COLUMBIA | Zuckerman Institute

BIOBUS

BRAIN STEM | Bringing Neuroscience to the Classroom

TOPIC 2

# Brain Anatomy & Function

Supported by: BNY MELLON

# Brain Anatomy & Function

The brain is the body's control center, sending and receiving information to and from the body and the external world. Students will gain an overview of the brain's organization and the functional role of different structures and regions.

## Suggested Duration

- 3 x 45 min classes

## Essential Questions

- What are the functions of different brain regions?
- How do different brain regions work together?

## Objectives

**Overall STEM goal**: Different parts of the brain can have different functions.

**All students will...**

- Gain an overview of the gross anatomy of the human brain, identifying the functions of the four lobes.
- Understand that the brain works together as a whole, but different brain regions can have different functions.
- Design and create a model of the brain.
- Conduct a brain dissection and identify key anatomical structures.

**Advanced students will...**

- Be able to distinguish cortical and subcortical brain regions.

## Materials

- Range of arts and crafts materials (e.g. air-dry clay, pom poms, textiles, string, paint)
- Post-its
- Blank paper
- Empty water bottle
- Sheep brains (purchase brains from www.carolina.com in 'Carolina Perfect Solution')
- Disposable gloves
- Scalpel
- Dissection trays (tip: you can use lids of photocopy paper packs or baby pads instead)
- Optional: camera or phone for photographing dissections

**Supplementary materials**

- Topic 2 slides: Brain Anatomy & Function
- Topic 2 exit ticket: Brain Anatomy

# Instructional Activities

## Class 1

### 1. Do Now | 5min

*Use Topic 2 slides (part 1)*

Project to the class the 3D human brain model from Brain Facts (slide 3), provide an overview of the brain's anatomy. Explain to students that they will look at the brain map to guide them into the different locations of different functions around the brain, the same way explorers use maps to find their way around land or sea. Ask students to note down what they observe about the anatomy of the brain and follow with a share out of observations as a class.

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**Discussion point and demo:**

Prompt students to reflect on the reasons why the brain has bumps and folds. Discuss how it allows the brain to fit inside the skull by increasing the brain's surface area.

You can help students visualize the concept of surface area through a quick hands-on activity. Ask two volunteers to come up and demonstrate to the class how they would fit a flat sheet of letter size paper into a water bottle. Students will have to fold or crumple the paper to get it to fit in the bottle. Explain to students that this is the same thing that happened to the brain: it had to form these folds in order to fit into the skull made of hard bone

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### 2. Direct Instruction | 10min

*Use Topic 2 slides (part 1)*

Prompt students to think about*: What is the role of the brain?*

Discuss their thoughts with the class and ask students to take notes:

- Different areas of the brain are specialized for different functions, allowing us to multi-task e.g. talk to a friend while we are getting dressed.
- The brain takes in information from the body and outside world, and produces outputs or responses such as movements, emotions, and thoughts. It controls our body, such as the functioning of our organs, our breathing, digestion, etc.
- (Slide 4) The brain is divided into two hemispheres that are highly connected.
- (Slide 5) The brain is divided into four major lobes located in the cerebrum of the brain.

**BACKGROUND**

**Frontal lobe:** Responsible for thinking, planning, problem solving, some aspects of personality, the production of speech, as well as movement.

**Parietal lobe:** Responsible for integrating information coming from different senses (e.g. taste, vision and smell when you are eating). It also specializes in processing the sensation of touch.

**Occipital lobe:** Processes visual information (e.g. recognizing colors and shapes)

**Temporal lobe:** Responsible for interpreting auditory information, for our ability to use and recognize language, for memory and emotion.

### 3. Group Work | 20min

Divide the class into four groups and assign one of the four brain lobes to each group. Depending on the class size, you can subdivide each group further into smaller groups of 3-5 students.

Each group will conduct research about the assigned brain lobe, thinking about the primary functions of this brain area. Instruct students to:

- Write a short paragraph to share with the class, summarizing their findings. In their summary, they should explain the location of the lobe, and the main functions associated with this brain lobe.
- Prepare 4 questions with short answers to include in the class Brain Trivia that will be played at the start of the next class. The Brain Trivia will be composed of 4 questions about each brain lobe, including a total of 16 questions in a random order.

