DESIGN AN IMAGINARY ANIMAL

LESSON PLAN

Title: Design an Imaginary Animal
Setting: In Classroom
Subject: Biology - Neuroscience
Grade Level: 6-8
Time Frame: 1 Hour
Paired Dana Foundation Fact Sheets:
6th-8th Grade How Does the Brain Work?
Next Generation Science Standards:
Meets MS-LS1-3, MS-LS1-5, & MS-LS1-8

STUDENT OBJECTIVES

- Explore the structure and function of various parts of the human brain.
- Identify similarities and differences across animal brains and understand the reasons for having homologous structures.
- Utilize knowledge to create an imaginary animal and its brain.

BACKGROUND

The "Design an Imaginary Animal" exercise integrates a creative group activity with a basic neuroanatomy lesson. The instructor first provides a short explanation of brain structures and the functions they sub-serve, followed by a quick neuroanatomy lesson on comparative animal brains. Students are then asked to utilize this information to create an imaginary animal from scratch, focusing on four key points: life cycle, social communication, physical attributes, and environment.

The goal is to integrate freshly learned brain facts into the design of the new organism. Students are asked to draw out their animal, create their animal's brain out of Play-Doh, and present their imaginary animal to the rest of class.

MATERIALS

- Printed copies of 6th-8th grade Dana Foundation fact sheet, "How Does the Brain Work?" **Downloadable here: www.dana.org/factsheets/**
- Audio and visual capacities for a PowerPoint presentation.
- Markers and large sheets of paper (enough for a class divided into groups of 3).
- 4-5 different colors of Play-Doh (enough for a class divided into groups of 3).

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TEACHER BACKGROUND INFO

WHAT TO KNOW BEFORE YOU TEACH

* Note: This content is primarily for the instructor's reference; the accompanying PowerPoint presentation will be for the students.

The Human Brain

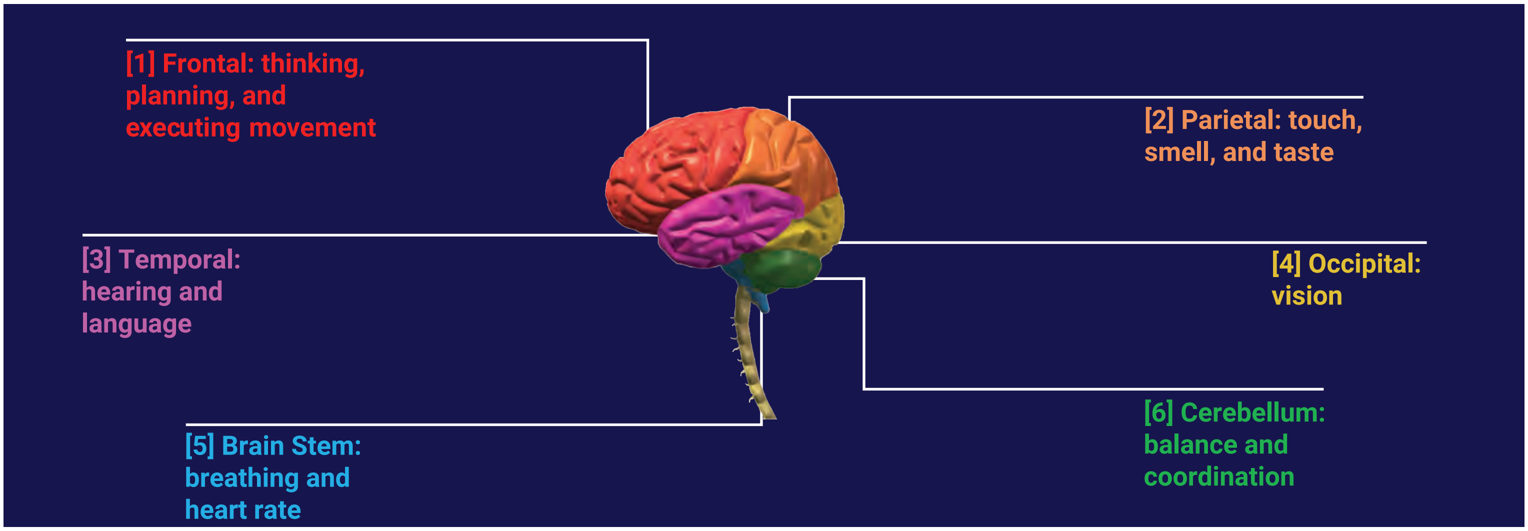
The cerebral cortex is the wrinkly outer layer of the brain that is responsible for higher cognitive thought and for processing sensory information. The wrinkles maximize the surface area of the brain, allowing for more neurons and increased connections between them.

