

BioEdSM

*Teacher Resources from the
Center for Educational Outreach at
Baylor College of Medicine*



A Messenger System

Activity from Brain Chemistry: Teacher's Guide

by

Nancy P. Moreno, Ph.D., and Barbara Z. Tharp, M.S.

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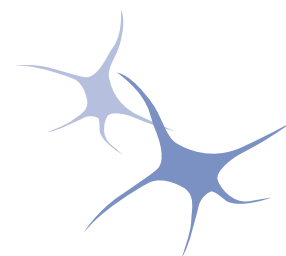
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The activities described in this book are intended for school-age children under direct supervision of adults. The authors, Baylor College of Medicine and the publisher cannot be responsible for any accidents or injuries that may result from conduct of the activities, from not specifically following directions, or from ignoring cautions contained in the text.

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“The brain is the last and grandest biological frontier, the most complex thing we have yet discovered in our universe. It contains hundreds of billions of cells interlinked through trillions of connections. The brain boggles the mind.”

James D. Watson
from *Discovering the Brain*
National Academy Press, 1992

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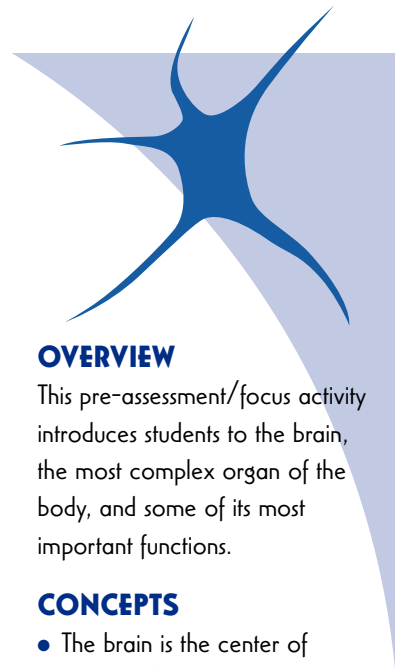
We are especially grateful to the many classroom teachers in the Houston area who eagerly participated in the field tests of these materials and provided invaluable feedback.

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A MESSENGER SYSTEM



Did you ever wonder why you can respond so quickly when you are startled? Wonder why you can “see” a picture in your mind’s eye? Wonder why you can remember facts, events and



Unit Links

LEGACY OF LOST CANYON

Story, Chapters 1-3; Science box, p. 7. (If using BrainLink for the first time, have students read “How the Club Began . . .,” p. ii; and “The NeuroExplorers,” pp. iii-iv.)

EXPLORATIONS

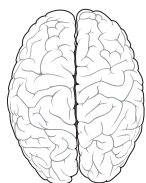
Cover activity; Matter of Fact!, pp. 2-3.

skills that you learned or experienced a long time ago? Your brain and **nervous system** make these and many more things possible.

The brain of the average adult weighs about three pounds and fills over half the skull. Even though it is soft (like pudding), the brain can be divided into several regions, each with very specific functions.

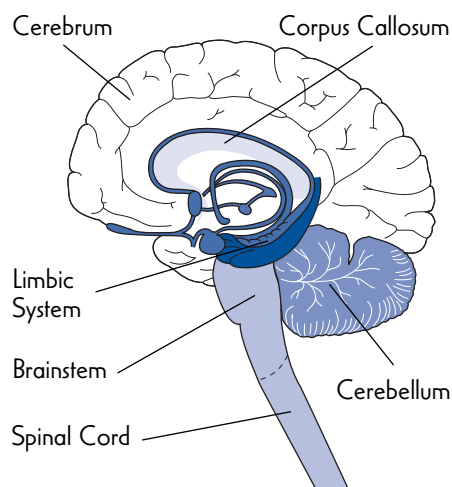
The **cerebrum**, about 85% of the brain’s mass, sits above the brainstem and cerebellum. The surface of the cerebrum is folded or wrinkled. The cerebrum enables one to think, learn, rea-

son, remember, feel sensations and emotions, and move muscles purposefully. It is comprised of two hemispheres (or halves), separated by a deep fissure. The hemispheres are connected by the **corpus callosum** and communicate with each other constantly. Even though the hemispheres may look the same, they are somewhat specialized. For example, the ability to form words is a function that seems to be located within the left hemisphere.