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**Differentiation**

- Select the groups, mixing more advanced students with less advanced students.
- Students can do the research themselves, if you give them access to a computer, or you can provide resources from the student resources section below.

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## 4. The Lobes | 10min

*Use Topic 2 slides (part 1 and 2)*

At the end of class, ask one or two members of each group to come up to the front of the class and share their findings summary with the class, introducing students to the functions and location of each brain lobe. Share slide 6 from 'Topic 2 slides (part 1)' with the class.

Collect the 4 questions and answers from each group and collate them into slides (refer to slides 13-17 for a template) to use to play the game at the start of the next class. Ensure to mix up the questions in a random order.

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**Next class:**

In preparation for next class, introduce students to the upcoming activities. Explain that after the Brain Trivia they will be working in groups to create human brain models with diverse arts and crafts materials. Ask students to start thinking about what materials they can use to create their brain models and to bring some materials from home, including recycled materials, old textiles, etc.

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# Class 2

## 5. Class Trivia | 15min

*Use Topic 2 slides (part 2)*

Divide students back up into their groups from last class. Explain to students the rules of the Brain Trivia and then present the slides:

- There are a total of 16 questions but each group will only answer 12. Groups are not allowed to answer their own questions.
- The question is presented and each group has 1 minute to write down their answer.
- The teacher collects the answers and each group will get 1 point for each correct answer.
- Teacher will be keeping the group scores and the group with the higher number of points at the end of the trivia is the winner.

## 6. Direct Instruction | 10min

*Use Topic 2 slides (part 1)*

Guide the class through slides 7-10, introducing students to other key structures in the human brain, including some subcortical structures.

**BACKGROUND**

**Cerebellum:** located at the back of the brain and involved in almost all things that the brain does. Responsible for coordinating our movements or helping us learn new motor skills (e.g. how to use a pencil to write).

**Brain stem:** Upper areas are involved in basic functions such as sleep, respiration, heart rate, blood pressure. Lower areas connect to spinal cord and bring in most information from the body and also send messages to it (e.g. motor commands)

**Hippocampus:** Involved in forming and retrieving memories, as well as spatial navigation and memory.

**Amygdala:** Responsible for our emotions and combining memories with emotions.

**Thalamus:** Relays and sorts information that arrives from our senses e.g. information received in our eyes is sent to the thalamus and then onto other brain regions so that we can make sense of what we are seeing.

## 7. Creating Human Brain Models | 20min

In groups of 4-6 (depending on class size), students collaborate on creating models of the human brain using diverse arts and crafts, or recycled materials (slide 11). You can be creative here, providing students with diverse arts and crafts materials, or having them have total freedom to select their own.

Within each group, students divide themselves in two subgroups. One subgroup creates an exterior view of the brain that differentiates between the following different brain areas: the four lobes, the cerebellum and the spinal cord. The second subgroup will create a model with interior and subcortical structures (e.g. a sagittal view of the brain). Their model should include the corpus callosum, thalamus, brainstem and cerebellum. Share with students some activity details:

- The model does not have to be real size but students should ensure to make the different areas proportional to each other.
- Students should use different colors for the different structures for differentiation.
- Students should label each structure in their model (e.g. using toothpicks with flags).

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**Provide students with some brain anatomy tools:**

- 3D Tool for exploring the brain:
- Brain anatomy interactive

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Give students time to work on their models after class (or during another class if needed).

**EXTENSION/ALTERNATIVE**

- Students choose a brain region and answer the following question: What is the brain for me? Why is it important? Why is studying the brain important? Students **create an art piece** inspired on their answers to these questions. Art pieces can be made in any art form e.g. painting, drawing, writing, dance, music, etc. Examples of brain art to share with students are available on 'Topic 2 slides 18-20 (part 3)'.
- Organize a **gallery walk**: Have students display their models around the classroom and give the class time to walk around and observe each others' models. Distribute post-its and instruct students to add one comment and/or question to each model.
- **Role-playing:** Groups create a presentation in which students role-play teaching (or actually teach if this is possible in your school) a short

class on brain anatomy to younger students (e.g. middle school). Their lesson should be a simplified version of what they learned about brain anatomy and function, making it fun and engaging for younger students.