The cortex is divided into distinct areas called "lobes" that sub-serve different functions:

- **The frontal lobe** - planning, reasoning, speech, movement, and problem-solving.
- **The temporal lobe** - important for memory and learning, hearing, and language.
- **The occipital lobe** - visual processing center of the brain.
- **The parietal lobe** - processes sensory information like touch, pressure, temperature, and pain; integrates this with motor information.

Other very important regions of the brain include the cerebellum and brain stem.

- **Cerebellum** - structure at the base of the brain that regulates balance and coordination. This area receives information from the eyes and muscles to detect where the body is relative to space (proprioception).
- **Brain stem** - also known as "the reptilian brain," it is the most primitive part of our brain. Regulates basic functions such as breathing, heart rate, and blood pressure.



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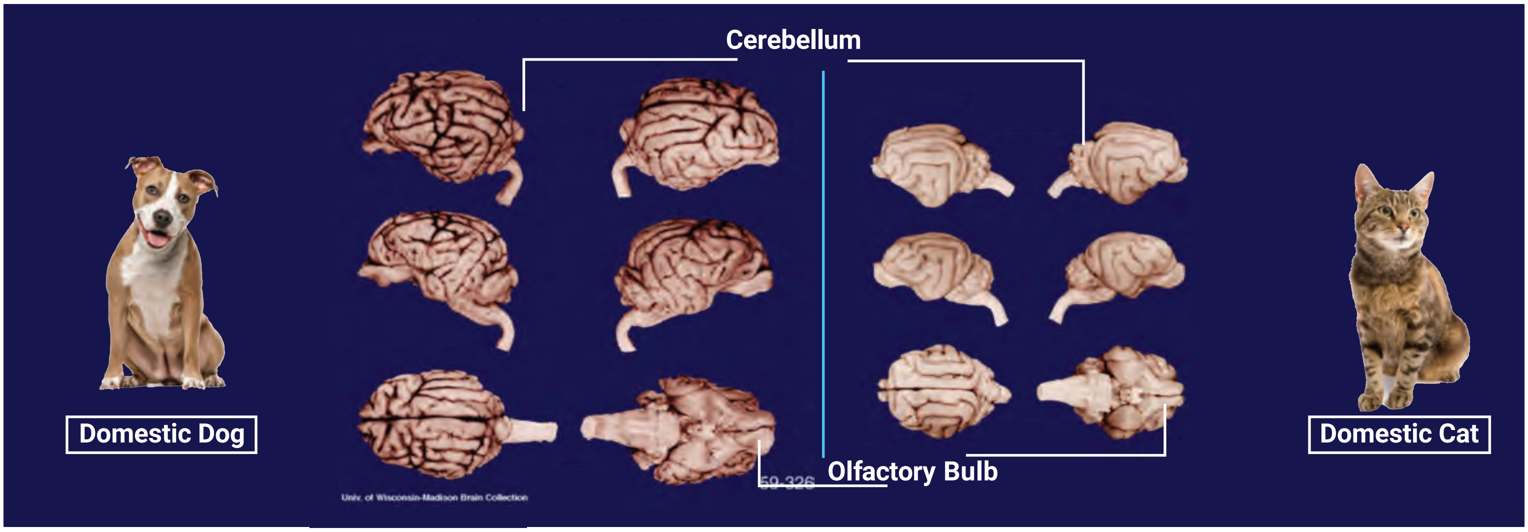
Comparative Animal Brains

One method to understanding the relationship between brain anatomy and function is to compare the neuroanatomy of different species. By assessing the differences and similarities in brain structure and their adaptive functions across animals, it's easier to understand the relative significance of each area within an organism.