Cerebral Hemispheres
(top view)

The right hemisphere appears to handle many abstract thinking skills. Different parts of each hemisphere handle specific functions, including hearing, vision, speech, memory, decision making and long-term planning.



Cross-section of the brain and spinal cord

OVERVIEW

This pre-assessment/focus activity introduces students to the brain, the most complex organ of the body, and some of its most important functions.

CONCEPTS

- The brain is the center of thinking, learning, reasoning, memory, the senses, emotions and movement.
- The brain has unique physical characteristics.
- The brain is specialized into many different areas, each with a different job.
- Brain functions and abilities develop over time.

SCIENCE & MATH SKILLS

Observing, measuring, predicting, comparing and drawing conclusions

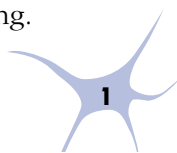
TIME

Preparation: 10 minutes

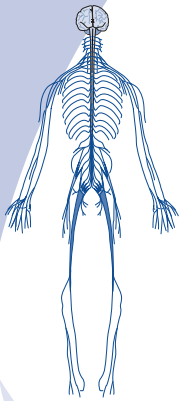
Class: 30-45 minutes, in two sessions

MATERIALS

- transparency of The Human Brain sheet
 - overhead projector
 - human brain model (optional)
- Each group will need:
- brain balloon filled with water (see SETUP)
 - sheet of drawing or chart paper
- Each student will need:
- copy of Know Your Brain? student sheet



The Complete Nervous System



The brain and spinal cord make up the central nervous system. All other nerves in the body form the peripheral nervous system.

Critical Timing

Some abilities and behaviors develop during critical windows of time. For example, vision is the last sense to develop. If a baby's vision is distorted by cataracts and is not corrected in time, the visual area of the brain corresponding to the affected eye will not develop appropriately.

There also is a sensitive developmental window for the acquisition of language. It is possible for adults to learn, and even master, new languages. However, in most cases, people who learn new languages after the age of 10 will speak the new language with the accent of their native tongue.

The **cerebellum** sits at the back of the brainstem and is about the size of a tennis ball. It controls balance, coordinates well-learned movements (such as throwing a baseball), and helps with some types of memory processing (like learning the multiplication tables) and some types of decision making.

The **limbic system** is buried under the cerebrum. It is involved in many emotions and motivations, especially those related to survival, such as anger, fear, and even the fight-or-flight response. The limbic system also is responsible for feelings of pleasure, such as those experienced in eating and sex.

The **brainstem** connects directly with the spinal column and is responsible for automatic functions of the body, including heart-beat, digestion, breathing, swallowing, coughing and sneezing. Automatic functions are present at birth and happen without thinking about them.

The brain's main communication channel to the rest of the body is the **spinal cord**. Nerves branch out from the spinal cord to the rest of the body. The brain and nerves are comprised of nerve cells, or neurons.

Functions and abilities develop as the brain grows and matures. Even though the human brain reaches its full size by age five, it continues to develop throughout adolescence. During adolescence, the areas important for emotions (limbic system) tend to mature earlier than parts of the cerebral cortex responsible for judgment, organization and reasoning.

SETUP

Prior to class, fill a "brain" balloon with water for each group of students. To do this, first stretch the balloon. Then fill it with water by placing the open end of the balloon over a faucet until it contains approximately three lbs (48 oz or 1,450 mL) of water. Use a scale or compare the balloon to something of appropriate weight to estimate when you have reached three pounds.

