Histology

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Objectives:

The purpose of this activity is to teach attendees how histology is used in neuroscience research. Attendees will gain an understanding of several of the most common tools/methodologies that are used to visualize neurons, including transgenic reporters, immunostaining, *in situ* hybridization, and chemical stains. Through viewing example images and microscope slides, attendees will see firsthand how these methods can be used to visualize parts of a neuron, distinguish neurons from other cells in the brain, and understand how neurons change in disease.

Materials and Supplies Needed:

Item	Quantity	Notes (Vendor, price, purpose, etc.)
Light microscopes	3~6	Borrowed from science teaching labs
Slide of unstained brain slice	2	To show how visualizing neurons is difficult without staining
Histology slides	As many as possible	Borrowed from various labs throughout Northwestern University. Ideally, slides of different stains (e.g., cresyl, golgi) obtained from distinct areas of the brain (e.g., hippocampus, striatum, olfactory bulb) and from various species (e.g., mouse, rat, rabbit, monkey).
Pictures of fluorescent staining		Print pictures of pretty fluorescent images, insert them in sheet protectors then put them in a binder. Can also make poster.

Background Information / Activity Explanation:

- Neuroscientists study how the brain works, and to do this they need to understand the function of the cells that make up the brain. One way to understand how brain cells work is to observe them. But it's hard to see brain cells and the parts that make them up just by looking at the brain (show example unstained brain slice).
- That's where histology/neuron staining comes in. We use many different techniques to see different kinds of brain cells, the small parts that make up brain cells, and how these change in disease. We'll talk to you about a few of the most important ones.
- A lot of neuron staining uses fluorescent proteins or dyes. These are proteins or dyes that glow, or fluoresce, when you shine light of a different color on them. The most famous fluorescent protein is called green fluorescent protein. It was discovered in jellyfish and now it's used in all sorts of science applications.
- Neuron staining doesn't have to be fluorescent; there are all sorts of dyes that you can see without having to shine a light on them. You'll see examples of both fluorescence and staining that isn't fluorescent on the poster and in the binder. On the microscopes, you'll see examples of non-fluorescent staining.

- Genetic labeling - Genetic labeling means that an animal's cells are labeled throughout its lifetime, even before it is born. Scientists insert a gene (a piece of DNA) that encodes a fluorescent protein into an animal's genome (DNA). You can restrict the glowing to the cell type you're interested in by controlling it using another piece of DNA called a promoter. The promoter is in front of the other piece of DNA and acts as its 'boss': it tells it where and when it can be expressed. So based on what kind of promoter you have, you can restrict expression of a fluorescent protein to a specific cell type, like a neuron, or another type of cell called glia.
- Immunostaining – Immunostaining uses antibodies tagged with fluorescent dye to visualize cells or parts of cells. Your body makes antibodies when you are sick so it can fight off bacteria or viruses that are invading. The antibodies your body makes are very specific to the invaders – they bind to those and nothing else. In immunostaining, antibodies are very specific to a protein of interest on the cell. These antibodies are tagged with fluorescent dyes so you can see exactly where they're binding.
- In situ hybridization – In situ hybridization uses a DNA or RNA probe that's tagged with a fluorescent dye. Instead of binding to a protein, like in immunostaining, it binds to a specific DNA or RNA sequence. It can tell you useful information like where or when a gene is expressed, or what DNA looks like when a cell is dividing.
- There are many, many other ways to visualize brain cells and their parts. Talk about/show Golgi stain (morphology of individual neurons), cresyl violet (cell bodies).

Procedures:

- Create a poster and scrapbook with images and examples of histology. Direct attendees to relevant images on the poster and scrapbook as they are discussed (see background info/activity explanation). Tailor explanations to the age of the attendees.
- Each microscope should be used to visualize one slide (to avoid having to focus/refocus every time a slide is changed). Attendees can peruse the slides on the microscopes after the short talk.

Additional Information (advice, spiel, links, figures, etc.)

The background information can be tailored to the audience and specific age groups. For example, for younger participants, explain to them that neuroscientists use special chemicals to help them stain and see neurons. For older, more advanced participants, you can go more in depth about specific techniques such as in situ hybridization, genetic labeling, and immunostaining.

The background information is also written in the format of a spiel. Feel free to use this as a reference during the event.