## Class 3

### 8. Comparing Animal Brains | 10min

*Use Topic 2 slides (part 4)*

Show students slide 23, asking them to guess what brain belongs to what animal. Then reveal the answers in slide 24, explaining how different animals have different brain structures. Prompt students to think why different animals have different brain structures.

Discuss how the structure of the brain is related to its function and how different areas of the brain have different sizes in different animals, depending on what the needs of each animal. One example is the olfactory bulb in mice and rats that is huge, in porportion to the size of their brains This is because they use smell alot to feed and survive. Other examples are some species of birds, who have areas of the brain specifically dedicated to learning songs.

### 9. Brain Dissections | 25min

*Use Topic 2 slides (part 4)*

Continue through slides 26-28, prompting students to observe the differences between the animal brains and the human brain. Explain to students that they will be dissecting sheeps brain today, and ask them to observe and discuss the differences between the human and the sheep brain.

Then, divide the class into groups of 4-6 students (depending on class size and available brains) and distribute the dissection materials.

Go through the dissection step-by-step instructions on slides 29-30 as a class, ensuring students understand the safety instructions, the materials they will use, the procedure to follow and what brain structures to look for.

Ensure all students are comfortable with participating in the dissection and using the equipment. For students who do not want to participate in the dissection, you can allow them to just observe other students and/ or provide them with the following resources:

- Virtual dissection online tools:
  - Exploratorium
  - Biology Corner
- Dissection video (refer to Student Resources page)

Once the class is ready, instruct students to:

- Collaborate on dissecting the sheep brains as per instructions.
- Identifying key regions and structures.
- Write a dissection log as a group: a record of the step by step process of their dissections. Students can document their dissection logs with labelled diagrams, drawings and/or photographs.

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**Differentiation**

Use the available slides (32-36) with information on what structures to identify or you can guide students through the cuts and allow them to identify the structures themselves.

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At the end, discuss the dissection with the whole group class. Prompt students to discuss and take notes on:

- What did they learn about the brain's anatomy?
- What structures were easiest and hardest to identify?

- Did they note any further differences between the sheep brain and the human brain?

## 10. Exit Ticket | 5min

*Use 'Topic 2 exit ticket'*

Give each student an exit ticket handout. Ask students to label the relevant parts of the human brain illustrations and to write at least one question they still have about the brain's anatomy and function.

**EXTENSION/ASSESSMENT**

- After students put together their group dissection logs, you can work as a class to put together a combined class log.
- Ask students to develop graphic organizers or slide presentations with their dissection logs (individually or in groups) and labelled diagrams.
- Ask students to compare the sheep brain dissections with the models they made in lesson 2 and take notes of similarities and differences.

## Resources for Students

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| **FIRST LEVEL** | Koshland Science Museum: Brain anatomy tool | https://www.koshland-science-museum.org/explore-the-science/interactives/brain-anatomy |
| | Eyewire: Explore the brain | https://science.eyewire.org/ |
| | Sheep brain dissection (videos) | https://www.youtube.com/watch?v=y7gEWzPqm94<br>https://www.youtube.com/watch?v=o3v9cdD6Sqo |
| | Zooming in on the brain (video): | https://www.youtube.com/watch?v=Zj3RxtJ_Ljc |
| **MEDIUM LEVEL** | Brainfacts.org: Brain anatomy tool | https://www.brainfacts.org/3d-brain#intro=true |
| | BioEd Online (video) | http://www.bioedonline.org/videos/lecture-series/your-brain-is-you/meet-your-brain/ |
| | Exploratorium: Sheep brain dissections | http://www.exploratorium.edu/memory/braindissection/3.html |
| | Biology corner: Sheep brain dissection | https://www.biologycorner.com/anatomy/sheepbrain/sheep_dissection.html |
| **ADVANCED LEVEL** | Brain Facts Book: Chapter 1 | https://www.brainfacts.org/the-brain-facts-book) |

