

COLUMBIA | Zuckerman Institute  
**BIOBUS**



**BRAIN**  
**STEM**

Bringing  
Neuroscience  
to the Classroom

TOPIC 1

# Introduction to Neuroscience

Supported by:  BNY MELLON

# Introduction to Neuroscience

This topic introduces students to the complexities of the brain and nervous system. Students will explore different ways that scientists study the brain, and how sometimes research can lead to incorrect interpretation of results.

## Suggested duration

- 3 x 45 min classes

## Essential questions

- What is the role of the brain and nervous system?
- Why is the brain important?
- How do we study the brain and nervous system?
- What are some common misconceptions about the brain?

## Objectives

**Overall STEM goal:** Understand how we study the brain and nervous system, and why.

### All students will...

- Review their prior knowledge and generate further questions about the brain and nervous system.
- Gain an overview of the importance of the brain and nervous system.

- Explore different ways in which scientists study the brain and nervous system of different species.
- Research and present evidence supporting or debunking a neuromyth.
- Evaluate the reliability of different sources of information.

### Advanced students will...

- Be able to explain why some existing misconceptions about the brain endure.

## Materials

- Projector

### Supplementary materials

- Topic 1 slides: Introduction to Neuroscience
- Topic 1 activity sheet: KWL
- Topic 1 activity sheet: Mock Trials Assessment




# Instructional Activities

## Class 1

### 1. Introduction | ⌚ 5min

Introduce students to the upcoming topics that will be covered over the following classes (if you will cover more than one Brain STEM topic, ensure to provide an overview of what will be covered), including learning objectives and what is expected of them throughout the lessons. Tell students that in this topic they will be learning about the nervous system, particularly the human brain and how it works.

### 2. Do Now | ⌚ 15min

 Use 'Topic 1 activity sheet: KWL'

This topic will start with students exploring what they already know about the human brain and how it works. Ask students to work in pairs to fill in the first two columns of their KWL sheets. Instruct students to write on column K, what they already know about the brain and W, what they are interested in knowing about the brain.

Prompt students by writing on the whiteboard:

- What does your brain do?
- Why do we need a brain?

Ask students to share some of their responses with the class and generate a class discussion. Where obvious misconceptions in students' understanding arise, ensure to clarify them. Instruct students to take notes in the "L" column (i.e. what they have learned) of their KWL worksheets throughout the next two classes.


Follow this activity with some direct instruction, explaining to students:

- The brain is the body's control center. It sends and receives information to and from the body via

the spinal cord and the nerves. It is responsible for the functioning of our body and its organs, for storing knowledge and memories, for our thoughts, feelings and actions.


- The brain is part of the nervous system, a system of nerve cells that communicate across the brain and body. These specialised cells are called neurons and the way they communicate is a bit like the body's electrical wiring.
- The brain is extremely complex and there are still many things we do not know about how it works.

#### EXTENSION

 Show students "How the brain works" [video](#) (by Sentis).

While watching the video, ask students to complete column L of their KWL worksheets, writing notes on what they have learned from the video. Ask students to share some responses out loud with the class.

### 3. How Do We Study the Brain? ⌚ 15min

 Use 'Topic 1 slides (part 1)'

Show students slide 2, prompting them to think about how we study the brain - *How do we know all the things we know about the brain? What methods are used to study the brain?* Instruct students to discuss their thoughts with their pairs for a few minutes, following with a class discussion.

Guide students through slides 3 to 15, discussing the different ways the scientists study the brain. Refer to the notes section for more information.



## 4. Exit Ticket | ⌚ 5min

Give students time to reflect on their KWL activity sheets and add what they have learned about the brain and nervous system to the “L column”. Collect these at the end of class for a first review of students previous knowledge and current understanding of the brain and nervous system.

### EXTENSION

#### Question Board

In one of the classroom walls (or if you use Google Classroom you can add it as a document) put up a poster called Question Board. Explain to students that generating questions is the foundation of science research, driving us (and scientists) to look for answers.


Ask students to look at the ‘W’ column of their KWL worksheets and generate at least one question each. The question should reflect something that they are interested to know more about the brain and how it works. Students should write their question in a post-it and put it up on the board/poster.

Throughout the course, you should have students refer back to these questions. Students should think about what questions have been answered through their research and class work. When they feel like one of these questions is answered, they can remove the post it or they can write the answer in another coloured post-it next to it. When new questions emerge, they should add new post-its to the board.

