NEUROSCIENCE AND SOCIETY
Curriculum for High School Teachers

Unit 1: Introduction

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NOTE TO TEACHERS

From sensing to moving to thinking to feeling, neuroscience explains how we perceive and interact with the world around us. This field provides a rich opportunity for high school students to explore fundamental science, framed within the context of everyday decisions and new challenges they will face as they enter adulthood.

Information about the intersection between neuroscience and society abounds online and in the media, yet many sources are unreliable. Meanwhile, there are few textbooks on neuroscience and its societal applications that are designed intentionally for high school students. This curriculum, therefore, is a curated collection of resources—reviewed by experts and tested by teachers—to help you bring this fascinating content into your classroom.

The curriculum is intentionally modular to provide flexibility. Each unit can stand alone, ready to be incorporated into an existing biology, psychology, or other course. Alternatively, multiple units can be linked together to create a semester-long elective course.

You can adapt the content to meet the readiness and capabilities of your class as needed. You can select certain topics and activities to match your students’ interest and skip others depending on time constraints.

The goal of the curriculum is to inspire excitement about and increase knowledge of neuroscience. The suggested activities include a variety of instructional approaches, and we encourage you to ask open-ended questions and guide conversations so students are interacting instead of being passive listeners. Students often find personal relevance in these topics, so feel free to extend activities and discussions.

If you feel you have reached the limit of your knowledge about a particular subject, don’t worry! Even scientists may not know the answer. Neuroscience is still a developing field and you can create opportunities for you and your students to think critically and learn together. Use the provided links and documents as a gateway to finding additional sources and evaluating their quality.

Your feedback is also welcomed, of course. Please contact the program administrator at neuroscience@fi.edu with comments and suggestions. Thank you for all your hard work!
Alignment with Next Generation Science Standards

The “Neuroscience and Society” curriculum supports Next Generation Science Standards in the following areas.

**High School – Life Science**

**HS-LS1 From Molecules to Organisms: Structures and Processes**

**Disciplinary Core Ideas**
- LS1.A: Structure and Function
- LS1.B: Growth and Development of Organisms

**Science & Engineering Practices**
- Developing and Using Models

**Crosscutting Concepts**
- Structure and Function
- Stability and Change

**HS-LS3 Heredity: Inheritance and Variation of Traits**

**Disciplinary Core Ideas**
- LS3.A: Inheritance of Traits
- LS3.B: Variation of Traits

**Science & Engineering Practices**
- Asking Questions and Defining Problems
- Analyzing and Interpreting Data
- Engaging in Argument from Evidence

**Crosscutting Concepts**
- Cause and Effect
- Systems and System Models
- Science is a Human Endeavor
The Basics: What Does the Brain Do?
Big Picture magazine has an entire issue dedicated to an overview of the basics of the brain. The downloadable PDF can be used as a handout for students.

Overview of the brain:
Present a short lecture on the structure of the nervous system (CNS, PNS), hemispheres, lobes; sulci & gyri; brain facts, etc. For example:

- The brain makes up 5% of your body mass but consumes 20% of its energy. Why is this?
- There are around 86 billion neurons (nerve cells) in the brain. How many is that? Compare to the number of people in the world (7.4 billion in 2016) or stars in the Milky Way (100-400 billion).
- Neurons extend throughout the body: some nerve cells are more than 3 feet long. Emphasize the reasons for neuronal structure and function; see example photos below.
- Each neuron can connect with thousands of other neurons, making trillions of connections (synapses) in the brain.
- The functional purpose of all that connectivity is computation. For example, ideas (e.g., a cat) are links between visual images, sound information (meow), motor responses (petting), memories (your childhood cat) and other aspects of the idea of a cat, all using different but connected parts of the brain.

This interactive MRI scan visualizes the interior structure of the brain and locations of different body parts.
E.g. Purkinje cells (on right) have a lot of dendrites because they receive a lot of inputs.

There are multiple types of neurons with multiple functions. Compare this to hepatocytes (on right) which all have the same “job.”

**Classroom Activities:**

**Activity #1 – Brainstorm the Brain**

What does the brain do? As a class, make a list of the functions of the brain. Examples include: personality, imagination, movement, balance, sensation (vision, hearing, smell, taste, sense of touch), language, emotions, learning, planning, remembering, sensing the body’s needs, etc.

Discuss brain myths (adapted from The Brain: Our Sense of Self, The Mind’s Machine, and Neuroscience for Dummies)
<table>
<thead>
<tr>
<th>Myth</th>
<th>Fact</th>
</tr>
</thead>
<tbody>
<tr>
<td>We only use 10% of our brains.</td>
<td>We use 100% of our brains. <a href="#">This video</a> visualizes the constant activity throughout the entire brain, even when it is “at rest.”</td>
</tr>
<tr>
<td>People are “right brained” or “left brained.”</td>
<td>Everyone uses both sides of their brain, but the two halves (hemispheres) of the brain have slightly different functions that work together. For example, each side of the brain controls the muscles on the opposite side of the body; the right and left hemispheres process different elements of language but the left is largely responsible for speech production.</td>
</tr>
<tr>
<td>If someone has a bigger brain, it means they are more intelligent.</td>
<td>Albert Einstein’s brain was smaller than average.</td>
</tr>
<tr>
<td>The brain only controls voluntary activity.</td>
<td>The brain regulates involuntary processes such as metabolism, body temperature, respiration, digestion, blood circulation, and more.</td>
</tr>
<tr>
<td>Once our brains are developed, we can never grow new nerve cells.</td>
<td>We can continue to grow new neurons well into adulthood.</td>
</tr>
<tr>
<td>The brain is separate from the nervous system.</td>
<td>The brain, spinal cord, and all the nerves in your body all form the nervous system.</td>
</tr>
<tr>
<td>The brain is a uniform mass of tissue.</td>
<td>The brain is composed of billions of specialized cells, further organized into specialized functional regions.</td>
</tr>
<tr>
<td>Your brain’s development is entirely determined by your genes.</td>
<td>Different environments can change the physical structure of the brain and how it functions.</td>
</tr>
</tbody>
</table>

**Activity #2 – Brainstorm Societal Impacts**

How does neuroscience affect decisions we make in our everyday lives? As a class, make a list of societal impacts. Examples include:

- Using ADHD medications to improve performance
- Criminality/law and the brain
- Socioeconomic status and brain development
- Football-related concussions and chronic deteriorative brain disease or traumatic brain injury
- Post-traumatic stress disorders and war veterans
- Depression and mental illness
- Addiction to pain medication; prescription of opioids

**Assignment Idea:**

**Assignment #1: Impact of Head Injuries**

Have students choose a scenario in which head injuries occur. They should select a key stakeholder relevant to the issue and write a letter to the stakeholder about the danger of potential brain injury.

Possible scenarios include:

- Sports and concussions
- IED explosions and head injuries in war
- Traumatic brain injury as a result of car accidents