mendel's genetics, Einstein's theory of relativity, and Watson and Crick's double helix.

GroupWork 1: Activity Guide - Is Seeing Believing? (Student Reproducible)

Big Idea: What Makes the Visual System a System?

Is seeing believing? Your friend insists she saw you walking home from school yesterday. After all, she saw a person with the same color hair, wearing the same clothes, and carrying the same backpack as yourself. You, however, know your friend could not have seen you-you took the bus home. Why the mistake?

Materials

- TV, VCR, and videotape

Procedure

1. Watch the video clips. After each clip, pause the VCR and write down what you saw in your journal. Do not discuss the clips while you write.

2. Compare your descriptions of each clip. Create a group chart of similarities and differences.

3. Discuss the following questions: Did group members see the same things in each clip? Why or why not?

4. Create a story in which two observers see and react to the same event. The observers should differ in interests, age, gender, ethnicity, and/or physical location. In your story, explain the following:

- What did each observer see?
- How did what each observer see affect his or her feelings about the event? Conclusions about what occurred? What he or she did?
- How does your story relate to the title of this activity: Is Seeing Believing?

GroupWork 1: Individual Report - Is Seeing Believing? (Student Reproducible)

Big Idea: What Makes the Visual System a System?

1. Did you and other group members see the same things in the video clips? Why or why not?

2. For each observer in your group's story, describe what he or she saw and why.

3. Is seeing always believing? Explain.

GroupWork 2: Teacher Activity Notes - What Is It Like to Be Blind?

Big Idea: What Makes the Visual System a System?

PLAN

Summary In this activity, students learn what it is like to be blind. They attempt to identify objects blindfolded and create a plan to help a blind student adjust to life in their classroom.

Group Size 4 to 5 students

Objectives

Students:

- identify sensory systems used to guess objects.

- explain how the other systems of the body interact with the visual system.
- describe services for and special needs of the blind.

Student Materials

Blindfold; a large box with common to unusual objects; and brochures, articles, or information packets about services for and special needs of the blind

Multiple Abilities

- Reasoning ability (making connections between ideas/concepts, logically analyzing a problem)
- Ability to make plans (organizing group, focusing on goal, prioritizing tasks and ideas)
- Creativity (generating alternatives, imagining what it would be like to be someone else or experience something you have never experienced)

Estimated Time 40 minutes

Suggested Use

- This set of activities works well near the end of the unit.

IMPLEMENT

- Place at least five objects-from the everyday to the unusual-in a box with a lid. Cut a hole in the lid large enough for a hand to reach through but small enough so that the objects inside cannot be seen.

Conclude GroupWork Activity 2 by asking the following questions:

- What are other disabilities that make it difficult to know and experience the world?
- How does loss of one's visual system affect other systems within the body?
- Does anyone know a blind person? How does he or she live? What does he or she do?

ASSESS

Use the group data sheet, presentation, individual report, and group discussion to assess if students can

- explain the purpose of the visual system (how people use the visual system in their everyday life).
- explain the interaction between the visual system and the other systems of the body.
- identify services for and special needs of the blind.

Extend GroupWork Activity 2 by

- If possible and appropriate, invite a blind person to talk with your class.
- Asking students to write a short report on one of the following topics.

1. Louis Braille and the development of Braille.
2. Diseases that cause blindness and prevention/cures.
3. Problems blind people encountered or still encounter in society and enacted or possible solutions to these problems.

Groupwork 2: Activity Guide - What Is It Like to Be Blind? (Student Reproducible)

Big Idea: What Makes the Visual System a System?

Imagine that you couldn't see. What would your life be like? How would you get to school in the morning? How would you complete your homework? How would you play with your friends?

Materials

- Blindfold, a large box with objects, and information about services for and special needs of the blind.

Procedure

1. Take turns trying to identify at least three objects in the box while blindfolded. Record your guesses about the objects. Compare your guesses to what the objects actually are.

2. As a group, discuss the following questions:

- What senses did you use to guess the objects? Was guessing easy or difficult? Explain.
- People often use their visual system to identify objects. How else do people use their visual system to get through a typical day?
- With what other systems in the body does the visual system interact? How do you know?
- In your opinion, what problems do blind people encounter in our society? How could you find out more about the services for the blind in your community? How could you help people in your community who cannot see?

3. You just learned that a blind student will be joining your class next week. Using the resources available, create a plan to help this student learn about your classroom. Include the following:

- a description of your classroom.
- ways to help him or her remember the location of people and things.
- ways to help him or her participate in group activities.
- ways to include the Braille alphabet in teaching and learning.

GroupWork 2: Individual Report - What It Is Like to Be Blind? (Student Reproducible)

Big Idea: What Makes the Visual System a System?

1. What senses did you use to guess the objects? Was guessing easy or difficult? Explain.

2. With what other systems in the body does the visual system interact? Provide two examples.

3. What are three suggestions to help a student who is blind adjust to your classroom? For each suggestion, explain why it would be helpful.

GroupWork 3: Teacher Activity Notes - Cushioning the Blow

Big Idea: What Makes the Visual System a System?

PLAN

Summary Students explore how the eye is protected and how these different protective layers function. They then construct and test a structure to protect a shell-less egg. They compare their egg's protection to that of the eye.

Group Size 4 to 5 students

Objectives

Students:

- identify and describe the function of the parts of the eye that provide protection.
- explain how the protective layers function.
- predict how damage to the eye would impact the rest of the visual system.

Student Materials

Egg without shell and building materials (cardboard, scissors, tape, cloth, cotton, string, wood, rubber, plastic tubing, and/or packing material)

Multiple Abilities

- Artistic/creative ability (thinking of new uses for familiar objects)
- Reasoning ability (making connections between ideas/concepts, logically analyzing the problem, applying previous knowledge, examining an issue from various perspectives)
- Spatial/visual ability (drawing an idea, creating a model)
- Creativity (generating alternatives)

Estimated Time 50 minutes

Suggested Use

- This set of activities works well near the end of the unit.

IMPLEMENT

- Three days before beginning this activity place one egg per group in white vinegar to dissolve the shell. (Make a few extra. They break easily!) Wash each shell-less egg gently in water to remove any remaining shell or vinegar.
- One student Resource includes an extensive description of the protective layers of the eye; two others, detailed drawings of these structures. Rather than including all these Resources, you may choose to discuss this information with your students prior to implementation of this activity.
- One way students could test their structures' effectiveness is by dropping them from bleachers, stairs, or a second floor.

Conclude Groupwork Activity 3 by asking the following questions:

- What part does the eye play in the visual system?
- Why do we sometimes need additional protection for our eyes? What kinds of additional protection do we use?
- Why is the testing of a design important?
- The egg's protection models the eye's protection. What are other examples of models in science? How do scientists use models in their work?

ASSESS

Use the individual report, group discussion, and group presentation to assess if students can

- identify the components that protect the eye.
- explain how the visual system is a system (what a system is, its purpose, how its parts interact).
- describe the strengths and limitations of models (the egg's protection as a model of the eye's protection).
- predict how damage to the eye would impact the rest of the visual system.