Before beginning any activity, have students complete the pre-assessment on page 5 individually. Students will work in groups of four to discuss functions of the brain (with the brain balloon), and they will work individually to create timelines.

PROCEDURE

Pre-Assessment and Brain Basics

1. Distribute the Know Your Brain? student sheet. Without discussion, ask students to answer the questions. Collect the finished

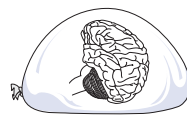
sheets (see Answer Key, sidebar, p. 4) and keep for use with the post-assessment (Activity 9) at the end of the unit.

Note. Do not grade the papers.

2. Begin a class discussion by mentioning that research scientists have learned much about the brain but that there still are many unanswered questions. Discuss students' answers to the assessment and tally the answers for each question on a chart at the front of the room. Moderate the discussion, but do not give answers to the assessment. You may wish to make a separate list of students' questions about the brain.
3. Show a brain balloon to the class. Ask, *How is this like a real brain? How is it different?* Give each group one prepared brain balloon. Have students within each group share ideas. The Recorder should prepare a chart with two columns labeled "Same" and "Different," and record the students' ideas.
4. Discuss group answers as a class. Some responses might include the following.

- **Same:** Balloon is similar size, similar weight, contains water, fragile, has three major parts visible.
- **Different:** Balloon is not alive, not made of cells, not wrinkled, without defined parts, not connected to anything, doesn't change or grow.

You also may want to use information listed in Brain Facts (see sidebar).



Brain balloon filled with water

Function Areas in the Brain

1. Project a transparency of The Human Brain sheet (p. 6) on the board. Discuss the different areas of the brain and the functions that are governed by those areas.
2. Prompt student thinking by asking questions such as, *What part of the brain would be involved in planning your homework?* (cerebrum) *Coordinating your movements when you play soccer?* (cerebellum) *Controlling your rate of breathing?* (brainstem) *Feeling angry?* (limbic system)
3. Then have students consider which types of activities or functions might be handled by a single part of the brain and which might require coordination among several different parts. Reading, for example, involves many areas of the brain (visual information and language is processed in the cerebrum; eye movements are coordinated by the brainstem; triggered

Brain Facts

- An average brain weighs about three pounds.
- Brain tissue is about 80% water.
- The brain contains over 100 billion neurons (equivalent to the number of stars in the Milky Way galaxy).
- The brain is contained within and protected by the skull.
- The brain is divided into left and right halves.
- The brain has three main parts, each with a special job (cerebrum, where thinking and processing of sensory information take place; cerebellum, which coordinates well-learned muscle movements; and brainstem, which governs automatic functions such as breathing and heart beat).
- The brain is pinkish-gray and has the consistency of warm butter, cooked oatmeal or pudding.

Individual talents and skills cannot be predicted based upon the appearance of someone's brain. All humans have brains of about the same size with the same pattern of folding. Differences among individuals are determined by the numbers and kinds of connections among nerve cells within each person's brain.

Good Wrinkles

The human brain is very wrinkled. The folds allow more cells in the outer layer of the cerebrum to crowd within the skull. The cells in this layer, known as the **cerebral cortex**, are responsible for many aspects of thinking, reasoning, the senses and movement. The raised parts of the folds in the cerebrum are called **gyri**. The creases or valleys are referred to as **sulci**.

Sample Timeline

AGE	MILESTONE	TYPE
1 mo.	Smiled	Emotion
3 mos.	Rolled over	Movement
1 year	Walked	Movement
14 mos.	Ran	Movement
14 mos.	Spoke first word	Communication

Answer Key

The following are answers to the Know Your Brain? Pre-Assessment activity

- **True:** 1, 2, 3, 5, 6, 8, 9, 10, 12, 14, 15, 19, 20, 22
- **False:** 4, 7, 11, 13, 16, 17, 18, 21

emotions might involve the limbic system). Have students work in groups to come up with other examples of activities or functions that involve multiple regions of the brain working together. Have groups present their examples to the class.