For example, we can make predictions about the brains of common pets just by exploring some of their traits. Cats have extraordinary balance. Therefore, it's safe to assume that the cerebellum, the area responsible for balance and coordination, would be relatively larger in cats than other comparable animals with less balance and coordination. Dogs are known for their keen sense of smell. It's no surprise that dogs have larger olfactory bulbs when compared to cats.

We can also understand the brain/behavior relationship by examining the differences in structure. For instance, dog brains have more wrinkles to be able to fit more brain cells into their skulls. Dogs are more social animals and tend to live in packs in the wild. This may contribute to a more developed cortex. It doesn't necessarily mean dogs are smarter in every way, however. Depending on how you define intelligence, the debate about which animal is smarter than the other is complicated and not always straightforward.



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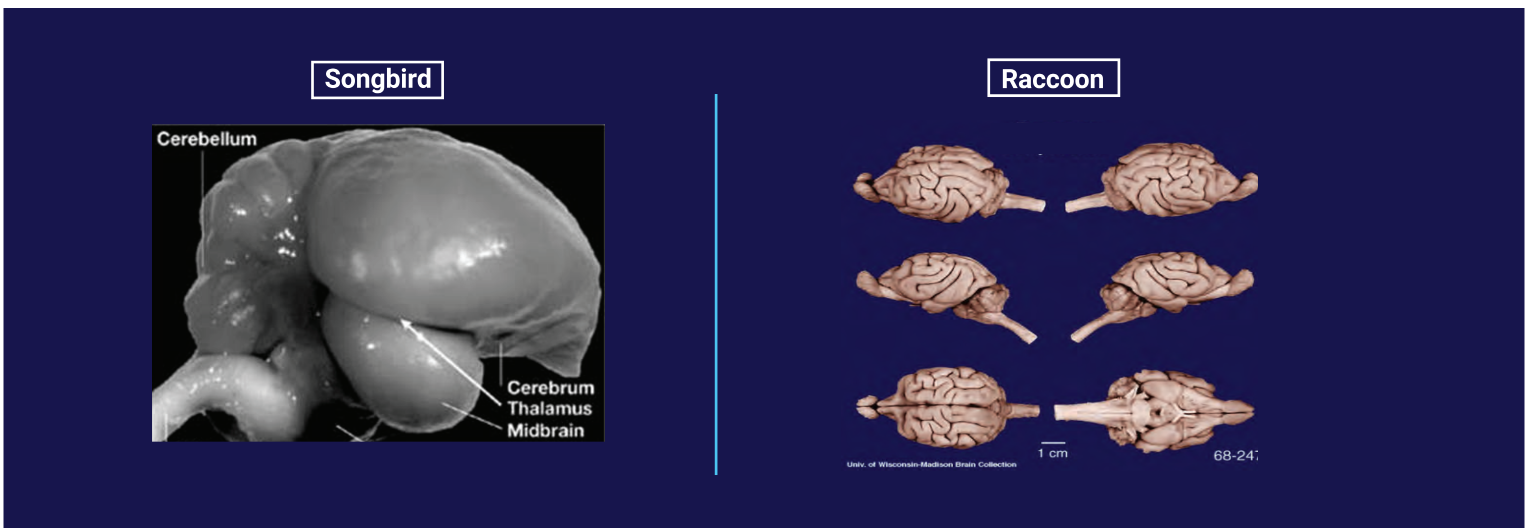
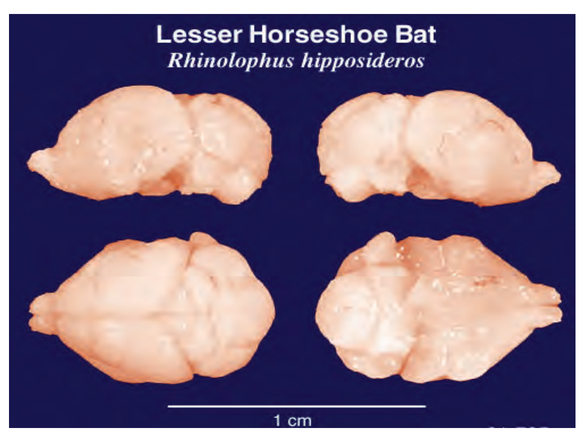
Comparative Animal Brains