Extend GroupWork Activity 3 by

- using the activity as an introduction to the more general topic of safety-safety in the science lab or on the athletic field.
- having students investigate if other organisms' eyes are protected in the same way as humans? (Aquatic animals, for example, do not produce tears. They do not need them because their eyes are in constant contact with water.) Examining the eyes of other organisms can spark a discussion of design and the importance of fitting design to function.

GroupWork 3: Activity Guide - Cushioning the Blow (Student Reproducible)

Big Idea: What Makes the Visual System a System?

Your eyes are an important part of the visual system. They also can be easily infected or damaged. In this activity, you explore how your fragile eyes are kept safe and healthy.

Materials

- Egg without shell and building materials

Procedure

1. Examine the Resource. Discuss

- How is the eye protected? How does each form of protection help keep the eye healthy?
- How do these various protective layers function?
- How would damage to the eye affect the rest of the visual system?

2. Imagine the shell-less egg is an eye. Design and build a structure to protect it.

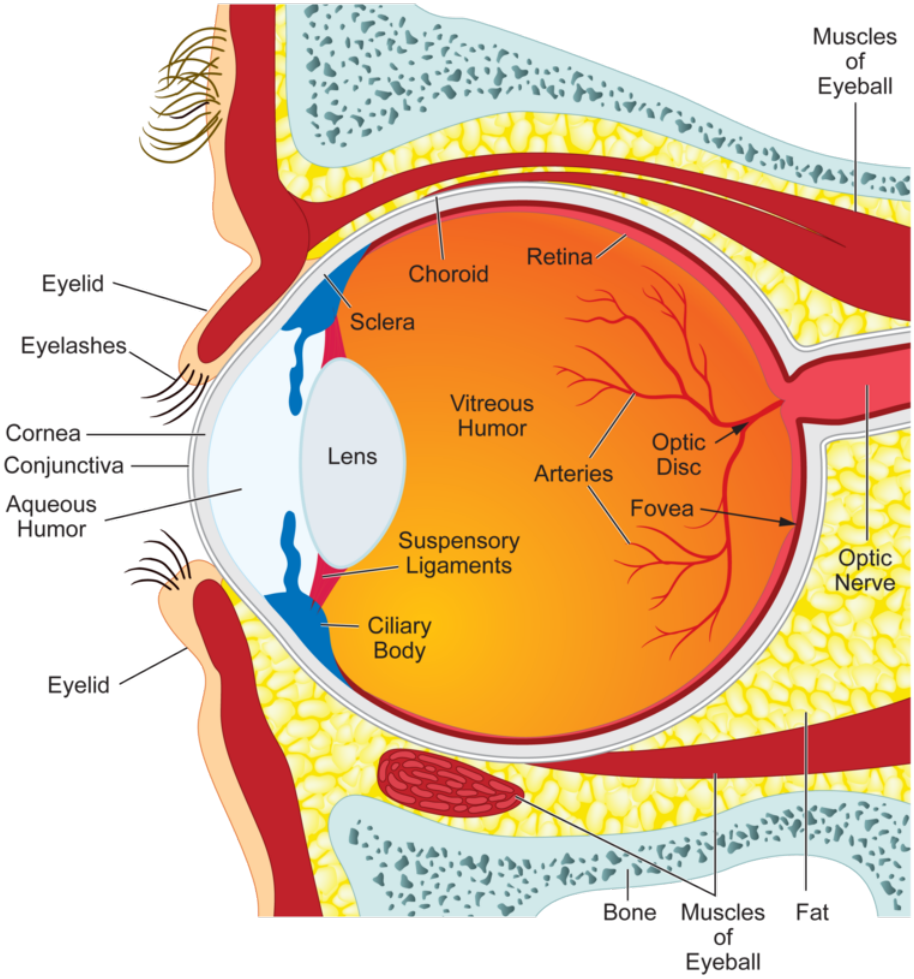
3. Present your structure to the class. In your presentation, explain the following:

- Why did you design and build your structure as you did?
- How is your egg's protection similar to and different from the eye's protection?
- How could you improve your design?

Test the effectiveness of your structure with your audience.

GroupWork 3: Resource 1 - Cushioning the Blow (Student Reproducible)

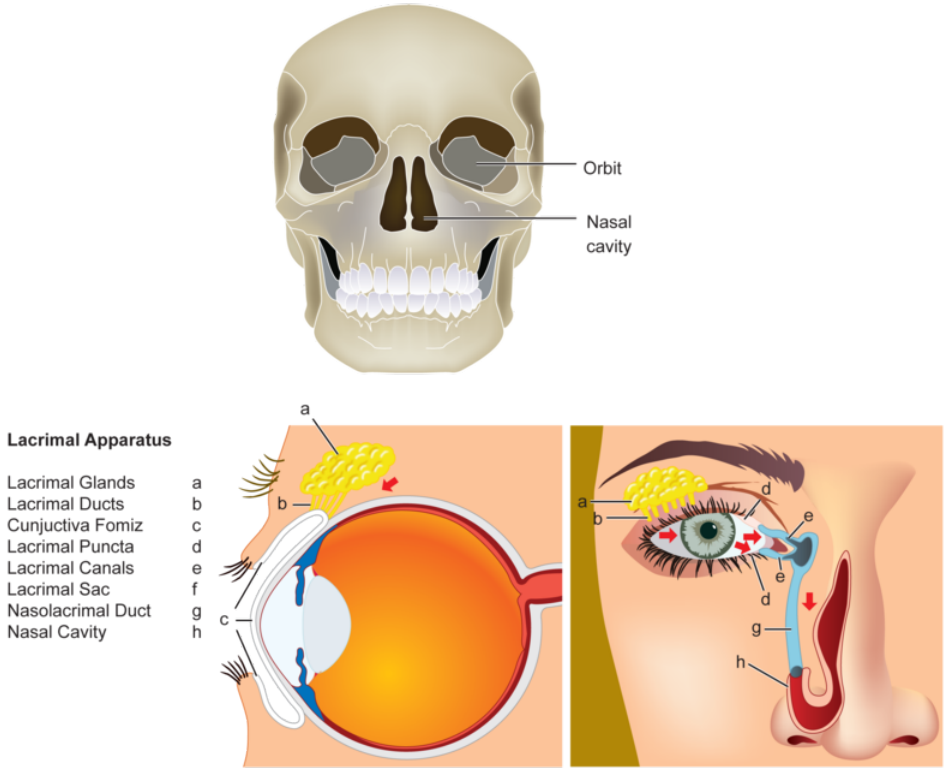
Big Idea: What Makes the Visual System a System?



GroupWork 3: Resource 2 - Cushioning the Blow (Student Reproducible)

Big Idea: What Makes the Visual System a System?

8.1. USING GROUPWORK ACTIVITIES



Groupwork 3: Resource 3 - Cushioning the Blow (Student Reproducible)

Big Idea: What Makes the Visual System a System?

Eyebrows, Eyelashes, and Eyelids

Eyebrows protect the eye by preventing dust, sweat, and glare from entering.