## Class 2

## 5. Brain Facts: True or False?

⌚ 10min

 Use 'Topic 1 slides (Part 2)'

Engage students in a true or false quiz that presents brain facts and myths for students to consider. Project the 'Topic 1 slides: Introduction to Neuroscience (part 2)' to the class, taking students through each statement. To collect students' answers you can either 1) ask students to put their hands up to indicate their responses (true or false), or 2) have them write their response on a piece of paper, or 3) use an interactive tool such as [Poll Everywhere](#) that allows students to text their responses to generate a class poll.

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**NOTE:** You can also present the brain facts statements as an online quiz by creating your own [Kahoot](#) quiz. This interactive tool allows students to create teams, view live how other students are responding and provides the class with analyses of their responses.

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## 6. Neuromyths | ⌚ 5min

Review some of the false responses from the quiz above and discuss how some of these false responses are common misconceptions about the brain. Explain to students what neuromyths are (i.e. incorrect ideas about neuroscience that do not accurately reflect research in the field) and prompt them to think about:

- Why do you think neuromyths emerge?
- What might be the impact of people believing in neuromyths?



## EXTENSION

Introduce students to the different types of sources that students will use for their research: research journals, news articles, websites.

Discuss the difference between primary and secondary resources and the reliability, validity and credibility of the different sources.

## 7. Activity: Neuroscience or Neuromyth? | ⌚ 30min

Divide the class into groups of 4-6 students (depending on class size) and assign a neuromyth to each group. Examples of neuromyths include:

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**NOTE:** Ensure that you describe these to students as 'neuroscience research statements' instead of 'neuromyths'.

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- We only use 10% of our brains
- Brains are “hard-wired”
- The size of your brain dictates how smart you are
- Some people are right-brained and others left-brained
- Brain damage is always permanent
- Different students have different learning styles
- Intelligence is fixed (i.e. we have a fixed IQ)

Students will participate in a mock trial, where they will debate if each neuroscience research statement is a neuromyth. Provide students with instructions for the activity:

1. Each group will divide themselves in two, where half the group (2-3 students) will take on the role of prosecutors, and the other half (the other 2-3 students) as defenders in a mock trial. Prosecutors

will argue that the neuromyth is false and the information being communicated to the public is unreliable. Prosecutors will work together to gather evidence that debunks the neuroscience statement and supports their arguments that claim it to be a neuromyth. As for the defenders, they will defend the statement as true. Defenders must gather evidence in favor of the neuroscience statement, collecting the research that supports it (and has led to the emergence of that neuromyth).

2. Both sides will engage in a debate that attempts to convince the jury that their side of the case is true, answering to each other. The jury will be formed of the teacher (i.e. the main juror) and students from the other groups who are observing the debate. The jury will question the validity and reliability of their research and arguments, and will have to wage who is more convincing.
3. At the end, the jury will provide feedback as to which side of the case was more convincing and who won the trial - were the defenders guilty of misinforming the public?

Groups will spend the rest of the class time (and homework time if needed) preparing their arguments and presentations for the mock trials. These should include:

- A description of the neuroscience statement (2 minutes).
- A review of the scientific research evidence that supports or contradicts the statement. Prosecutors will present evidence that debunks the neuromyth and defenders will present evidence that supports the neuromyth (5-8 min).
- 2 to 3 questions to ask the other side of the group.
- A few arguments against the evidence presented by the other side of the group that will be used during the debate and questions portion of the trial.
- *Optional:* Any visual elements such as graphs or images that can support their arguments.



Explain to students that the mock trials will run in the next class and that each group will be given around 10-15 minutes to present their cases and engage in the debate.

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**NOTE:** Introduce the '*Claim-Evidence-Reasoning*' format for students to use when preparing their presentations:

*Claim + Evidence + Reasoning = Explanation*

*Claim:* What do you know?

*Evidence:* How do you know that?

*Reasoning:* Why does your evidence support your claim?

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### Class 3

*Due to larger class sizes or time constraints, an additional class period might be required.*

## 8. Mock Trial Presentations |

🕒 35min

📄 Use '*Topic 1 activity sheet: Neuroscience or Neuromyth?*'

Groups will take turns in presenting their cases and engaging in a debate in front of the class.