Comparing the differences and similarities between the brains of a non-flying mammal (raccoon) and a bird can also be helpful in understanding the relationship between brain structure and function.

Songbirds have relatively larger cerebella to account for their exquisitely coordinated flight behavior. Normally, when comparing species, one would assume more wrinkles = more neurons due to more surface area. However, recent research has shown that smooth bird brains are more densely packed than the brains of their equally sized, mammal counterparts. Calling someone a "bird brain" isn't as effective an insult as it used to be!



If you look at the brain of a bat, you can see how it looks like an integration of the raccoon and bird brain. Bat brains look similar to bird brains because both animals rely on flight for movement. Bats also have a highly developed central region of the cerebellum like a bird. Anatomically, the cerebellum is expanded laterally like a mammal's. These attributes reflect the fact that the bat is the only mammal that can truly fly.



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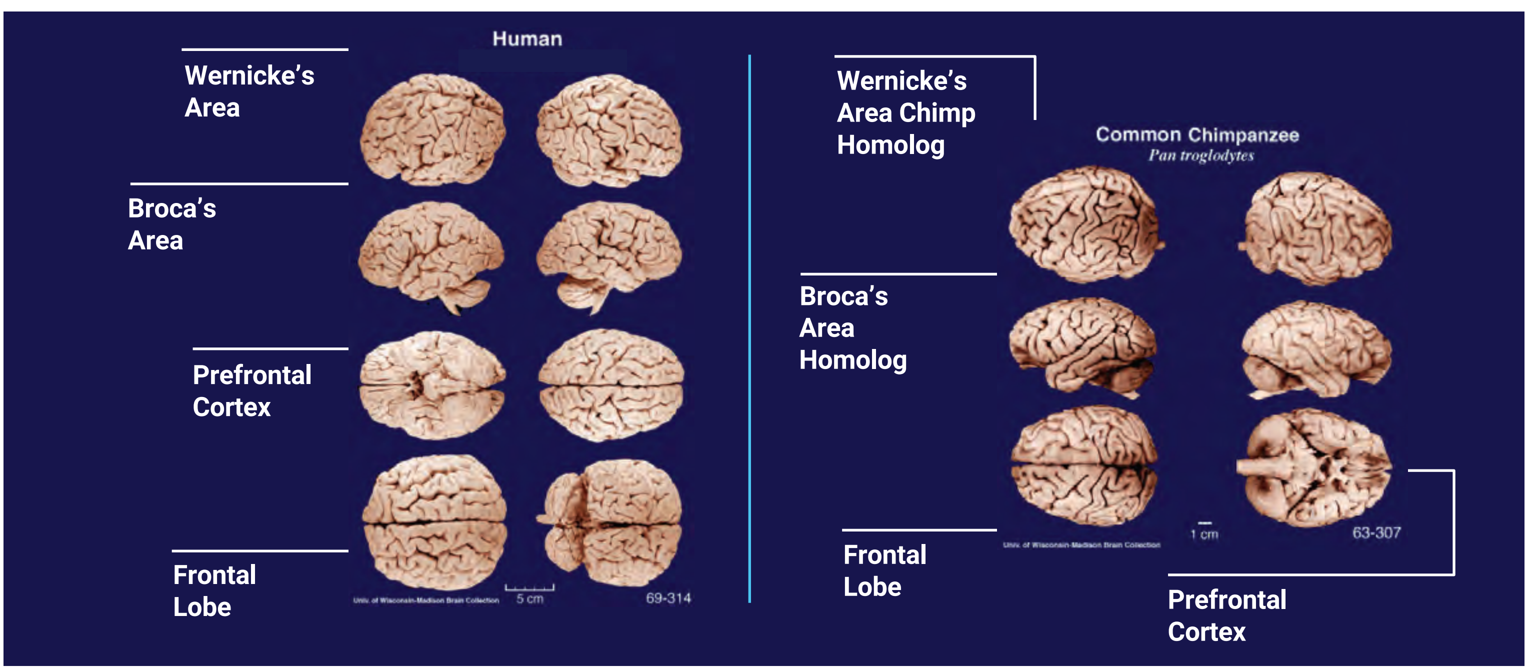
Comparative Animal Brains

