Lesson Summary: Students observe external brain anatomy to make inferences about the needs of various animals and to identify the types of brains in the Brain Zoo.

Purpose: The goal of this activity is to observe and analyze brain structure in order to infer function, relationships among species, and how brain structure helps animals respond to stimuli and meet their needs.

Grade Level 9-12

Lesson Length
2 class periods

Standards Alignment

Next Generation Science Standards

- 4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- MS-LS1-1. Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.
- MS-LS4-2. Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.

National Science Standards – Project 2061: Atlas of Science Literacy reference

Scientific inquiry: Claims, Evidence and reasoning – lines of reasoning and observations and evidence (p. 17, Atlas Vol. 1)

Objectives—Students will

- Observe external brain anatomy and infer function as it relates to needs of the animal.
- Analyze similarities and differences to identify the types of animals in the Brain Zoo.
- Communicate scientific explanations using claim, evidence, and reasoning format.

Assessment

- Communicate scientific explanations using claim, evidence and reasoning format.

Materials

- Variety of unnamed Brain Specimens
- Multiple size Post-it® notes
- Markers and highlighters
- Poster Paper
- 1 Brain Model per group
- Student Guide per student

Safety Alert: DO NOT open specimen. Preservatives may cause skin and eye irritation.

Lesson Overview

Students will participate in a series of activities following the 5 E's framework to identify the types of brains in the Brain Zoo. This lesson can be set up as a "puzzle" for the entire class to complete, or as a friendly competition between groups, but don't introduce this idea until after the Engage activity.

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Engage

Provide each group of 3-4 students with markers, poster paper, an observational task, and unidentified brains for observation and analysis. Stations 1-5 each have one brain, station 6 has a brain model with labeled parts, and station 7 has a set of five brains. Each student will individually respond to the task and write her/his ideas on the poster paper. Give groups 2-3 minutes to perform the assigned task, before rotating to the next station. Repeat until groups have been to all stations. Below are the observational tasks at each station.

Station 1 **What Do You Notice?** (Describe what you see/hear/touch/smell.)
I notice that . . .

Station 2: **What Does It Remind You Of?** (What memory, experience, story, does this trigger?
It reminds me of . . .

Station 3: **What Emotions Do You Feel As You Engage With This Task?**
I feel . . .

Station 4: **What Questions Do You Have?**
I'm wondering . . .

Station 5: **One Thing About The Brain You Have Always Wondered.**
I have always wondered . . .

Station 6: **Use The Resources At This Station To Draw A Brain And Label The Parts.**

Station 7: **Group Task: Compare And Contrast The Five Brains**
Compare: All the brains have . . . **Contrast**: Differences I notice are . . .

Footnote: Critical Response Protocol adapted from Artful Teaching & Learning Handbook. May be reproduced for classroom use by teachers.

When students return to the station where they started, have them sort through all of the comments and create an informal presentation to share with the class.

Explore

Figure 1

Show students a picture with a variety of mammalian brains. The image from www.brainmuseum.org, above, works well. Tell students they are going to re-visit the brain stations to figure out what animals are in the Brain Zoo.

Using the brain visual, have students generate ideas about what types of observations are useful as evidence to solve the "problem" and what types of observations are not useful. For example, while "Nasty!" might be a frequent comment, it is not a useful observation. Use one of the examples they

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give and have them brainstorm what inferences they could make and how these inferences might help them approach this challenge. Possible inferences about function that students can draw from observing the brains are: Size of cortex is related to cognitive capacity; olfactory bulb size implies sense of smell ability; size of cerebellum is related to complex balance and motor function. Don't worry too much that students don't yet fully understand this; the next part of the activity explains further.

Tell students to keep careful track of what questions they have in a Need-to-Know List. Explain that the Need-to-Know List will be used later to give them hints or to refer them to resources to help them solve the challenge. You may want to help them locate the olfactory bulbs on one of the brains since these structures are often easy to miss. Move around the room as students work, facilitating detailed observations such as the direction of the brain stem, indentations suggesting eye location, and what this suggests about the animal.

Explain

Set up each table with markers, highlighters, a brain model, 6 small Post-it® notes per student, a reading that introduces basic brain structure, function, and the importance of comparative anatomical study.