Eyelashes also prevent small particles in the air from entering the eye. Oil from small glands coat the eyelashes so they do not become dry and brittle. When one of these oil glands becomes infected, a sty develops.

The upper and lower eyelids protect the eye by blinking. Blinking is a reflex action. One blink takes about 0.1 seconds. Blinking cleans the eye and keeps it moist. Blinking also protects the eye from approaching objects that might cause damage.

Bone

Two-thirds of our eye (the part hidden from view) is protected by a bony cavity. Moreover, each cavity is lined with a layer of fatty tissue. The fat cushions and absorbs most of the shock from blows to the eye. The one-third of our eye that sticks out of these bony, padded cavities needs the protection of the lids and lashes.

Extrinsic Eye Muscles

What prevents our eyeballs from falling out of their sockets when we bend over? (A sick thought!) How about muscles? There are six muscles attached to the white part of each eyeball. They help protect the eye by anchoring it to its cavity.

The Conjunctiva

There is a thin, clear membrane that lines the inner eyelid and folds over to protect the front of the eyeball. This membrane is called the conjunctiva. Irritation of this membrane is known as conjunctivitis or “pink eye.” “Pink eye” may be caused by allergies, smoke, Wind, air pollutants, chlorine in swimming pools, or lack of sleep. Some forms are caused by bacteria or viruses. These forms can be passed from person to person. Antibiotics can be used to treat

"pink eye" caused by bacteria.

Tears

Tears, believe it or not, are produced in small quantities all the time-not just when you Cry. Glands, located on top of the eye, produce tears. The tears flow across the surface of the eyes-helped by blinking. Tears help protect the eye in three ways. One, they help keep the eye clean. They contain an enzyme that kills bacteria. Two, they help lubricate the eyelids and eye so that the eye's surface is not scratched. Three, tears prevent the eye's exposed cells (the eye is composed of living cells) from drying out and dying.

GroupWork 3: Individual Report - Cushioning the Blow (Student Reproducible)

Big Idea: What Makes the Visual System a System?

1. What are three forms of protection around the eye? How does each help keep the eye healthy?

2. Briefly describe how you protected your egg. Explain how your egg's protection is similar to and different from the eye's protection.

3. How do the protective structures of the eye function?

Groupwork 4: Teacher Activity Notes - The Way Lenses Work

Big Idea: What Makes the Visual System a System?

PLAN

Summary Students learn how converging and diverging lenses help solve the problems of nearsightedness and farsightedness. They create a presentation for third graders on the benefits of glasses.

Group Size 4 to 5 students

Objectives

Students:

- compare and contrast the shape of converging and diverging lenses.
- compare and contrast the problems of farsightedness and nearsightedness.
- explain how corrective lenses interact with the lens of the eye.

Student Materials

Several converging and diverging lenses and a common object

Multiple Abilities

- Reasoning ability (making connections between ideas/concepts, logically analyzing the problem)
- Spatial/visual ability (drawing an idea, creating a model)
- Ability to make plans (organizing the group, breaking a task into its parts)
- Communication skills (explaining clearly and fully, using words precisely)
- Creativity (imaging what it would be like to be someone else)

Estimated Time 40 minutes

Suggested Use

- This set of activities works well near the end of the unit.

IMPLEMENT

- Before beginning this activity, make sure students have comprehensive knowledge of the eye's lens. The purpose of this activity is to learn how glass or plastic lenses interact with the lens of the eye.
- Depending on the age and sophistication of your students, you may choose to ignore or explore the light-ray diagrams presented in the teacher's text. Students need to know a great deal about light and how it travels to understand these diagrams. At the most basic level, they would need to know that light travels in straight lines; that objects reflect light; and that when they see an object, they see light reflected from that object.
- Try to use lenses that are from and fit into eyeglasses.
- Try to select a common object that is both easy to draw and contains letters or numbers. Examples include a watch, a pencil, and a battery.

Conclude GroupWork 4 by asking the following questions:

- How does a microscope or telescope work? What kinds of lenses are found in each?
- What are some reasons people may refuse to wear glasses or contacts? Do these reasons change with age?
- What are advantages and disadvantages of using contact lenses over glasses? Eyeglasses over contact lenses?

ASSESS

Use the group data sheet, discussion, presentation, and individual report to assess if students can

- compare and contrast the shape of converging and diverging lenses.
- describe the difference between farsightedness and nearsightedness.
- explain how lenses correct the problems of farsightedness and nearsightedness (how glass or plastic lenses interact with the lens of the eye).

Extend GroupWork Activity 4 by

- discussing the following question: Glasses and contacts are a form of technology. What are other examples of people refusing to use technology?
- using this activity as an introduction to the physics of light.

GroupWork 4: Activity Guide - The Way Lenses Work (Student Reproducible)

Big Idea: What Makes the Visual System a System?

For many people, the world can be a fuzzy and confusing place. Without glasses or contact lenses, they have a hard time reading, seeing a movie, or riding a bike. In this activity, you learn more about how lenses help people to see.

Materials

- Several converging and diverging lenses and a common object.

Procedure

1. In your group, complete the following:

- Examine the lenses. How does the shape of a converging lens differ from a diverging one?

- Examine an object using the lenses. How does an object appear when seen through a converging lens? A diverging lens? Draw each on the group data sheet.
- What is farsightedness? Nearsightedness? Which type of lens is used to correct each problem? How do you know?
- For people that wear glasses or contacts, how do these lenses interact with the lens of the eye?

2. Your group has been asked to give a presentation to the third grade class at a nearby school. Some of these third graders have glasses but refuse to wear them. Your task is to explain how eyeglasses and contact lenses work and how students could benefit from wearing them. Be sure to include the following in your lesson:

- the difference between farsightedness and nearsightedness.
- what type of lens is needed and why.
- reasons to wear glasses.
- diagrams or props to help you explain.

GroupWork 4: Data Sheet - The Way Lenses Work (Student Reproducible)

Big Idea: What Makes the Visual System a System?

1. Sketch an object as seen with a converging lens.

2. Sketch the same object as seen with a diverging lens.

Groupwork 4: Resource - The Way Lenses Work (Student Reproducible)

Big Idea: What Makes the Visual System a System?

Converging and Diverging Lenses

Converging lenses are thicker in the center than at the edges. Converging lenses can make an object look upside down or right side up, smaller or bigger. The type of image a converging lens produces depends on how far the lens is from the object.

Diverging lenses are thinner in the center than at the edges. They always make objects look smaller.

Nearsightedness versus Farsightedness

Jerome can see objects clearly that are close. However, he cannot read freeway signs or identify a person across the street without his eyeglasses. People like Jerome, people who cannot see distant objects clearly, are called nearsighted. Jerome is nearsighted because the diameter of his eye is too long or his lens is too thick. In either case, faraway images are always focused in front of the retina and appear blurry. However, Jerome can hold an object closer to his eyes and see a more detailed image of that object than a person with normal vision can. In this sense, being nearsighted is like having a built-in magnifying glass.