Brain Development Timeline

1. Begin a class discussion by asking, *Do you have the same capabilities and skills as when you were born? Which capabilities have you always had?* Encourage students to think about automatic functions, such as breathing, or senses, such as hearing. Ask, *Which capabilities or skills have you developed since then?* Responses might include walking, talking and reading.
2. Tell students they will be creating timelines of important events in their development. The timelines will include milestones such as the first time they sat up, walked, ran or spoke a word. Remind students that all of these functions are controlled in some way by the brain.
3. Guide students as they create templates for their timelines. The timelines should include spaces to record at least three important developmental events for each of the first two years of their lifetimes. At least one milestone should be recorded for each subsequent year. Students probably will need to consult their parents or other family members for details about the earliest events. The timelines also should identify whether each milestone was *most* related to movement, communication, senses, thinking, planning or emotions (see Sample Timeline, sidebar).
4. Have students bring their timelines to class to share in small groups or with the entire class. Ask students if they noticed any similarities in the types of milestones that were most significant in early years of development. In many cases, students will have recorded early events related to basic movements and beginning communication skills. Follow by having students discuss the types of milestones that occurred as they became older. Many of these milestones will be related to thinking, planning and complex movements and types of communication.
5. Conclude by helping students understand that their brains still are continuing to change. In adolescents, the areas of the brain important for emotions (the limbic system) mature and become more active earlier than those involved in judgement and reasoning (frontal lobes of the cerebrum). As the brain continues to mature, adolescents develop increased abilities to plan, reason and exercise self-control.

KNOW YOUR BRAIN?



Name _____

Read each statement below. Circle **T** if it is true or **F** if it is false.

1. Nerve cells can process many incoming signals from other neurons. T F
2. Hormones are chemical messengers that circulate in the bloodstream. T F
3. Our personal desires can affect how we interpret risks to ourselves and to others. T F
4. One special chemical acts as a messenger within the body. T F
5. Many automatic functions of the body, like breathing, are controlled by the brain. T F
6. Stress is a response by the body to help it survive. T F
7. Scientists now understand everything about the brain. T F
8. The pleasure system in the brain can be activated in harmful ways by some drugs of abuse. T F
9. Nerve cells use electricity and chemistry to send signals. T F
10. A person's skills and abilities are related to connections among nerve cells. T F
11. All nerve cells are alike. T F
12. The brains of teenagers still are developing and maturing. T F
13. It is easy to stop being addicted to a drug. T F
14. Our experiences contribute to the development of our brains. T F
15. Signals in the nervous system can travel from the brain all the way to the toe. T F
16. Nicotine, a drug in cigarettes, is not very addictive. T F
17. The part of the brain responsible for judgment and planning is one of the first parts to develop. T F
18. The brainstem is the thinking part of the brain. T F
19. The brain has many specialized areas. T F
20. Some drugs interfere with the sending and receiving of nervous system signals. T F
21. Neurotransmission is part of a car. T F
22. Whole grain breads and cereals provide a steady supply of energy to the brain. T F





THE HUMAN BRAIN

Cerebrum

- Thinking
- Learning
- Remembering
- Sensing
- Speaking
- Feeling emotions
- Voluntary movement (movements you choose to do)
- Planning
- Decision making
- Reasoning

Limbic System

- Feeling emotions related to survival, such as fear and anger
- Processing of memories for long-term storage
- Feeling pleasure
- Regulation of body temperature, thirst and appetite or hunger

Brainstem

Automatic body functions, such as:

- Swallowing
- Breathing in and out
- Sneezing
- Heart beat
- Eye movements and blinking

Spinal Cord

- Pathway for nerve signals to and from the brain
- Coordination of reflex actions, like jerking your hand away from something hot

Cerebellum

- Controlling balance and movement
- Remembering well-learned tasks and skilled movements
- Processing some types of memory

