Build-A-Brain

Facilitator's Guide

Cross-Cutting Subject Areas: Biology, Anatomy & Physiology

Grade: any (standards listed are 9-12)

Overview: This lesson uses easily identifiable characteristics of brain anatomy—such as relative size of specific brain structures, complexity of cerebrum and cerebellum, and proportion of brain to body mass—to explore structure-function relationships in biology. is used to reteach the scientific method. Students are asked to consider possible reasons for sweating when eating spicy foods, and they can easily be guided to the possible answer that it is due to an increase in body temperature. This is easily testable, so the exercise gives students the opportunity to write a simple hypothesis, design an experiment to test it, graph and analyze their own data using statistics, and draw conclusions from their data set. Given that outcomes are often not significant (body temperature does not differ after consumption of spicy vs. mild foods), the importance of a so-called "negative data set" is highlighted. This lesson plan was published in Science Scope, and we expect facilitators will read that article before implementing the lesson. Modeling dough (Play-Doh or other brands) may be purchased, or students can make their own for an extra preparatory exercise in procedure and measurement (recipe below). – ION/Teach

Standards

SCSh1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.
- a. Exhibit the above traits in their own scientific activities.
- b. Recognize that different explanations often can be given for the same evidence.
- c. Explain that further understanding of scientific problems relies on the design and execution of new experiments, which may reinforce or weaken opposing explanations.

SB5. Students will evaluate the role of natural selection in the development of the theory of evolution.
- d. Relate natural selection to changes in organisms.

SAP1. Students will analyze anatomical structures in relationship to their physiological functions.
- a. Apply correct terminology when explaining the orientation of body parts and regions.
- b. Investigate the interdependence of the various body systems to each other and to the body as a whole.
- e. Describe how structure and function are related in terms of cell and tissue types.

SAP3. Students will assess the integration and coordination of body functions and their dependence on the endocrine and nervous systems to regulate physiological activities.
- a. Interpret interactions among hormones, senses, and nerves, which make possible the coordination of functions of the body.
- c. Describe how the body perceives internal and external stimuli and responds to maintain a stable internal environment, as it relates to biofeedback.

Common Core Standards for Literacy in Science:
L9-10RST4: Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*

Topic(s): Comparative brain anatomy, and structure-function relationships

Essential Question: What are the main parts of the vertebrate brain, and what do they do?

Essential Vocabulary:

Cerebrum
Cerebellum
Cortex
Convolutions
Frontal
Parietal
Occipital
Temporal
Thalamus
Pons
Medulla oblongata
Brainstem
Spinal cord
Senses
Habitat
Behavioral repertoire

Materials:

Powerpoint slide set
Build-A-Brain article
Facilitator's Guide
Student Guide
Modeling dough (4 colors per 2-5 students)
Brain Models from CBN Lending Library
(models are optional; www.cbn-atl.org)

Hook:

What is your brain doing right now? List at least three things your brain is doing right now. (Use shared answers to generate discussion of the role of the brain in controlling all bodily functions, even those we do not think about.) Transition into discussion of brain anatomy in humans, then compare with brain anatomy in other vertebrate animals.

Procedure (from Student Guide):

1. List at least three things brain is doing. Discuss. Put these items into general categories of nervous system functions that are listed by the instructor or classmates.

2. Follow along with the anatomy slides, and label lobes of cerebral cortex (four of them) and subcortical regions (at least four of these) on your human brain diagram. (See student guide.)

3. Take notes on the functions provided by each major brain region.

4. Predict the features you might see in the dog brain vs. cat brain, based on skills you think each animal has. (Which one is more coordinated? Which one learns tricks better? Which one relies more on sense of smell?)

5. Predict the features you might see in the porpoise brain vs. sea lion brain vs. manatee brain, based on skills you think each animal has. (Which one communicates most? Which one uses smell to find her offspring? Which one is least coordinated?)

6. Write at least three reasons that animals are different from each other. When called upon, share your ideas with the class.