Allison has a different problem than Jerome. She can see faraway objects, like a movie screen, clearly. However, she cannot read a book or newspaper without her eyeglasses. People like Allison, people who cannot see close objects clearly, are called farsighted. Allison is farsighted because the diameter of her eye is too short or the lens is too thin. In either case, to focus on objects far away, she must accommodate her eyes, thickening the lens so that the image hits the retina. Thus, while a person with normal vision has her or his eyes relaxed when viewing distant objects, Allison must accommodate hers. Her eyes, then, can never accommodate enough-the lens can never get thick enough-to focus on close objects. The images of close objects are always focused behind the retina and appear blurry.

GroupWork 4: Individual Report - The Way Lenses Work (Student Reproducible)

Big Idea: What Makes the Visual System a System?

1. Describe two differences between converging and diverging lenses. When would you use a converging lens? A diverging one?

2. Ms. Row has difficulty reading the morning newspaper. What type of lens does she need to correct her vision? Why?

3. Nicole is nearsighted but will not wear her glasses. Is this a problem? Explain.

GroupWork 5: Teacher Activity Notes - The Versatile Eye

Big Idea: What Makes the Visual System a System?

PLAN

Summary In this activity, students conduct an experiment to explore the relationship between the structure and function of the retina. They then create a model of the retina to explain their findings to the class.

Group Size 4 to 5 students

Objectives

Students:

- identify the structure and function of the retina.
- describe how changing the retina's structure affects the rest of the visual system.

Student Materials

Colored, white, and black squares of paper; dark sunglasses; a black felt pen; poster paper; and art supplies.

Multiple Abilities

- Reasoning ability (making connections between ideas/concepts, logically analyzing a problem)
- Spatial/visual ability (drawing an idea, creating a model)
- Ability to be precise (recording data correctly and clearly, measuring accurately, explaining clearly and fully, observing carefully and accurately)
- Creativity (generating alternatives)

Estimated Time 40 minutes

Suggested Use

- This set of activities works well near the end of the unit.

IMPLEMENT

- Try to use those glasses given to people who have had their eyes dilated-glasses that are very dark and that wrap around.
- Students need to be familiar with the structure of the retina, the difference between rods and cones, and how they see at night in order to successfully complete this activity. You may or may not choose to include the two resource cards that review some of this information.

ASSESS

Use the group discussion, presentation, and individual report to assess if students can

- identify the structure and function of the retina.
- describe how changing the retina's structure affects the rest of the visual system.

Extend GroupWork Activity 5 by asking the following questions:

- How many students have difficulty seeing clearly at night? Why is this a common problem?
- How does vitamin A deficiency cause night blindness?
- Many mammals are nocturnal. What kind(s) of receptors do they have in their retina? Why?

GroupWork 5: Activity Guide - The Versatile Eye (Student Reproducible)

Big Idea: What Makes the Visual System a System?

Why can't we see things clearly out of the corner of our eye? Why do we see things differently at night? In this activity, you explore how the structure of the eye affects its function.

Materials

- Colored, white, and black squares of paper; dark sunglasses; a black felt pen; poster paper; and art supplies.

Procedure

1. Using the materials at your table, devise an experiment to investigate people's **field of view.** Find out how people see **colors and words** differently when

- looking straight ahead versus peeking from the corner of their eye.
- staring at a stationary object versus tracking a moving target.
- viewing objects during the day versus at night.

Record your observations in your journal. Summarize your findings in a diagram.

2. Research the structure and function of the retina. How is what you've read about the retina related to your findings?

3. Now, as a team, use what you have learned in this activity to create a model of the retina. For your presentation, use the model to explain the following:

- In what ways is the eye versatile?
- How does the retina's structure make it versatile?
- How would changing the retina's structure affect the rest of the visual system? Affect what you were able to see?

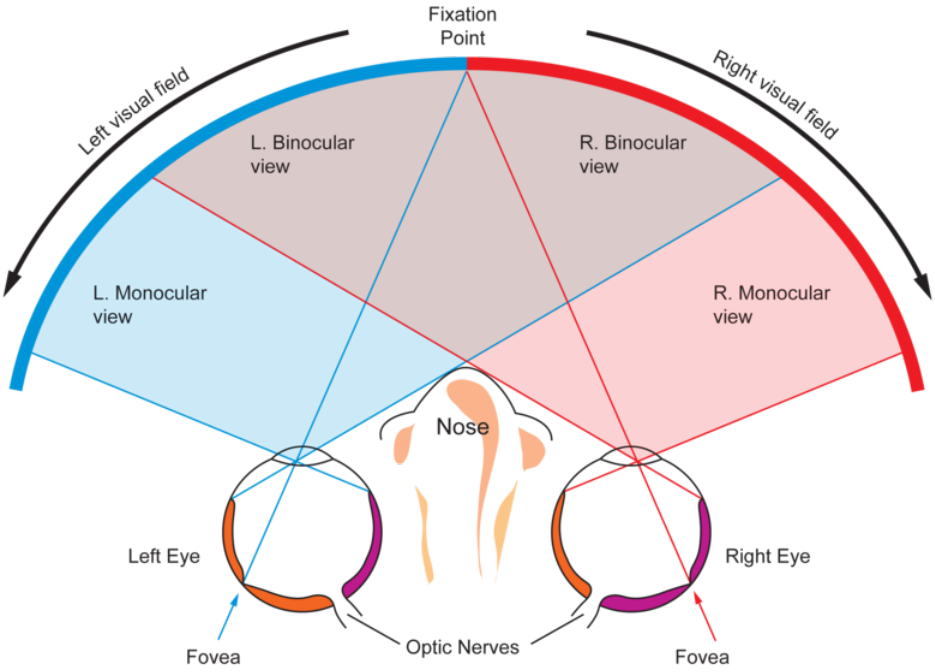
Groupwork 5: Resource 1 - The Versatile Eye (Student Reproducible)

Big Idea: What Makes the Visual System a System?

Field of View

Your field of view is made wide by the presence of two eyes. On average, humans have a field of view of 208 degrees.

Diagram of Field of View:



GroupWork 5: Resource 2 - The Versatile Eye (Student Reproducible)

Big Idea: What Makes the Visual System a System?

The Retina: Inspector Versus Detector

The retina is designed to do two jobs: examine detail and detect motion. To do so, it is divided into two regions. The first region of the retina is the inspector. It is the area we use when we want to see an object clearly. This region is less than half a millimeter across and is concentrated with cones. It is called the fovea. Why does the fovea provide such a clear picture? First, most of the processing cells and blood vessels have been cleared out of the fovea. This arrangement allows light direct access to the cones there and prevents its scattering. Second, cone cells in the fovea make a one-to-one connection with the processing cells in the outer layer of the retina. This one-to-one connection relays a point-by-point image to the brain. For these two reasons, the fovea produces a clear, crisp image.

