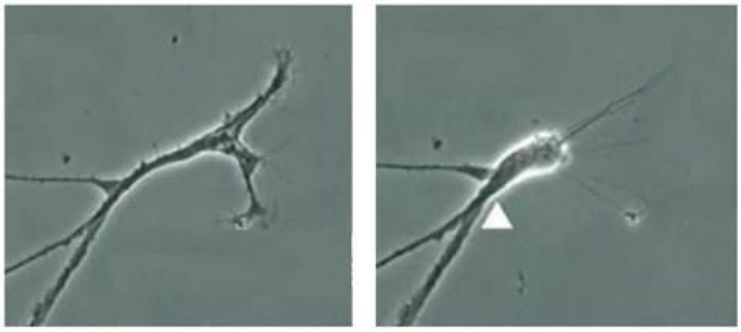
Minimata's Mercury Mayhem

Subject Area(s) Life Science, Science and Technology

Associated Unit Environmental, Water Pollution, Biomagnification

Lesson Title Minimata's Mercury Mayhem



ADA Description: *(Two photos are shown side by side. The one on the left shows a neuron that is healthy and branching out. The photo on the right shows the neuron 30 minutes after exposure to a mercury solution. The one on the right is withered)*

Source/Rights: http://www.mouthbodydoctor.com/alzheimers-and-autism-the-mercury-connection-2/?

Caption: A NEURON BEFORE (L) AND 30 MINUTES AFTER THE INTRODUCTION OF A DILUTE MERCURY SOLUTION

Grade Level 11 (9-12)

Lesson # 1 of 1

Lesson Dependency

Time Required Three 50 min class sessions

Summary

Day 1: Students will be introduced to the story of Minimata, Japan. For more than 30 years from 1932-1968, the Chisso chemical company released waste water containing methyl mercury into Minimata Bay. As a result, humans and animals were affected by mercury poisoning.

Day 2: Students will be introduced to the process of Gas Chromatography. After a detailed explanation of the process, students will conduct a chromatography laboratory experiment where they use a prepared paper chromatography kit. At the end of class they will be given a scientific article on ways gas chromatography is being used in marine science. They will read these articles and be prepared to teach their classmates about the process

Day 3: Whole class table discussion about uses of gas chromatography in the marine field.

Students will push desks together to form a large table in the center of the room. Each student will discuss their article with the group and will be prepared to ask each other questions.

Engineering Connection
Scientists including environmentalists, oceanographers and engineers are continually looking for ways to measure, prevent, and treat water pollution. One major problem facing our oceans and therefore our food supply is rising levels of mercury. Through the study and application of chemical engineering, levels of pollutants like mercury in ocean water and the tissues of marine organisms can be calculated using gas chromatography. These efforts will lead to making our oceans healthier and our food safer.

Engineering Category =
Choose the category that best describes this lesson's amount/depth of engineering content:
1. Relating science and/or math concept(s) to engineering

Keywords
Mercury, gas chromatography, ocean pollutants, Minimata, Marine Science

Educational Standards (List 2-4)
State STEM Standard (required)
SC.912.N.1.6 Describe how scientific inferences are drawn from scientific observations and provide examples from the content being studied
SC.912.N.3.5 Describe the function of models in science, and identify the wide range of models used in science.
ITEEA Standard (required)
Standard 5. Students will develop an understanding of the effects of technology on the environment.
- I. With the aid of technology, various aspects of the environment can be monitored to provide information for decision-making.
- J. The alignment of technological processes with natural processes maximizes performance and reduces negative impacts on the environment.
- K. Humans devise technologies to reduce the negative consequences of other technologies.
- L. Decisions regarding the implementation of technologies involve the weighing of trade-offs between predicted positive and negative effects on the environment.

Standard 13. Students will develop the abilities to assess the impact of products and systems.
- J. Collect information and evaluate its quality.
- K. Synthesize data, analyze trends, and draw conclusions regarding the effect of technology on the individual, society, and environment.
- L. Use assessment techniques, such as trend analysis and experimentation, to make decisions about the future development of technology.