Presentations will run as follows:

1. Each side of the group (first the prosecutors and then the defenders) will have 2 minutes to explain their view of the neuroscience research statement.
2. Each side will then have 5 minutes to present their arguments and research to the jury.
3. Each side will have 2 minutes to ask questions to the other side, engaging in a debate led by the teacher.
4. Further questions may be asked by the jury. Encourage students observing the debate to ask questions.

5. Distribute '*Topic 1 activity sheet*' to individual students. Students observing others' presentations will act as juror's and use the handouts to provide feedback on each presentation debate, reaching a verdict as to what side was more convincing. Students should take notes while listening to the debate. When making the decision, prompt students to think about:

- How well the prosecutors vs defenders presented their case.
- The reliability of the evidence presented - is the evidence presented reliable?
- How valid was their reasoning?
- How strong and effective were their arguments?
- Did the group successfully debunk the neuromyth?

6. After the debate, the jury discuss their verdict and rationale out loud. The teacher provides the final conclusion as to which side was more convincing (and concluding if the prosecutors debunked the neuromyth successfully). By having this debate out loud, presenters can learn from the evaluation process and get immediate feedback on their cases.

## 9. Class Discussion | 🕒 10min

After all presentations are complete, guide a class discussion about:

- The effectiveness of arguments: was it easier to defend a myth or destroy it? What kind of arguments were used by the defender and the prosecutor? Were there scientific arguments or emotional arguments?
- Why are myths born and how do they survive? Can you think of any science myth that is harmful to society?

Collect students' activity sheets at the end of all presentations.



## NOTES FOR EDUCATORS:

- **Dealing with students' questions:** It is likely that at times students will ask questions about the brain that educators are unsure of the answer. Neuroscience is a broad field, with only a few topics being covered in these lessons. There are many things that we still do not know about the brain and therefore educators are not expected to know all the answers. It is important to explain this to students, as well as to acknowledge the importance of asking questions. Students will then understand that it is possible that not all questions get answered. For questions that don't get answered in the classroom, provide reading resources (available at the end of every lesson plan) and encourage students to research further. One recommended tool that connects classrooms with scientists is [Skype a Scientist](#), an opportunity to have a live Q&A session with a real scientist.
- **Keep students' KWL charts** to be reviewed throughout the course. Students can reflect back on their initial understandings or questions, as well as keep adding new insights. For example, you can review these charts at the end of the course or after you discuss neuromyths. This will allow students once again to identify, clarify or debunk any misconceptions that they might have had.
- Encourage students to have a **notebook or science journal** where they can keep notes, observations, questions, etc. throughout the unit.



## Resources for Students

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| <b>FIRST LEVEL</b>    | Meet your brain: Crash Course                          | <a href="https://vimeo.com/168252115">https://vimeo.com/168252115</a>   |
|                       | Sentis Digital: How the brain works:                   | <a href="https://vimeo.com/59023149">https://vimeo.com/59023149</a>   |
|                       | British Neuroscience Association: Chapter 1 (Page 2-3) | <a href="https://www.bna.org.uk/static/uploads/resources/BNA_English.pdf">https://www.bna.org.uk/static/uploads/resources/BNA_English.pdf</a> - Chapter 1   |
| <b>MEDIUM LEVEL</b>   | 2-Minute Neuroscience- Divisions of Nervous System:    | <a href="https://youtu.be/q3OITaAZLNc">https://youtu.be/q3OITaAZLNc</a>   |
|                       | Episode from Brainworks: Neuroscience for Kids:        | <a href="http://uwtv.org/series/brainworks/watch/CAKsczkhHg/">http://uwtv.org/series/brainworks/watch/CAKsczkhHg/</a>   |
|                       | The Nervous System Crash course                        | <a href="https://vimeo.com/180697226">https://vimeo.com/180697226</a>   |
|                       | Big Picture Education: Inside the brain                | <a href="https://bigpictureeducation.com/sites/default/files/bp_files/inside%20the%20brain/wts040941~3.pdf">https://bigpictureeducation.com/sites/default/files/bp_files/inside%20the%20brain/wts040941~3.pdf</a> |
|                       | BrainFacts.org: Neuromyths                             | <a href="http://www.brainfacts.org/Explore?type={DFE6255B-6C26-42D6-BAEF-90E0D28F224C}">http://www.brainfacts.org/Explore?type={DFE6255B-6C26-42D6-BAEF-90E0D28F224C}</a>   |
| <b>ADVANCED LEVEL</b> | Brain Facts Book: Chapter 1                            | <a href="https://www.brainfacts.org/the-brain-facts-book">https://www.brainfacts.org/the-brain-facts-book</a>   |
|                       | Neuromyths: Why do they exist and persist?.            | <a href="https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1751-228X.2012.01141.x">https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1751-228X.2012.01141.x</a>   |