The rest of the retina is the detector. It detects movement and boundaries along the edges of our field of view. This region consists mainly of rods and provides us with a blurry image. It is called the peripheral retina. Why does the peripheral retina produce a blurry image? First, blood vessels and processing cells scatter the light before it reaches the rods. Second, more than 125 rods feed information into one processing neuron. This processed image is then transmitted to the brain. For these two reasons, our peripheral retina produces blurry images.

The Retina: Day Versus Night

What happens to colors at night? During the day, we see colors because the cones of our retina are active. The cones have high thresholds. In other words, they respond only to high levels of light. Because cones come in three types-blue, red, and green-they allow us to see color. At night, we use rods to see. Rods have low thresholds. They are hundreds of times more sensitive to light than cones. In weak light, rods will send signals to the brain while cones will not. However, rods come in only one type. All rods absorb violet-blue light. Thus, they cannot provide the brain with information on color. That is why, in dim light, everything appears black, white, or gray.

Why is our vision at night often blurry? We learned part of the reason above. During the day, we use our cones to see. Our cones are concentrated in the fovea-the only part of the retina to produce a clear image. Moreover, in bright light, the pupils of our eyes are constricted. This reduces the number of light rays entering the eye and limits those that do enter to passing through the center of the lens. These two factors allow the eye to focus a clear

image. Unfortunately, we cannot use our fovea in dim light-it does not contain enough rods. Instead, we must use our peripheral retina, which transmits processed images to the brain instead of point-by-point ones. Furthermore, the pupil cannot remain constricted in dim light. Not enough light would enter the eyes. Instead, the iris opens and the pupil dilates. Light that enters passes through a larger area of the lens. The lens bends light more at its edges than in its center. The difference in bending contributes to the making of a blurry image.

GroupWork 5: Individual Report - The Versatile Eye (Student Reproducible)

Big Idea: What Makes the Visual System a System?

1. What happens to the color of objects at night? Why?

2. In creating your model of the retina, what are two pieces of information you used from your experiment? Two pieces of information you used from the resource material?

3. How is the eye versatile? Give at least two reasons.

4. How would changing the structure of the retina change what you were able to see? Provide one specific example.

Groupwork 6: Teacher Activity Notes - Looking into the Future: The Bionic Eye

Big Idea: What Makes the Visual System a System?

PLAN

Summary In this activity, students study the eye as an organ in the visual system. They design a bionic eye and attempt to sell their design to a company.

Group Size 4 to 5 students

Objectives

Students:

- identify and describe the function of the parts of the eye.
- explain how the parts of the eye form an organ.
- describe how the human eye can be improved.

Student Materials

Art supplies

Multiple Abilities

- Artistic/creative ability (thinking of new uses for familiar objects, conceiving of an idea for an illustration)
- Spatial/visual ability (drawing an idea, creating a model)
- Ability to make plans (organizing group, breaking tasks into its parts, focusing on a goal)
- Communication skills (explaining clearly and fully, using words precisely)

Estimated Time 40 minutes

Suggested Use

- This set of activities works well near the end of the unit.

IMPLEMENT

- Students need to be familiar with the structures of the eye and their functions.
- Schedule time for the presentation.

Conclude Groupwork Activity 6 by asking the following questions:

- What happens when one part of the eye is damaged? How does this situation help answer the question: How is the eye an essential organ in the visual system?
- How do the eyes of other animals differ from those of humans? If you don't know, how could you find out? What might account for similarities and differences between the eyes of different animal species?
- Would you like to work for a biotechnology firm someday? Do you know someone who already does?

ASSESS

Use the group discussion, presentation, and individual report to assess if students can

- identify the parts of the eye-their separate functions and how they work together.
- explain the functions of the eye within the visual system.
- describe how the human eye can be improved.

Extend GroupWork Activity 6 by

- inviting someone from a local biotechnology firm to speak to the class about his or her work.
- having students research a technological innovation intended for use in the human body. Examples include pacemakers, hearing aids, and artificial limbs. How does this innovation work? How does it interact with the rest of the human body?
- Discussing the costs and benefits of using technology to enhance or extend human life. Are there examples in which technology should not be used?

GroupWork 6: Activity Guide - Looking into the Future: The Bionic Eye (Student Reproducible)

Big Idea: What Makes the Visual System a System?

Examine the eye of a teammate. Why is there a black dot at the eye's center? What does the colored part do? In this activity, you take a closer look at the structure and function of the eye. You learn how the eye's parts work together to allow you to see.

Materials

- Art supplies

Procedure

1. In your group, discuss the following questions:

- What are the different parts of the human eye?
- Which do you think is the most important part ? Why? Is there one right answer?
- What are the functions of the eye within the visual system?

2. Your team has just been hired by EyeTech, Inc., a company that designs and produces bionic components. Your task is to create a new and improved human eye. Draw or build a model of an improved human eye and present it to the Board of Directors of EyeTech.

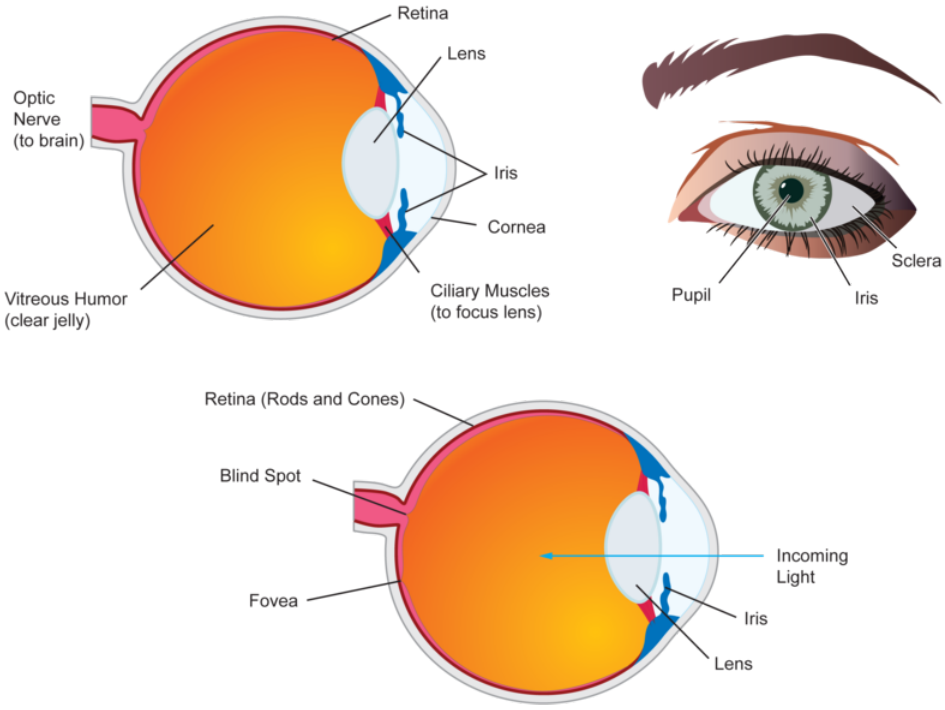
Your presentation should include the following:

- the improvements you made to the eye and reasons why you made them.
- reasons the company should accept and pay for your design.
- an example of an advertisement (a jingle, a billboard, a TV ad) for the new eye.