NGSS Standard (strongly recommended)
SC.912.E.7.8 Explain how various atmospheric, oceanic, and hydrologic conditions in Florida have influenced and can influence human behavior, both individually and collectively.
SC.912.L.17.13 Discuss the need for adequate monitoring of environmental parameters when making policy decisions.
SC.912.L.17.15 Discuss the effects of technology on environmental quality.
SC.912.L.17.16 Discuss the large-scale environmental impacts resulting from human activity, including waste spills, oil spills, runoff, greenhouse gases, ozone depletion, and surface and groundwater pollution.

CCSS Standard (strongly recommended)

LAFS.1112.RST.1.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

LAFS.1112.RST.4.10 By the end of grade 12, read and comprehend science/technical texts in the grades 1112 text complexity band independently and proficiently.

Pre-Requisite Knowledge

Learning Objectives

After this lesson, students should be able to understand how mercury moves through the environment and how it can affect species. They will also be able describe the process of gas chromatography and will be able to make connections to how this procedure applies to the field of marine science.

Introduction / Motivation (5E – Engage)

In Marine Science II, students learn about many of the problems that are facing our ocean. Mercury pollution is one of the major issues. Throughout history, in places like Minimata Bay, Japan, the effects of mercury pollution are clear. Two questions persist, however. The first is how do we accurately assess the level of mercury in the ocean and secondly, what can we do to fix or decrease the effects of this pollutant.

This lesson plan opens with a video that shows how neurons behave in response to their exposure to mercury. (Leong Syed and Lorscheider 2001 degeneration of neuron structures following exposure to mercury http://www.youtube.com/watch?v=b2CtINZWy00)

Students will see that the neuron immediately begins to wither and the myelin sheath disintegrates rapidly leaving behind the denuded neurofibrils. This will motivate students to learn more about what is happening and what is causing the distruction

Lesson Background & Concepts for Teachers (5E – Explain) **Please see Prezi Presentation for background information on Minimata and Mercury pollution**

http://prezi.com/s78-ygzdjsws/?utm_campaign=share&utm_medium=copy&rc=ex0share

Vocabulary / Definitions

Word	Definition
Bioaccumulation	Build up of substances within the tissues of an organism over its lifetime.
Biomagnification	An increase in the concentration of substances within the organisms of a food chain with the greatest concentrations occurring at the tops of

	the food chains.
Mercury	Hg – Chemical element #80 occurring naturally from volcanic emissions, can lead to mercury pollution when in water and air
Monomethylmercury	MMHg – a neurotoxin that move up the food chain and become highly concentrated in the larger species
Neuron	"nerve cell" electrically excitable cell that processes and transmits information through electrical and chemical signals

Associated Activities (5E – Explore)

Image #2

Figure 1

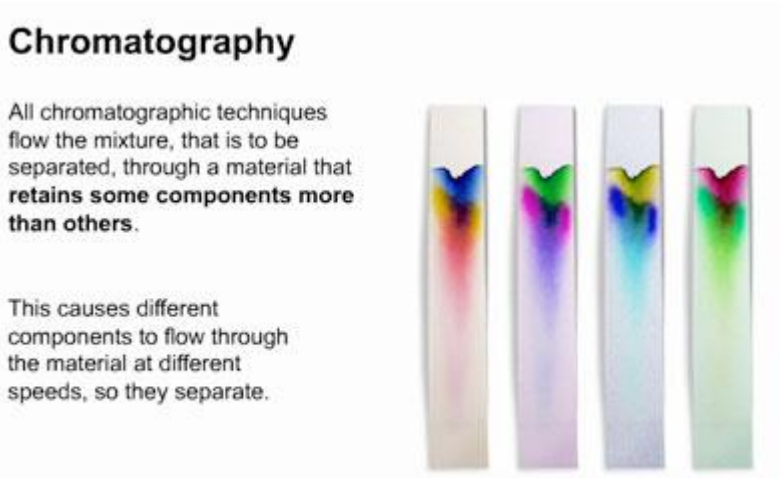


Image file: 1

ADA Description: Four strips of paper show the color separation after a chromatography test.

Source/Rights: Copyright © http://lifeofplant.blogspot.com/2011/05/chromatography.html

Caption: Basic results from a paper chromatography lab

Lesson Closure: Socratic Seminar

Students will form a double circle. Students on the inner circle will discuss the article they read. Student on the outside will take notes and ask questions. Then they will switch seats and roles. Rules: Each student must speak twice and ask one question. Two other students must talk before you can speak again. Grades will be based on participation and accuracy.

