Classroom Lesson Development

Title of Lesson	**An Inquiry into Sensation with Termites**
RET Project Connection	Toxicity Study of Neuroprosthetic Implant Materials. Department of Chemical Engineering: Biological Surface Modification and Microfluidics Laboratory, Northeastern University. Boston, MA. Summer 2007 We covalently bonded proteins (laminin and nerve growth factor) to a glass surface and analyzed the successful growth of PC-12, a commercially available, immortal cell line that is used to model neurons. Through this process, we realized that there exists a synergistic effect upon neurite extension when these two proteins are present.
RET Teacher	Rocco Cieri
School	MEDFORD HIGH SCHOOL
Town/District	MEDFORD
Subject(s) taught	Honors Biology I, AP Biology
Subjects covered in lesson	Biology, Chemistry
Grades appropriate	9-12
Lesson duration	<1 week (5 one-hour classes)
Goals/Objectives of lesson	Nature of Science Biology Inquiry

Background information

Most termites found in the Southeast are referred to as subterranean termites, meaning that the major portion of the colony is located underground, which provides them the moisture that they require. In order to maintain the social structure of these colonies, these termites use a sophisticated chemical (pheromone) communication system. Although termites utilize a wide range of pheromones categorized as trail, alarm, aggregation, recruitment, mating, and others, this exercise only examines trail pheromones. This type of pheromone is produced by termites when they are trying to get other members of the colony to follow them to a particular area, perhaps a new food source for the colony. Trail pheromones, like most other types, are typically short-lived so that when the food source is no longer available, the trail rapidly dissapates. This keeps workers from going to the location after the food source is no longer present. The drying agent in the ink in Papermate® and Scripto® pens acts similar to the trail pheromone of the eastern subterranean termite, Reticulitermes flavipes (Kollar).

Students should also be presented with important components to designing their scientific inquiry. Suitable preparation materials can be found in Surmacz (2004) and Wortmann (2007). Both of these resources provide detailed information on the language of the scientific process and plenty of practice exercises. In fact, these exercises are best suited to occur prior to this Inquiry Lesson.

Essential questions

What factors do organisms sense in their environment? What factors (evolutionary, ecological) impact sensation and the physiology of sensation in the environment?

Links to Frameworks and Standards

National

State

MA Science and Technology/Engineering Curriculum Frameworks (October 2006)

Biology, High School:
I. Content Standards

4.4 Explain how the nervous system (brain, spinal cord, sensory neurons, motor neurons) mediates communication among different parts of the body and mediates the body's interactions with the environment. Identify the basic unit of the nervous system, the neuron, and explain generally how it works.

II. Scientific Inquiry Skills Standards (ALL)

Local

Materials required

PAPERMATE Pens and other writing implements
Other materials dependent upon the direction of inquiry
Workers are best for this study, but you also may want to have the students examine differences between workers and soldiers.

Termite Kit Available from Carolina Biological
(Cat. # 14-3722 Classroom Kit $35.50 Each)
(Cat. # 14-3724 Demonstration Kit $19.25 Each)

Just Termites from Carolina Biological
(Cat. #14-3734 - Workers $14.50 Pack of 25)
(Cat. #14-3736 - Workers $27.95 Pack of 100)

Reference about the particular chemical responsible for the phenomenon available from Chen, et. al. (1997) Journal of Entomological Science, v. 33: 99-105.

Lesson development

1. Students are presented with the problem through a LIVE demonstration of the behavior of termites.
2. Students devise questions and ideas about the phenomenon.

Example Topics:

A. Determine what type of pens (inks) contain termite attracting compounds. (Culin)
B. Determine the shape lines that termites can best follow. \ (Culin)
C. Determine how long the scent trail lasts. (Culin)
D. Determine how temperature effects the trail-following ability of the termites or the speed of the termites upon the 'course'. (http://www.science-projects.com/physiology.htm#termites)

3. Students come up with a list of factors to test with termites.
4. Students develop a procedure and carry it out.
5. Students collect data, analyze and share their findings.

References

S. Wood and N. L. Staub. "Lab 1: Doing Science: Testing Termites." Biology L101, Gonzaga University, Fall 2002.

Culin, Joe. "Bugs in the Classroom: Chemical Communication in Termites" PDF Created 4/13/2001. Clemson University, 2001.

Oettinger, Joseph. DTSE Video & Lesson Plan Project: Interesting Insect Investigation (I3) Performing a Scientific Investigation into Insect Behavior. April 19, 2006.

Surmacz, C. A. 2004. Inquiring minds want to know: Introducing freshmen to experimental design. Pages 316-327, in Tested studies for laboratory teaching, Volume 25 (M. A. O'Donnell, Editor). Proceedings of the 25th Workshop/Conference of the Association for Biology Laboratory Education (ABLE), 414 pages.

Chen, J., Henderson, G., and R.A. Laine. 1997. Isolation and identification of 2-phenoxyethanol from a ballpoint pen ink as a trail-following substance of Copotermes formasanus Shriraki and Reticulitermes sp. Journal of Entomological Science, 33:91-105.

Wortmann, Gail. 2007. US-DOE Teacher-to-Teacher Initiative Presentation: " Understanding Inquiry's Tool: The Scientific Method for K-12" at Microsoft in Waltham, MA on 7/27/2007.

"Animal Physiology Experiments (AP Biology Extension Experiments)." By Author on 7/16/2007: http://www.science-projects.com/physiology.htm#termites