7. Get ready to model the brain of an imaginary creature. In pairs or groups of 3-5 students, think of a creature that intrigues you. On a separate sheet of paper, write down you creature's name and make a list of terms that describes that environment your creature lives in. Use the

environmental characteristics to generate a list of behaviors and brain structures your creature must have. For example, if the creature lives in dark caves, it might not see very well and might not need much brain tissue devoted to vision; it might have a lot of brain devoted to hearing instead. As another example, if your creature fights monsters and breathes fire, its medulla oblongata might be really big; that's the brain region that regulates breathing. As a final example, if your creature is extremely "crafty" (with very complex behaviors such as planning and communicating with other creatures in its social group), then the frontal lobes of the cerebral cortex might have a lot of convolutions to increase brain tissue devoted to these activities. Write down the behaviors and brain regions you included in your brain model.

8. Choose a representative (or two) to stand up, hold up your brain model, name the creature, and describe its main behaviors and brain features to the rest of the class. Be sure to use the names of at least five brain regions (structures), describe what they do for the creature (functions), and use appropriate directional terms to describe their location.

Closing Question: If you were not human, what kind of creature would you be? Why? Would that be better or worse than being human?

Extended Prep Activity: Prepare the modeling dough in class.
Use 1 cup flour; ½ cup salt; 3 tablespoons oil; 1 package of Kool-Aid (for color and scent); ½ cup water. Mix ingredients and keep refrigerated. If it gets too sticky, add flour. Keep in airtight container.

Extended Learning Activity: Independent student research on brain mass to body mass ratio, i.e. look for additional species to plot on the chart of Jerison's encephalization quotient. Write conclusions about whether status above or below the line of regression correlates with complexity of behavioral repertoire.

Formative Assessments:
Use holistic scoring rubric below to assess group presentations about their brain models (modified from Brown & Shavelson 1996). Keep or photograph the models for consideration after student departure.

Outstanding (4 points): Student gives complete descriptions that make logical sense; provides both detailed and specific comparisons; rationale is clearly stated; thinking process is evident; does not require leading questions. The brain is logically assembled.

Good (3 points): Student gives complete descriptions; comparisons may be less detailed; rationale is consistent; shows a thinking process; gives good answers to leading questions. The brain is logically assembled.

Satisfactory (2 points): Student gives incomplete or simplistic descriptions; rationale is not consistent; gives adequate answers to leading questions. The brain is logically assembled.

Serious Flaws (1 point): Student gives answers that are not complete or understandable; rationale is not consistent; gives wrong answers to leading questions. The brain is not logically assembled.

No Attempt (0 points).

Summative Assessment:
Test on general science principles and vocabulary.

-Match the brain region or body structure with its main function.

_____ corpus callosum	A. endocrine gland
_____ frontal lobe of cerebral cortex	B. sensory relay station
_____ medulla oblongata	C. cerebral cortex communication
_____ pons	D. vision
_____ temporal lobe	E. breathing
_____ pituitary	F. hearing and memory
_____ thalamus	G. cerebellar cortex communication
_____ occipital lobe of cerebral cortex	H. executive function (language, reasoning)

-If species A has a greater proportion of brain tissue devoted to vision than species B, what can you conclude about how species A sees, in comparison to how species B sees? Both species A and species B have similar relative brain sizes (1 pt.).

References:

Brown, J.H., and R.J. Shavelson. 1996. *Assessing hands-on science: A teachers guide to performance assessment.* Thousand Oaks, CA: Corwin Press.

Demetrikopoulos, M.K., Pecore, J., Rose, J.D., Fobbs, A.J., Johnson, J.I., and Carruth, L.L. 2006. *Build-A-Brain Project.* Science Scope. Summer 2006.

Brain models (and more) to borrow from the Center for Behavioral Neuroscience Lending Library— *http://www.cbn-atl.org/education/teaching.shtml*

Brain Museum, comparative mammalian brain collections— *http://brainmuseum.org*
Great site for downloadable brain images maintained jointly by the University of Wisconsin and Michigan State, as well as by the National Museum of Health and Medicine.

Animal diversity web— *http://animaldiversity.ummz.umich.edu*
Site with an extensive database that catalogs behavioral and physical characteristics of a great number of animals.

Eric Chudler's Neuroscience for Kids— *http://faculty.washington.edu/chudler/neurok.html*
Wealth of information about the nervous system, including extensive information on the basic parts of the brain, songs related to this lesson, creative writing projects. and games.