Individual Task:

Read ***Comparative Brain Anatomy: An Introduction to Structure and Function Relationships*** in the Student Guide. As students read, have them highlight any vocabulary they think is important to understand. When finished, ask them to narrow down the highlighted terms to six they think are the most important and write one on each Post-it note. While students wait for everyone to finish, let them see if they can find highlighted terms on the brain model at their table.

Small Group Task:

Ask each group member to read the six words the group chose. After everyone has shared, the group task is to further reduce the vocabulary terms by agreeing to a single set of the six most important of everyone's words from everyone's lists. Write one word on each of the large Post-it® notes. Don't worry about definitions yet. While students share, go around and put six extra large Post-it® notes at each table (8 ½ x 5 ½). Use ½ sheet of construction paper and tape if Post-it® notes are not available.

Whole Class Task:

As groups finish, have them come up and place the large Post-it® notes side-by-side along the base of a chalkboard, bulletin board, or window. When another group has already "posted" a word place that word above. When done you should have a graph of the key vocabulary terms. Help students further refine the list of key terms and help them define the 6-10 most important terms. Leave the vocabulary graph up and define more terms as necessary over the course of the lesson and unit. See figure 2.

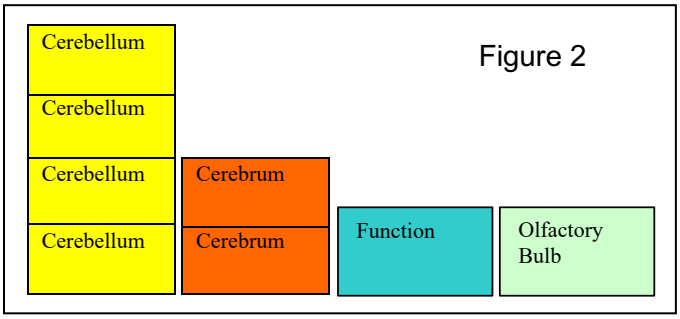

Figure 2

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Elaborate

Before asking students to re-visit their earlier observations and make final decisions about what types of brains are in the unidentified collection, provide them with resources to do some additional research.

If computers are available, ask students to visit the **Neuroscience for Kids** website at faculty.washington.edu/chudler/compare2.html and take the Brains, Brains, Brains comparative brain anatomy self-quiz. This works well because none of the brains are the same as in the Brain Zoo; this gives students an opportunity to go through the process of observing external anatomy to make inferences. Focus their attention on the questions that follow the activity.

Now that you have seen these brains, consider the following:

1. What are the similarities and differences between the brains?
2. What are their relative sizes?
3. Identify areas of the brain. Cortex? Cerebellum?
4. Are there noticeable differences in any particular parts of the brains?
5. Is the cortex smooth or rough?
6. Describe the placement of the cerebellum and spinal cord.
7. Compare the size of the olfactory bulb in the different types of brains.
8. Compare the size of the cerebral cortex in the different types of brains.
9. Discuss brain weight vs. body weight issues.

Ideally, the process described above would be a homework assignment so class time could be used to begin writing their hypotheses about the identity of the brains in the Brain Zoo. Let students re-visit their earlier observations and make a preliminary hypothesis about the brains in the Brain Zoo, using their own questions, observations, and the questions above. Direct them to decide which brains they can identify and write out their reasoning for each. Explain that scientists would, at this point, use a reference collection to help narrow their choices. The students will check their ideas using resources such as www.brainmuseum.org/ as their “reference collection.”

Depending on how much time is available, a good way to begin this section of the activity is to make "not knowing" fun – that is to say, make a guessing game out of their questions. Offer to give them hints but make the students work for them. If a student wants a hint, she must "buy it" using a currency that's fun: that is, she must share it with the rest of the class by acting it out without speaking (charades) or drawing it (as in the game *Pictionary*) while the other students guess.

Evaluate

Students communicate their hypotheses about what animals are in Brain Zoo using Claim – Evidence – Reasoning format.

Post-activity Reading Option thebrain.mcgill.ca/flash/i/i_05/i_05_cr/i_05_cr_her/i_05_cr_her.html

McGill University, ***The Evolutionary Layers of the Human Brain***. This could be used for the earlier reading as well and might be appropriate for advanced students, but would give some answers unless adapted.

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