Assessment (5E – Evaluate)

Pre-Lesson Assessment

Descriptive Title: Class discussion about damage to neuron

Lesson Summary Assessment
Descriptive Title: Quality of participation in Socratic Seminar

Homework
Descriptive Title: Research an article about how gas chromatography is used in Marine Science

Lesson Extension Activities (5E – Extension)
Students will bring in a sample of something they believe can be separated using chromatography and will test it using the paper chromatography kit.

Students can research the real world application for chromatography and will discuss what they discover with the class. (Examples can include pregnancy tests, drug/alcohol tests, forensics etc)

Additional Multimedia Support
Prezi Presentation containing all background and lesson information

Link: http://prezi.com/s78-ygzdjsws/?utm_campaign=share&utm_medium=copy&rc=ex0share

Videos used in Prezi:

Toxic Food Webs

http://vimeo.com/45969895

Mercury Poisoning: the Minimata Story

https://www.youtube.com/watch?v=ihFkyPv1jtU

Gas Chromatography

https://www.youtube.com/watch?v=4Xaa9WdXVTM

Attachments
Prezi Link

Paper Chromatography Experiment

Article links (see references)

References and Article Suggestions for Students

1. Jaime, Elke, Christian Hummert, Philipp Hess, and Bernd Luckas. "Determination of Paralytic Shellfish Poisoning Toxins by High-performance Ion-exchange Chromatography." Journal of Chromatography A 929.1-2 (2001): 43-49. Web.
2. Farrington, J.W. 2014. Organic chemicals of environmental concern: Water sampling and analytical challenges. Oceanography 27(1):214–216, http://dx.doi.org/10.5670/oceanog.2014.24.
3. Qiu, Canrong, and Minggang Cai. "Ultra Trace Analysis of 17 Organochlorine Pesticides in Water Samples from the Arctic Based on the Combination of Solid-phase Extraction and Headspace Solid-phase Microextraction–gas Chromatography-electron-capture Detector." Journal of Chromatography A 1217.8 (2010): 1191-202. Web.
4. Seewald, Jeff. "A Little Burp in a Big Ocean." NOAA Ocean Explorer Podcast RSS. Woods Hole Oecanographic Institute, 2011. Web. 25 July 2014.
5. Tomiyasu, Takashi, Akito Matsuyama, Tomomi Eguchi, Kohji Marumoto, Kimihiko Oki, and Hirokatsu Akagi. "Speciation of Mercury in Water at the Bottom of Minamata Bay, Japan." Marine Chemistry 112.1-2 (2008): 102-06. Web.
6. Tomiyasu, Takashi, Akito Matsuyama, Tomomi Eguchi, Yoko Fuchigami, Kimihiko Oki, Milena Horvat, Rudi Rajar, and Hirokatsu Akagi. "Spatial Variations of Mercury in Sediment of Minamata Bay, Japan." Science of The Total Environment 368.1 (2006): 283-90. Web.
7. Wagemann, R. "Mercury Species in the Liver of Ringed Seals." The Science of The Total Environment 261.1-3 (2000): 21-32. Web.
8. Wagemann, R., E. Trebacz, G. Boila, and W. Lockhart. "Methylmercury and Total Mercury in Tissues of Arctic Marine Mammals." The Science of The Total Environment 218.1 (1998): 19-31. Web.
9. Winner, Cherie. "How Does Toxic Mercury Get into Fish?" Oceanus Magazine. Woods Hole Oceanographic Institute, 1 Oct. 2010. Web. 25 July 2014.
10. YanBin, Li, and Cai Yong. "Progress in the Study of Mercury Methylation and Demethylation in Aquatic Environments." Chinese Science Bulletin Special Issue Toxic Metal Pollution 58.2 (2013): 177-85. Web. 25 July 2014.

Attachments

1- Link to Prezi presentation for content and multimedia

http://prezi.com/s78-ygzdjsws/?utm_campaign=share&utm_medium=copy&rc=ex0share

2- Link to Paper Chromatography lab

http://www.teacherspayteachers.com/Product/Paper-Chromatography-Experiment-968171