fe Sciences/HHMI
OutReach
PROGRAM

Lesson Plan-Embryonic Development of the Nervous System

Introduction-In the past I have taught the development of the nervous system in the usual 3 sections:

1. Neurulation
2. Brain Development
3. Wiring of the Brain

I have found that students struggle to relate the 3 different stages and their physical relationship to each other. This classroom activity is designed to allow the students to build models and describe the processes as a continuum of development.

Resources:

Overviews of Brain Development:
The Society for Neuroscience (sfn.org) has a fabulous free publication, Brain Facts, that is also available for download on-line. The chapter on Brain Development http://www.sfn.org/skins/main/pdf/brainfacts/2008/brain_development.pdf is very good and gives a brief overview of neural cell induction, differentiation, migration, axon guidance and synapse formation.

Another great web site for brain development that meshes nicely with the Brain Facts chapter is: http://www.learningdiscoveries.com.au/StagesofBrainDevelopment.htm There is a nice chart that goes over the stages of development: induction, proliferation, migration, differentiation, synaptogenesis, selective cell death and synapse strengthening.

Neurulation Unit:
I usually use the Anatomy Coloring Book (E. Wise and S. McCann, Kaplan Publishing, Chicago IL) for basic brain features but the Human Brain Coloring Workbook (K. Gupta, Princeton Review Publishing, New York, NY) for this unit. I have the students color in the parts of the developing brain as we go over the web sites and powerpoint.

This web site, by Dr. Marvin Sodicoff at Temple University, has a fantastic semi-interactive site with great drawings of a cross-sectioned and 3-dimensional d16-d24 embryo. Choose "Neural Tube" from the table of contents.
http://isc.temple.edu/neuroanatomy/lab/embryo_new

Brain Development Unit:
Choose "Ventricular System" from the web site for drawings of 4, 5 and 6-wk embryos from the 3 to 5 vesicle stages.
http://isc.temple.edu/neuroanatomy/lab/embryo_new/vse/1

A nice animation of the growth of the embryonic brain is:
"Development of the human embryonic brain"
http://www.hhmi.org/biointeractive/neuroscience/animations.html

Wiring the Brain Unit:
Great video clips of neuronal path finding are:
"Growth cones in action"
"Long-distance neuronal path finding"
"Contact repulsion of a growth cone"
http://www.hhmi.org/biointeractive/neuroscience/video.html

Materials-

Rolls-Have the students collect toilet paper rolls and paper towel rolls from home starting at the beginning of the course.

Playdough or modeling clay-have the students purchase these or make your own classroom playdough with one of the following recipes from
http://www.teachnet.com/lesson/art/playdough061699.html

Colored paper or white paper and crayons.

Stapler/tape/glue

Unit 1. Neural Tube Formation.

Homework Assignment. Have the students read the Brain Facts chapter on Brain Development. http://www.sfn.org/skins/main/pdf/brainfacts/2008/brain_development.pdf

Day 1. Lecture/Drawing Exercise-In class, review the stages of neural tube development. The following web site has a semi-interactive site with great drawings of a cross sectioned and 3 dimensional d16-d24 embryo.
http://isc.temple.edu/neuroanatomy/lab/embryo_new

Activity: Have the students color in the parts on worksheet from "Chapter 1.1 The Neural Tube" "Chapter 1.2 Overview of the Brain and Venticles" in the Human Brain Coloring Workbook.

Accent the following vocabulary words and explain them in this context, bridging the anatomy from the workbook and the molecular signaling from the Brain Facts chapter (in italics below):

Ectoderm
Mesoderm
Endoderm
Somites
Notochord
Neural plate
Neural fold
Neural crest
Neural canal
Anterior neuropore
Posterior neuropore

CNS
PNS
Spinal cord
Induction
Differentiation
Shh
Cell fate
Cell position
Cell signaling
Cell proliferation

End with the powerpoint (provided) to overview and help visualize where the neural tube is within the cross section of the embryo body.

Day 2. In-class Model Building-Have the students mock up neural tube formation with colored paper, paper rolls, clay, playdough or whatever you have on hand. They can work in groups to generate the models and they must work on a narrative that includes all the vocabulary words above.