project NEURON

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Novel Education for Understanding Research On Neuroscience

Project NEURON brings cutting-edge science to middle and high school students through inquiry-driven activities based on research conducted at the University of Illinois.

http://neuron.illinois.edu/

What can I learn from worms?

Regeneration, stem cells, and models

Lesson 1: What is regeneration?

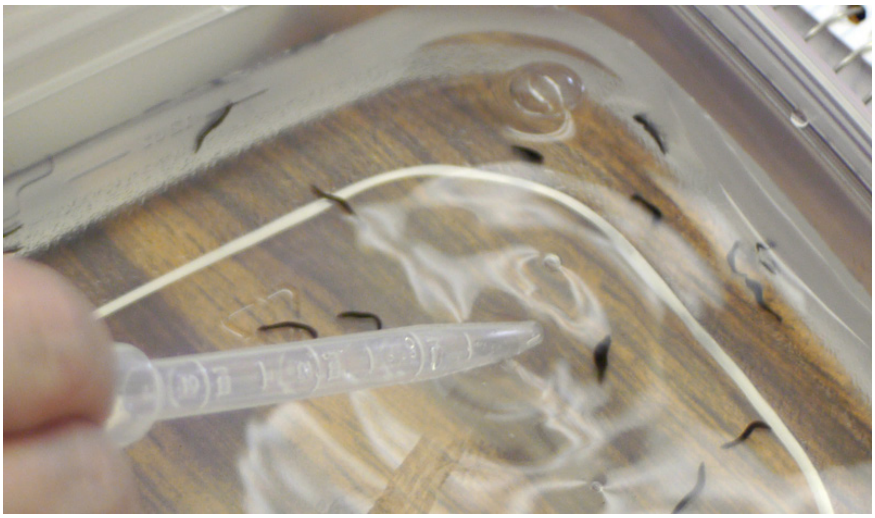
This introductory lesson motivates the unit by asking the question "What is regeneration?" Through this lesson, the unit's driving question is introduced and examined. The lesson activities stimulate student interest in learning about what the term regeneration means by providing a series of science articles on regeneration and healing in humans and other species. Students generate questions about regeneration that will be investigated throughout the unit. Students are introduced to the idea of model organisms, which provides the rationale for studying planarians in this unit, and the practice of modeling.

Lesson 2: How do planarians react to their environment?

In this lesson, students identify and discuss different types of behavior that are seen in both humans and planarians. After a discussion on the three different taxes: chemical, mechanical, and light, the students use various stimuli to observe planarians behavior in response to the different taxes. Finally, students create their own model of how planarians sense their environment and respond to the different stimuli.

Lesson 3: How do planarians regenerate?

Students are introduced to the use of planarians as a model for neural regeneration through a historical overview about planarians as a model organism and a basic exploration of planarian biology. In this lesson, students design and carry out an experiment focused on developing their understanding of regeneration. Students do this by cutting planarians in different ways based on an explicit hypothesis they develop. Over the course of several days, students record a range of observations about their planarians' regeneration. In the conclusion of Lesson 3, included as a separate lesson plan, students analyze their data in order to evaluate their hypothesis and draw scientific conclusions about planarian regeneration. Groups of students present their findings to the rest of the class, which effectively concludes the regeneration experiment.



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Lesson 4: What happens in the worms' cells during regeneration?

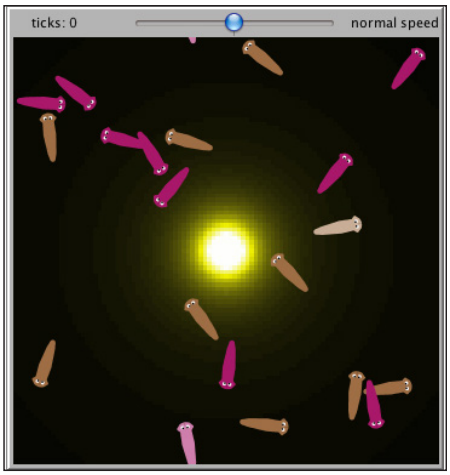
In this lesson, students learn about regeneration at the cellular level by studying cell division, a necessary component of regeneration, using their recently cut planarians as a model. At this point in the unit, the students have observed the planarians at the behavioral level and have started to investigate regeneration, one of the observed behaviors, at the phenomenological level. In this lesson, students develop models of cell division in order to explain how regeneration occurs in planarians. After developing initial models, students revise their models using a list of criteria (provided in the lesson are a list appropriate for introductory biology and another for advanced biology classes). The lesson culminates with students documenting and explaining their models with another group to identify key characteristics in each model.

Lesson 5: How can we see the worms' cells during regeneration?

In this lesson, students examine how scientists study cell growth and division using the incorporation of 5'-bromo-2-deoxyuridine (BrdU) and subsequent visualization. Students are introduced to a Univeristy of Illinois scientist whose work uses this technique to investigate the process by which planarians regenerate. At the end of the lesson, students make a hypothetical drawing of BrdU localization in their cut planarians from Lesson 4, illustrating how stem cells have divided and migrated during the process of regeneration.

Lesson 6: How do DNA and protein determine behavior?

In this lesson, students learn about cutting-edge techniques used by scientists in cutting edge scientific research. Students learn about RNA interference (RNAi), a research technique that scientists use to disrupt protein expression and function. In order for students to develop an understanding of what RNAi is and how it can be used to answer scientific questions, students explore a number of simulations that incorporate RNAi. The computer program NetLogo allows students to test virtual planarians in order to determine the role a protein has in determining planarian behavior. Students explore the possible impact on behavior an actual mutation could have on a living planarian.



Lesson 7: What does planarian regeneration tell us about human regeneration?

In this lesson, students use what they have learned throughout the unit, including their models of cell division, to explain the importance of studying planarians and how it can help scientists understand human diseases and biological processes. Students are presented with a scenario, where their parent or other family member has read an article in the local newspaper about the discovery of several genes in the planarian that control the migration and division of stem cells. This begins a conversation where the student explains to the family member why this discovery is important and what implications it has for human stem cell research.

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