REMEMBER, the future of the company is in your hands!

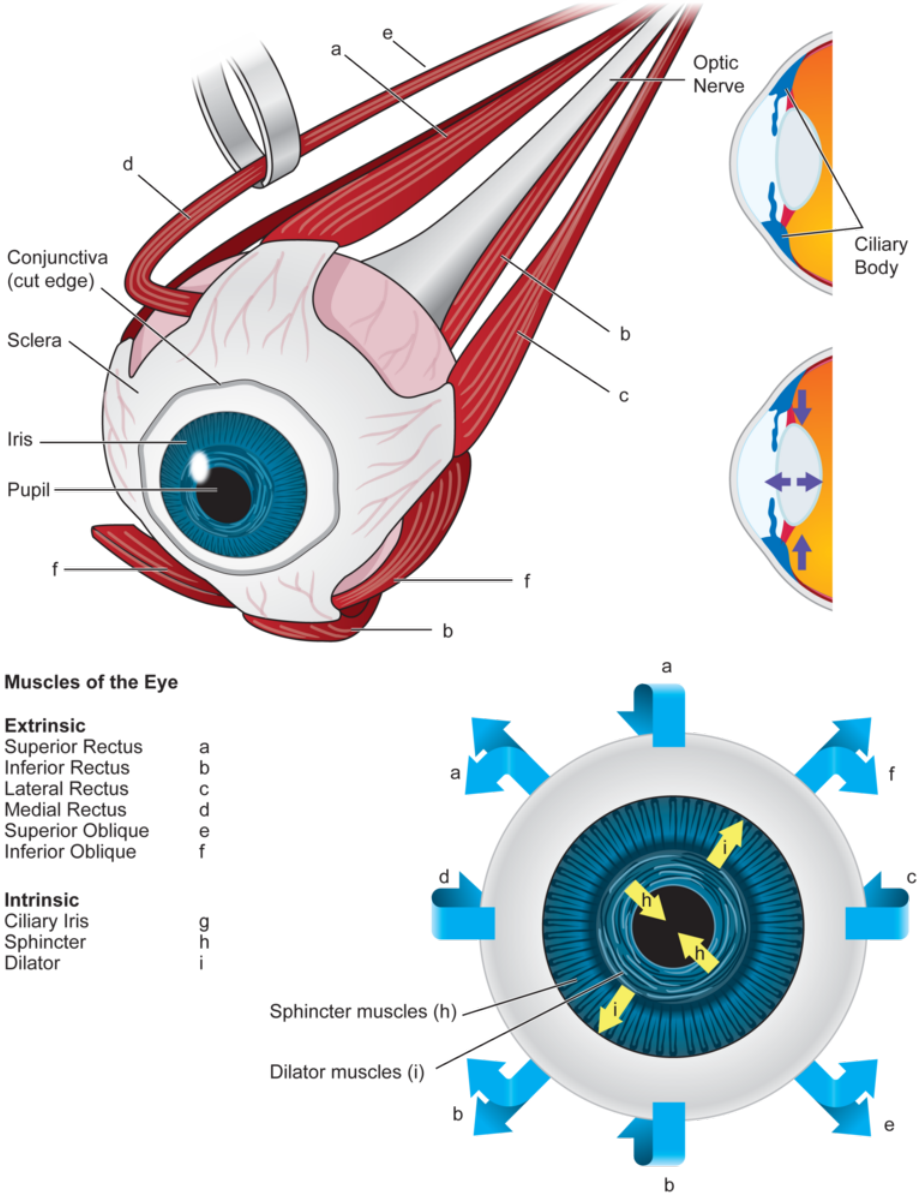
Groupwork 6 : Resource 1 - Looking into the Future: The Bionic Eye (Student Reproducible)

Big Idea: What Makes the Visual System a System?



GroupWork 6: Resource 2 - Looking into the Future: The Bionic Eye (Student Reproducible)

Big Idea: What Makes the Visual System a System?



GroupWork 6: Individual Report - Looking into the Future: The Bionic Eye (Student Reproducible)

Big Idea: What Makes the Visual System a System?

1. What do you think is the most important part of the human eye? Why?
2. What two improvements did you make to the human eye? Why did you make them?
3. What are the functions of the eye within the visual system?

8.2 Projects

The following Projects are an assortment of long-term activities that can be completed individually, in groups or as a class. We have provided starting points for research and development; you and the students can work together to create a more detailed plan of action. Consider the following two recommendations. First, because of the amount of work involved in a Project, students should choose one of great interest to them. Second, to encourage excellence and promote student-student learning, students should present their finished projects to the rest of the class, to the school, and to the community, if appropriate.

Project 1: Research Questions

Project 1 differs from the others: it is a list of possible research topics organized according to some key ideas and addressed to students.

In assigning a Research Question, we ask that you allow students to choose their topic-either one provided or one of their own. You might also

1. Specify length of piece.
2. Make clear the purpose and the audience.
3. Suggest sources and ideas for information.
4. Provide in-class time for compiling information and writing.
5. Require students to exchange papers and provide written feedback.
6. Provide a breakdown of due-dates for the following stages: choice of topic, outline, rough draft, and final draft.
7. Permit students to supplement a written report with a skit, a piece of artwork, a piece of music, a dance, a video, or a multimedia presentation.

ASSESS

Provide the students with evaluation criteria that include

- accuracy of the content based on guiding questions.
- clarity of writing.
- effective organization of main ideas.
- use of detailed examples or evidence to support their conclusions.

Project 1: Teacher Activity Notes - Research Questions

The following Research Questions require independent research. They are organized according to some key ideas and phrased in the form of a question.

1. Do all animals have the same nervous system? Compare the human nervous system to that of another animal. Make sure you explain why this comparative study is both interesting and useful.
2. What is a reflex? Compare a reflex action in humans with a reflex in another animal (e.g., the knee jerk in humans with the “righting reflex” in cats that helps them land on their feet). Answer the following questions:

What is the purpose of the reflex? What are the similarities and differences in how each reflex is performed? What do these reflexes tell you about the nervous system in particular and about the organism in general?