## Resources for Educators

| Background Reading   |   |
|--|---|
| Big Picture Education: Inside the Brain (2013). Page 10-11   | <a href="https://bigpictureeducation.com/sites/default/files/bp_files/inside%20the%20brain/wts040941~3.pdf">https://bigpictureeducation.com/sites/default/files/bp_files/inside%20the%20brain/wts040941~3.pdf</a>   |
| Brain Facts Book (Chapter 1)   | <a href="https://www.brainfacts.org/the-brain-facts-book">https://www.brainfacts.org/the-brain-facts-book</a>   |
| Dana Foundation  | <a href="https://dana.org/Briefing_Papers/When_the_Myth_is_the_Message__Neuromyths_and_Education/">https://dana.org/Briefing_Papers/When_the_Myth_is_the_Message__Neuromyths_and_Education/</a>   |
| Educational Neuroscience.org   | <a href="http://www.educationalneuroscience.org.uk/resources/neuromyth-or-neurofact/">http://www.educationalneuroscience.org.uk/resources/neuromyth-or-neurofact/</a>   |
| Pasquinelli, E. (2012). Neuromyths: Why do they exist and persist?. <i>Mind, Brain, and Education</i> , 6(2), 89-96. | <a href="https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1751-228X.2012.01141.x">https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1751-228X.2012.01141.x</a>   |
| Educational Activities   |   |
| Brain Facts.org: Neuromyth quiz  | <a href="http://www.brainfacts.org/neuroscience-in-society/the-arts-and-the-brain/2019/can-you-separate-the-brain-facts-from-the-neuromyths">http://www.brainfacts.org/neuroscience-in-society/the-arts-and-the-brain/2019/can-you-separate-the-brain-facts-from-the-neuromyths</a> |
| Kahoot   | <a href="https://www.kahoot.com/">https://www.kahoot.com/</a>   |
| Mindmeister: Mindmapping tool  | <a href="https://www.mindmeister.com/blog/teach-mind-mapping/">https://www.mindmeister.com/blog/teach-mind-mapping/</a>   |
| Skype a Scientist  | <a href="https://www.skypeascientist.com/">https://www.skypeascientist.com/</a>   |
| Poll Everywhere  | <a href="https://www.polleverywhere.com/">https://www.polleverywhere.com/</a>   |



# Vocabulary

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**Central nervous system**      The brain and spinal cord.

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**Hypothesis**                      In science, a hypothesis is a prediction or explanation that can be tested through experimentation and scientific methods.

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**Nervous system**                A network of nerve cells and fibers that transmit signals across the brain and body to coordinate the functioning of our body, process sensory information and produce actions.

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**Neuroscience**                 The field of science that studies the structure and function of the nervous system of different species

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**Spinal Cord**                    A bundle of nerve fibers running through the vertebral column that primarily functions to facilitate communication between the brain and the rest of the body.

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## Standards

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



## Credits and Sources

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[Big Picture Education](https://www.bigpictureeducation.com/): <https://www.bigpictureeducation.com/>

[BrainFacts.org](https://www.brainfacts.org)

[Brain Facts Glossary](https://www.brainfacts.org/glossary): <https://www.brainfacts.org/glossary>

[Center for Educational Neuroscience](https://www.ucl.ac.uk/cei): University College London

[Edutopia.org](https://www.edutopia.org)

[Sentis Digital](https://www.youtube.com/user/SentisDigital): <https://www.youtube.com/user/SentisDigital>

### Journal Articles:

Pasquinelli, E. (2012). Neuromyths: Why do they exist and persist?. *Mind, Brain, and Education*, 6(2), 89-96.

## Acknowledgements

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Francesca Anselmi

**Teacher Council 2018:**

Vince Joralemon

Arlene Ramos

Alice Cardoso

William Bertolotti

Vanessa Keen

Deborah Reich

Paula Croxson

Jennifer Dahlstrom

Bonnie Lestz

Charon Sioson

