

How the Brain Works and What Goes Wrong in Alzheimer's Disease

Setting: In a classroom

Subject: Biology - Neuroscience - Health

Grade Level: 7th-12th grade

Time Frame: 45 min

Student Objectives:

1. Understand the basic anatomy of the brain and brain areas involved in memory
2. Learn about the brain changes associated with Alzheimer's disease
3. Identify ways that Alzheimer's disease can be detected and diagnosed

Materials:

1. Three sets of slides on how the brain works, how the brain changes in Alzheimer's disease, and slides/handouts on how Alzheimer's is detected and diagnosed with a spotlight on PET imaging

Background:

In this activity, students will have the opportunity to learn how the brain functions normally and then learn about the biological changes associated with Alzheimer's disease. The final section of this module will focus on what a doctor may do to diagnose Alzheimer's disease and test students' understanding through a neuroimaging based activity that a doctor may use.

What to know before you teach:

This information is primarily for the teacher's background knowledge and the slides are for students. Ample notes are provided for each slide.

- Alzheimer's disease is not a normal part of aging. Although researchers are still trying to understand what the causes of Alzheimer's disease are, there is general consensus about the underlying pathology, or brain changes, associated with the disease. The abnormal buildup of two proteins, amyloid beta and tau, are considered the hallmarks of Alzheimer's disease. Amyloid beta builds up OUTSIDE of the neurons and tau builds up INSIDE the neurons.
- As these proteins build up in the brain, the neurons (brain cells) start to not work correctly and die. As more neurons become sick and die, the brain starts to atrophy, or shrink. As brain mass is lost in specific brain regions, behaviors and functions that those regions were responsible for start to become impaired.
- Although there are many brain areas involved in memory, the hippocampus is especially important and is the region typically affected first by Alzheimer's disease-related brain changes.
- Dementia versus Alzheimer's disease: dementia is the umbrella term describing the clinical symptoms and there are many different neurodegenerative diseases that cause symptoms of dementia. Alzheimer's disease is the most common cause of dementia.

- Whenever someone is concerned about their cognition (thinking, planning, decision-making, memory, etc) it is always a good idea to go to the doctor for evaluation to understand what is causing the cognitive changes. A doctor will do many different tests to understand what the cause of the symptoms are and to treat it as best as possible. Note that not every diagnostic test will be used with every patient and the doctor will do what they think is best to evaluate the patient. This activity is showing the most common diagnostic testing procedures.
- Amyloid Positron Emission Tomography (PET) Imaging is FDA-approved for use in the clinic and is also used frequently in research. Amyloid PET imaging is considered a biomarker, or biological marker, for Alzheimer's disease. A tracer is injected into the bloodstream which binds to the amyloid beta protein in the brain. Using the imaging technique, the colors on the scan indicate how much amyloid beta is present in the brain. The warmer colors (reds, oranges) indicate a high amount of amyloid beta present and the cooler colors (violet, blue) indicate a lower amount.
- Although amyloid PET is approved for use in the clinic, it is very expensive and the current recommendations are to use this technique only in specific cases where the doctor is not sure what the causes of symptoms are using other standard diagnostic techniques.
- Amyloid PET imaging is not the only method used to differentiate what type of dementia may have and many sophisticated measures are currently being researched and developed.

Procedure:

1. Briefly introduce the module and give the short presentation on how the brain works.
2. Then move into the presentation on what happens to the brain with Alzheimer's disease. Note that this presentation is designed to be interactive with question prompts on many of the slides for the students to answer.
3. Next present the slides on detection and diagnosis. The "Test your knowledge" activity can either be done with the slides or with handouts (see supplemental PDFs that can be printed)

Additional Resources:

- **Additional Reading on Alzheimer's disease:** https://alz.org/alzheimer_s_dementia
- **Amyloid Imaging Common Questions:** Rabinovici, G. D., Karlawish, J., Knopman, D., Snyder, H. M., Sperling, R., & Carrillo, M. C. (2016). Testing and disclosures related to amyloid imaging and Alzheimer's disease: Common questions and fact sheet summary. *Alzheimer's & Dementia*, 12(4), 510-515.
- **Appropriate Use Criteria of Amyloid PET Imaging:** Johnson, K. A., Minoshima, S., Bohnen, N. I., Donohoe, K. J., Foster, N. L., Herscovitch, P., ... & Hedrick, S. (2013). Appropriate use criteria for amyloid PET: a report of the Amyloid Imaging Task Force, the Society of Nuclear Medicine and Molecular Imaging, and the Alzheimer's Association. *Journal of Nuclear Medicine*, 54(3), 476-490.