3. How are human sensory systems similar to and different from those of other animals? Compare the sensory abilities of humans to that of two other animals. For example, compare human sight to the sight abilities of hawks or other birds of prey. Or compare the sense of smell of humans to the sense of smell of dogs. You may want to use the theory of evolution to help explain similarities and differences. Make sure to explain the reasons this comparative study is both interesting and useful.
4. Research how an invention that transmits, stores, or produces sound was invented. Explain its uses and its impacts on society. Examples include the telephone, phonograph, radio, television, CD player, headphones, ultrasound machines, and many more. If you or a family member has used this device, include those as experiences and insights about its effects.
5. What is an invention that transmits, stores, or produces images? Examples include the TV, Projects VCR, film projector, computer, laser disc, and CD Rom. Research how a device was invented, its uses, and its impact on society. If you have used this device, include your own experiences and insights.
6. What can harm your ears? Explore an infection, disease, or activity that can harm the ear. Examples "swimmer's ear" and listening to loud music. Select one and research its cause, prevention, and, where appropriate its cure. Offer recommendations of how people might use this information to create policies regarding this issue.
7. What can harm your eyes? Explore an infection, disease, or activity that can harm the eye? Examples include pink eye and sports injuries. Select one and research its cause, prevention, and, where appropriate, its cure. Offer recommendations of how people might use this information to create policies regarding this issue.
8. How is the human brain similar to and different from that of other animals? Compare the size, structure, and function of the human brain with those of another animal. Include reasons this comparative study is both interesting and useful.
9. Have scientists always explained how the human brain works the way we do now? Trace the history of scientists' knowledge of the brain's structure and function over the past 50 years.
10. Will computers ever become as intelligent as humans? Research the current state of artificial intelligence. Answer the following questions: How is intelligence defined? How advanced are today's computers? Have scientists used their knowledge of the human brain to build computers? How does/will artificial intelligence impact your life? What are the predictions for the future?
11. What is a disease that directly affects the human nervous system? Examples include muscular dystrophy and Alzheimer's disease. Choose a disease that affects the nervous system primarily and research its cause, treatment, and/or prevention. What is the current state of research on this disease?
12. What is paralysis? How does it occur? What are scientists and doctors doing to help people who are paralyzed? What are research scientists doing to help "cure" paralysis?

Project 2: Teacher Activity Notes - Mind and Body

PLAN

Summary Students learn about the connection between "mind and body" (how the health of the body can affect the mind and the health of the mind can affect the body) by researching and comparing various biomedical and social science theories about the possible connections between mind and body.

Interdisciplinary

Science, Social Studies, Language Arts, Health

Estimated Time

- Two weeks for research and planning

- Three or four class periods for presentations

Suggested Materials

Books and magazine articles that cover the topic of mind and body, such as *Scientific American* articles and other science or psychology magazines, as well as Web sites such as the National Institute for Mental Health and the Society for Neuroscience.

Product

Written report

Oral presentation

IMPLEMENT

1. Discuss with students the idea of a connection between mind and body. People in different places and at different times have argued that the mind and body are closely connected, that the state of one's mind affects the state of one's body and vice versa. What is their opinion? Does your body's condition affect your mind's thoughts and feelings? Does a healthy mind ensure a healthy body?
2. As, a class, create a hypothetical community health action project that involves promoting the health of the mind as well as the body, integrating the theories of the groups you've studied when you feel they enhance the program. For example, you may decide to build a library and a fitness club next to each other. Or you may decide that a health spa and relaxation center would benefit the community.
3. Have students prepare a persuasive presentation to convince the local city council that your proposal would benefit the community, using their research and the scientific evidence of the connection between mind and body. They can then present their project to another class, parents, members of the community, or the real city council.

ASSESS

Use the group discussions, action plan, and presentation to assess if students can

- identify scientific and nonscientific theories about the interaction between mind an body.
- critically analyze each theory based on their knowledge of the nervous system.
- explain what they think about the interaction between the mind and body.
- use detailed examples and/or cite evidence to support their opinion.
- develop a community health plan that involves the health of the mind, as well as the body.

Project 3: Teacher Activity Notes - Sleep and Dreams

PLAN

Summary Students learn about the purpose and effects of sleeping and dreaming in relation to the nervous system by conducting experiments and then presenting and comparing their results with others.

Interdisciplinary

Science, Social Studies, Language Arts, Health

Estimated Time

- Two class periods to plan the experiment

- Two to three weeks to conduct the experiment, either in or outside class
- Three to four periods to present and compare research results in class

Suggested Materials

Books, magazine, videos on the topic of sleep and/or dreams, Internet sites such as the Society for Neuroscience, and CD Roms about the nervous system. (If possible, invite an expert in the field to speak to your students.)

Product

- Research results presented in data, graphs, written summaries
- Oral presentation of results

IMPLEMENT

1. Introduce the topics of sleep and dreams by having students free-write for five or ten minutes about one of the following: a reoccurring nightmare, their favorite time and/or place to sleep, what they do when they can't fall asleep. Pose the following questions: Why do we sleep? What do our dreams mean? How do we know when to wake up? What connections do our dreams have to our nervous system? Then, break the class into small groups to share what they wrote.

2. Reconvene as a class and ask students to explain what they learned or what questions they raised in their small groups. Write their responses on the board, highlighting connections and starting points for research.

3. Either individually or in groups, have students choose one of the topics or questions generated by the class to research. Topics may also include

- the stages of sleep and the patterns of dreaming.
- why humans need sleep and what happens when they don't get enough.
- problems or diseases related to sleep such as insomnia and narcolepsy.
- drugs that prevent or encourage sleep like caffeine and depressants.
- sleeping patterns among individuals in different age groups or within one age group.
- the type and number of dreams people remember.
- the types of drugs people use to fall asleep and those used to stay awake, and their effects on the nervous system.

4. The first part of their research should involve getting a solid background in their topic through research using books, articles, Videos, CD Roms, and the Internet.

5. The second part of their research can be the implementation of a survey of classmates and adults, asking about sleep patterns and/or dream patterns. If students plan to examine patterns and types of dreams, they should tell their subjects to keep a notebook next to their bed and write down all that they remember upon waking.

6. After students have given their surveys to their target group and have compiled their results, have them present their findings to the class. After their presentations, discuss any conflicting data or similarities in students' research findings.

ASSESS

Use the research notes, presentation, and completed report to assess if students can

- generate a testable research question on the topic of sleep and dreams.
- conduct a literature review of work already completed on their research question.
- identify the variable(s) to be tested and include a control in the experimental design, if appropriate.

- write an experimental procedure that can be repeated by someone else.
- develop a procedure for collecting and recording data.
- collect quantifiable data through the use of surveys and/or interviews.
- construct a graph of the data.
- prepare a written and oral presentation to explain their results and conclusions.

8.3 Additional Resources

Research Foundations

Brain Briefings, Free monthly letter published by the Society For Neuroscience.

Society for Neuroscience

11 Dupont Circle, Northwest Suite 500

Washington, DC 20036

(202) 462-6688

Decade of the Brain: Answers Through Scientific Research (National Institutes of Health; Publication #88-2957).

Information:

National Foundation for Brain Research

3050 K Street, N.W., Suite 310

Washington, DC 20007

(202) 293-5453

Brain Facts: A Primer on the Brain and the Nervous System. Published by the Society for Neuroscience (Second Edition, 1993). *Brain Concepts* series and *Brain Briefing* series are an extension of the *Brain Facts* booklet, in which individual topics are summarized in 2 to 4 pages. Can request additional materials on "Teaching Neuroscience to Children."

Information:

Society for Neuroscience

11 Dupont Circle, NW, Suite 500

Washington, DC 20036

(202) 462-6688

BrainLink: Exploration in Neuroscience. Booklets published by Baylor College of Medicine. Stories and activities to teach neuroscience at the Elementary Level.

Information:

Judith Dresden, M.S.