The brains of humans and great apes (which include chimpanzees, bonobos, orangutans, and gorillas) have many similarities. Chimps and humans both have the frontal, temporal, parietal, and occipital lobes. In addition, they both have a brain stem and cerebellum.

Comparing side-by-side, humans have larger frontal lobes than chimpanzees. This is particularly obvious when you look at the prefrontal cortex which is more developed in humans than chimpanzees and is the last area of the human brain to fully mature in our 20s. When visually comparing the prefrontal cortices below, note the scooped-out indentation in the chimp brain.

Another difference is found in the language processing centers of the brain. The arcuate fasciculus is an axonal tract that connects two language areas: Broca's area & Wernicke's area in humans and their homologs in chimps. The word "homolog" simply refers to an area of similar structure, one that usually shares a common ancestor. In humans, the tract (made up of neuron cell bodies) is more prominent. This distinction most likely accounts for the complexity of human language when compared to chimp language.



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PROCEDURE

[1] Each student reads 6th-8th grade Dana Foundation fact sheet, "How Does the Brain Work?" **(5 minutes).**

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[2] Briefly introduce the exercise and give a short PowerPoint presentation about brain structure and function **(15 minutes).**

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[3] Have class split up into groups of three and distribute at least 4-5 different colors of markers and 4-5 different colors of Play-Doh to each group **(5 minutes).**

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[4] Instructions for students in groups:

a. Use your knowledge about brain structure and function to design an imaginary animal. Draw out your animal on paper. Be sure to address these four criteria and be ready to discuss what brain areas might be responsible for each one **(10 minutes):**

1. Life cycle - Does it produce eggs or give live births? How many offspring does it have at a time?
2. Social communication - What senses does it have? How does it communicate with conspecifics (same species)?
3. Physical attributes - What does it look like? How does it move? How does it breathe?
4. Environment - What is its habitat? How does it seek shelter?

b. Use your Play-Doh to make a prototype of this animal's brain. Think about what parts of its brain might be more developed due to its sense of vision, hearing, ability to move **(10 min).**

c. Present your imaginary animal and its brain to the rest of class as a group **(15 min).**

ADDITIONAL RESOURCES

- More information on brain anatomy and function: **www.brainfacts.org/Brain-Anatomy-and-Function/Cells-and-Circuits/2012/Neuron-Conversations**
- A collection of neuroscience puzzles and fact sheets for kids in grades K-12 that are available for download (PDF): **www.dana.org/educators/**

* The "Design an Imaginary Animal" activity was originally developed by Melissa Demetrikopoulos, Ph.D., Institute for Biomedical Philosophy, and was adapted by Elizabeth Weaver, M.S. and Linda Qi Beach, Ph.D. for the Dana Foundation.