## Resources for Educators

| Background Reading | |
|---|---|
| Brain Facts Book (Chapter 1) | https://www.brainfacts.org/the-brain-facts-book |
| Big Picture Education: Inside the Brain (2013). Page 10-11 | https://bigpictureeducation.com/sites/default/files/bp_files/inside%20the%20brain/wts040941~3.pdf |
| **Educational Activities** | |
| Skype a Scientist | https://www.skypeascientist.com/ |
| Exploratorium: Sheep brain dissections | https://www.mindmeister.com/blog/teach-mind-mapping/ |
| Dissection videos | http://www.exploratorium.edu/memory/braindissection/3.html |

## Vocabulary

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|---|---|
| **Amygdala** | A structure in the forebrain that is an important component of the limbic system and plays a central role in emotional learning, particularly within the context of fear. |
| **Brain Stem** | The major route by which the forebrain sends information to and receives information from the spinal cord and peripheral nerves. The brainstem includes the midbrain, pons, and medulla, and it controls, among other things, respiration and the regulation of heart rhythms. |
| **Cerebellum** | The largest part of the human brain associated with higher order functioning, such as thinking, perceiving, planning, and understanding language, as well as the control of voluntary behavior. |
| **Corpus Callosum** | The large bundle of nerve fibers linking the left and right cerebral hemispheres. |
| **Frontal Lobe** | One of the four subdivisions of the cerebral cortex. The frontal lobe has a role in controlling movement and in the planning and coordinating of behavior. |
| **Hippocampus** | A seahorse-shaped structure located within the brain and considered an important part of the limbic system. One of the most studied areas of the brain, it is involved in learning, memory, and emotion.. |
| **Occipital lobe** | One of the four subdivisions of the cerebral cortex. The occipital lobe plays a role in processing visual information. |
| **Parietal lobe** | One of the four subdivisions of the cerebral cortex. The parietal lobe plays a role in sensory processes, attention, and language. |
| **Temporal lobe** | One of the four major subdivisions of each hemisphere of the cerebral cortex. The temporal lobe functions in auditory perception, speech, and complex visual perceptions. |

## Vocabulary

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| **Thalamus** | A structure consisting of two egg-shaped masses of nerve tissue, each about the size of a walnut, deep within the brain. The key relay station for sensory information flowing into the brain, the thalamus filters out information of particular importance from the mass of signals entering the brain. |

## Standards

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| **CONTENT SPECIFIC CURRICULUM STANDARDS** | Developing and Using Models<br>Engaging in Argument from Evidence<br>Obtaining, Evaluating, and Communicating Information |
| **NEXT GENERATION SCIENCE STANDARDS (NGSS)** | Life Sciences:<br>HS-LS1-2: From Molecules to Organisms: Structures and Processes<br>Crosscutting concepts:<br>HS-LS1-1<br>HS-LS1-3<br>HS-LS1-4 |
| **COMMON CORE STATE STANDARDS** | CCSS.ELA-LITERACY: RST.9-10.3<br>CCSS.ELA-LITERACY: RST.9-10.4<br>CCSS.ELA-LITERACY: RST.11-12.7<br>CCSS.ELA-LITERACY: RST. 11-12.9<br>CCSS.ELA-LITERACY: SL.9-10.1<br>CCSS.ELA-LITERACY: SL.9.-10.5<br>CCSS.ELA-LITERACY: SL.11-12.1 |

## Credits and Sources

BioEdOnline

BrainFacts.org

Brain Facts Glossary: https://www.brainfacts.org/glossary

Brain Anatomy Interactive, Koshland Science Museum: https://www.koshland-science-museum.org/explore-the-science/interactives/brain-anatomy

Carolina: www.carolina.com

Exploratorium: https://www.exploratorium.edu/

EyeWire

National Institutes of Health / National Institute of Neurological Disorders and stroke: https://www.education.ninds.nih.gov/

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