Assistant Professor

Division of School-Based Programs

Baylor College of Medicine, MEDT 545

1709 Dryden, Houston, TX 77030

(713) 798-8205

jdresden@bcm.tmc.edu

Videodisc

"Atoms to Anatomy: A Multimedia View of Human Systems" ©1992 Videodiscovery, Inc.

Section on the Nervous System; Detail on Vision and Hearing.

Information:

Videodiscovery, Inc.

(800) 548-3472

VHS Tape

1. *The Brain: Our Universe Within* ©1994 Discovery Communications, Inc.

Excellent 3-part VHS Series: Great animations and narration; clear presentation Tape #1: "Evolution and Perception"; Tape #2: "Memory and Renewal"; Tape #3: "Matter over Mind."

2. *The Mystery of the Senses* ©1995 NOVA.

A five-part series emphasizing the cultural and historical aspects of the senses. Segments are "Hearing, Smell, Taste, Touch, and Vision." Narrated by Diane Ackerman; based on her book of the same title.

CD-ROM

A.D.A.M.-*Inside Story* ©1994 ADAM Software, Inc.

A.D.A.M.-*Essentials* ©1994 ADAM Software, Inc.

Probably the best anatomy material currently on the market. Subdivided by systems of the body: Includes the Nervous System. Loaded with detail. Good interface design. A teacher resource guide is provided with *Essentials. Inside Story* is available at local software distributors.

Information:

A.D.A.M. Software, Inc.

1600 RiverEdge Parkway

Suite 800

Atlanta, GA 30328

(404) 980-0888

World Book Encyclopedia 1997, World Book Inc.

Other Commercial Software

"BodyWorks v 3.0" ©1994 Software Marketing Corporation

Excellent graphic detail; navigation is easy. Like A.D.A.M., material is organized by systems of the body. Includes *Nervous System.*

Internet

"Neurosciences on the Internet." Excellent compilation of resources.

URL: http://www.lm.com-nab

Information:

Neil A Busis, Ph.D.

E-mail: nab@telerama.lm.com

Society of Neuroscience

National Institute of Mental Health

8.4 Nervous System Glossary

anorexia nervosa an eating disorder characterized by an irrational fear of being fat.

astrocytes (AS-trow-sites) star-shaped cells that play a role in the blood-brain barrier. Parts of these cells wrap around and cover the brain's small blood vessels to help control which substances enter the brain.

axon a process of a neuron that carries a message away from the cell body.

blood-brain barrier a mechanism that prevents the passage of germs and some chemicals from the blood to the brain, keeping germs and some chemicals from entering the brain.

brain the structure located inside the skull that coordinates almost everything the body does.

brain stem the structure at the end of the spinal cord leading to the brain from the spinal cord. The brain stem includes the medulla (meh-DOOL-Iuh), pons (PAHNS), and midbrain.

bulimia an eating disorder characterized by periods of excessive eating, called bingeing, that are followed by vomiting.

cardiac (KAR-dee-ak) muscle the type of muscle that makes up the heart.

cell body the part of the neuron, which contains its nucleus and other important cell parts.

cerebellum the part of the brain located at the back of the brain stem below the bump at the back of your head that controls movement.

cerebral cortex a thin layer of grayish-beige material that covers the cerebrum.

cerebrum the dorsal anterior portion of the forebrain. Lobes in the cerebrum are responsible for motion, speech, judgment, personality, some memory, hearing, understanding speech, touch, pressure, pain, vision, and awareness of language, reading, and the body.

cerebral hemispheres (ser-REE-bruhl HEM-i-sfeers) the two sections that make up the cerebrum.

cerebrospinal (ser-REE-broh-spi-nul) fluid a fluid found between the skull and the membranes covering the brain that works like a water bed to cushion the brain.

cochlea (KOH-klee-ull) a winding, cone-shaped tube containing a fluid and forming a portion of the inner ear.

cornea (KOR-nee-uh) a clear protective sheath that covers the iris and pupil of the eye.

dendrite a process of a neuron that carries messages toward the cell body of the neuron.

eardrum a thin piece of skin stretched across the ear canal. Sounds traveling through the ear canal make the eardrum vibrate.

electroencephalogram (ee-LEK-troh-en-CEF-loh-gram), or EEG, a record of electrical activity measurements of huge numbers of neurons measured by electrodes attached to the skull.

electrodes (ee-LEK-trohdes) very fine wires that are used to record the nerve impulse sent by neurons.

frontal lobe the anterior part of the cerebrum.

glial (GLEE-uhl) cells cells such as astrocytes that help neurons do their jobs.

hammer, anvil, and stirrup three tiny bones that cross the middle ear from the back of the eardrum. These tiny bones move whenever the eardrum moves.

homeostasis (hoh-mee-oh-STAY-sis) the state of internal balance by which the body keeps conditions about the same, even if conditions in the environment change.

hypothalamus (hypo means below) a structure in the brain below the thalamus that regulates body temperature, eating, drinking, and sexual functions. The hypothalamus is located at the center of the cerebral hemispheres and, with the thalamus, joins the cerebrum to the brain stem.

iris the circular, pigmented, muscular membrane around the pupil and behind the cornea.

lens an elastic, naturally curved tissue controlled by tiny muscles called ciliary muscles.

meninges (meh-NIN-jeez) membranes that look like a thin sheet of plastic and cover and protect the brain.

nerve fibers structures that run throughout all parts of the body and transmit information between all tissues and the nervous system.

neurobiologists (NUR-oh-bi-AHL-uh-jists) scientists who study the brain and nervous system.

neurons nerve cells, which are the building blocks of the nervous system.

neurotransmitters (NUR-oh-trans-MIT-urs) chemicals released at the synapse from the end of an axon of one neuron. The neurotransmitters travel across the synapse to the dendrites of the next neuron to be converted to an electrical signal and carry on the nerve impulse.

occipital lobe the part of the brain that controls vision.

parietal lobe the part of the cerebral cortex that receives information about touch, pressure, and pain. The parietal lobe also acts as a language, reading, and body awareness center.

pinna the part of the ear that surrounds the hole that goes into the skull.

pupil the hole that is the dark spot in the center of the eye.

reflex an automatic reaction to a stimulus.

retina (RET-ihn-uh) a structure of the eye made of cells that capture the light energy that falls on them and converts the light patterns into nerve impulses that go to the brain.

skeletal (SKELL-ih-tuhl) muscle the type of muscle that moves the bones of the body.

smooth muscle the type of muscle that lines the blood vessels and digestive tract and many other organs in the body.

spinal cord a freeway of thousands of information tracks going to and from the brain. The spinal cord runs down the center of the backbone and joins the brain at the base of the skull.

stimulus anything that causes an action or response.

synapse a space or gap between neurons.

temporal lobe a section of the brain located along the sides of the head, just above the ears that is responsible for hearing and understanding speech.

thalamus a structure in the brain that works like a switchboard. It receives messages from sensory nerves and passes them on to the correct part of the cortex maps. The thalamus is located at the center of the cerebral hemispheres and, with the hypothalamus, joins the cerebrum to the brain stem.