

Why dread a bump on the head? *The neuroscience of traumatic brain injury*

Lesson 1: What is traumatic brain injury?

This lesson serves as the introduction to traumatic brain injury (TBI) and the “Why dread a bump on the head?” unit. Students are introduced to TBI classification categories (mild, moderate, severe) through the reading and discussion of news articles. Pictures and discussions help students break down prior assumptions and begin to think about TBI from a scientific perspective. Based on the knowledge gained from readings, they identify indicators or critical questions that they would ask a theoretical patient during an evaluation or assessment. Additionally, students can assume the role of a medical student as they follow a patient with a TBI while playing an original computer game called The Golden Hour.

Lesson 2: What does the brain look like?

In Lesson 2, sheep brain dissections serve as a hands-on introduction to basic neuroanatomy. Students have the opportunity to explore the brain in the context of TBI. Special attention is given to providing a functional understanding of brain regions through an interactive dissection guide. This guide contains directions, supplemental information, and discussion questions so groups of students can engage in the activity at their own pace.

Lesson 3: How does a CT scan help diagnose TBI?

In this lesson, students examine and learn to interpret computed tomography (CT) scans of people with TBI. Students revisit what they learned in Lessons 1 and 2 (types of TBI and brain anatomy and sheep brain dissections). Through readings and a segment of the Golden Hour game, students will learn to identify the structures of the brain on a normal CT scan and compare them with the CT scans of TBI victims. Having identified the loci of injury, they revisit what they learned about the normal roles of these structures in different functions and predict the type of impairment or disorder that might be caused by the injury.

Lesson 4: How to build a neuron

After identifying the structures and the functions of the brain in Lesson 2, students move to the cellular and molecular levels to explore the neuron, the fundamental cellular building block of the nervous system. Students begin by discussing the versatile roles of the nervous system. Then student groups design their own neuron, based on knowledge learned in Lesson 2 and a series of guided questions. The students are introduced to the anatomy and physiology of an actual mammalian neuron and compare their design to a real neuron. Finally, the students are introduced to the ways in which traumatic brain injury manifests at the level of neurons and glial cells.

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Lesson 5: What happens to neurons after TBI?

In this lesson students learn what happens at the neuronal level after a traumatic brain injury by looking at two modes of cell death: necrosis and apoptosis. Students begin by studying micrographs of individual neurons that are undergoing two different types of cell death. They will be guided to make key observations that allow them to identify morphological characteristics of each pathway. The students then analyze gel electrophoresis results from DNA samples taken from injured brain tissue. Through this activity, they learn about the “step ladder” pattern of apoptotic DNA that has been systematically cleaved and the “smear” pattern from necrotic cells in which the DNA degrades more randomly.

Lesson 6: Exploring the data behind brain injury

This lesson exposes students to the role data access and analysis can play in answering questions about TBI. Students will first utilize Google Insights to gain insight into the way the public searches for TBI information on Google. Then they use the Project Neuron dataset collection to explore publicly available data on the occurrence of TBI injuries in various populations. Students select a portion of the data to represent visually through a graphing exercise in order to supplement or expand on the information presented in a recent new article. This lesson enhances students’ perceptions of how TBI is reported in the media, and it illustrates the importance of data collection in the monitoring of TBI.

Lesson 7: What can we tell others about TBI?

The goal of this lesson is for students to integrate what they have learned about TBI during the unit and present an idea that relates to the treatment or prevention of TBI. As a class, the students contribute pages that review concepts from the unit in a class zine (as in ‘magazine’). Students are introduced to zines, brainstorm what they want to include in their zine, and develop individual chapters of the class zine. Then students evaluate their peers’ zine chapters by looking for content accuracy, clarity, and coherence of the ideas presented. The end product can be used as a review and/or public awareness tool.

