

LESSON: Arsenic: An Element of Suffering

Summary: Students read the article “Arsenic: In Search of an Antidote to a Global Poison” and use the information as the basis for creating a fictional “case study” of an individual affected by arsenic exposure. Lesson type: Integrated Lesson—this lesson extends beyond traditional science content and can be used in other academic subjects.

EHP Article: “Arsenic: In Search of an Antidote to a Global Poison,”
EHP Student Edition, September 2005, p. A379
<http://ehp.niehs.nih.gov/members/2005/113-6/focus.html>

Objectives: By the end of this lesson students should be able to:

1. identify geographic regions with major health problems associated with arsenic exposure, and the sources of this exposure;
2. identify groups that are vulnerable to adverse health effects from exposure to arsenic in the environment;
3. describe the signs and symptoms of arsenicosis; and
4. use the Internet and other resources to research the details needed to develop a plausible and factually accurate creative depiction of a case of arsenicosis.

Class Time: 1.5–2 hours with some homework time for research

Grade Level: 11–12

Subjects Addressed: Environmental Health, Environmental Science, Biology, Health, International Studies, Chemistry, English/Creative Writing

►Prepping the Lesson (15 minutes)

INSTRUCTIONS:

1. Obtain a class set of *EHP Student Edition*, September 2005, or download “Arsenic: In Search of an Antidote to a Global Poison” at <http://ehp.niehs.nih.gov/members/2005/113-6/focus.html>.
2. Make copies of the Student Instructions.
3. Review the article, Background Information, and Student Instructions.
4. Decide on the level of detail and length you expect to see in your students’ case studies. If you assign only the *EHP Student Edition* article, students could write perhaps a one-page case study with minimal detail. If additional research is required, a two- to three-page case study would be a reasonable expectation, including a map and perhaps some images.
5. Decide how you will ensure that not all students write about the same type of case. You may want to have students separately research broad categories of the issue, such as adults and children, or domestic (i.e., U.S.) arsenic exposures and exposures in developing countries.

MATERIALS (per student):

- 1 copy of *EHP Student Edition*, September 2005, or 1 copy of “Arsenic: In Search of an Antidote to a Global Poison”
- 1 copy of the Student Instructions

VOCABULARY:

- arsenic trioxide
- arsenicosis
- cofactor
- cytokines
- endocrine disruptor



- genetic polymorphisms
- hyperkeratosis
- inorganic arsenic
- malignancies
- metabolites
- peripheral neuropathy
- pharmaceutical
- toxicologist
- tubewell

BACKGROUND INFORMATION:

Physicians and epidemiologists frequently use case studies to illustrate aspects of a health problem or as a starting point for research. By studying the particulars of a given person's story, they can find clues about the greater scientific mysteries involved. In this exercise, students essentially work backward from this approach. Using the wide-ranging and factual information presented in the *EHP Student Edition* article, students can choose from a variety of "characters" to develop into their own case study. This is the type of research that authors of fiction do to create vivid and accurate depictions of characters' lives from worlds they may have never actually experienced. The novel *On the Beach* by author Nevil Shute is a well-known example of "environmental fiction" which uses as its backdrop nuclear war. The nonfiction story *The Hot Zone* by Richard Preston is a well-told, gripping story about the deadly Ebola virus. Students may choose to write about the arsenic in their own local environment, searching for material by looking for local news on arsenic contamination or even interviewing local health department officials.

RESOURCES:

Environmental Health Perspectives, Environews by Topic, <http://ehp.niehs.nih.gov/topic/arsenic.html>. Choose Arsenic.

Environmental Health News, <http://www.environmentalhealthnews.org>. Search under "arsenic" and then by area.

Agency for Toxic Substances and Disease Registry, <http://www.atsdr.cdc.gov/HEC/CSEM/arsenic>. Look for case studies for training doctors as well as ToxFQA's, a series of informational statements on many known environmental contaminants.

National Library of Medicine Hazardous Substances Data Bank, <http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB>

▶Implementing the Lesson

INSTRUCTIONS

1. Hand out the article "Arsenic: In Search of an Antidote to a Global Poison" to students and allow them to read it.
2. Hand out the Student Instructions, adding in your requirements in terms of length and number of additional sources for the project.
3. Discuss the headings for the case study report: Background, Signs and Symptoms/Lab Results, Environmental Findings, and Treatment/Recommendations.
4. Lead a class discussion on how to successfully mix fact and fiction to create a meaningful hypothetical profile of a person with arsenic-related illness.
5. Have students share their completed case studies with the class.

NOTES & HELPFUL HINTS:

- As students prepare to begin work, make sure their case studies will represent a variety of countries (developed or developing), age groups (adults and children), and types of arsenic exposures. For instance, not everyone should describe a Bangladeshi child exposed to arsenic via a tubewell. Students should choose their fictional subjects with an eye toward telling an interesting and accurate story.
- Students can get as creative and as detailed with their stories as time allows. They can use maps to choose a village or town for their subject, pick a plausible name and age, even describe the home and family situation of the child or adult of interest. By engaging students' creativity, you create a connection with the material that is impossible to duplicate by assigning simple research.

▶Aligning with Standards

SKILLS USED OR DEVELOPED:

- communication (note taking, oral, written—including summarization)



- Comprehension (listening, reading)
- Critical thinking and response
- Research

SPECIFIC CONTENT ADDRESSED:

- arsenic
- chronic exposure
- cancer and non-cancer effects from arsenic
- arsenicosis

NATIONAL SCIENCE EDUCATION CONTENT STANDARDS MET:

Unifying Concepts and Processes Standard

- Systems, order, and organization
- Evidence, models, and explanation
- Form and function

Science As Inquiry Standard

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Physical Science Standard

- Structure and properties of matter
- Chemical reactions

Life Science Standard

- The cell
- Molecular basis of heredity
- Interdependence of organisms
- Behavior of organisms

Science in Personal and Social Perspectives Standard

- Personal and community health
- Population growth
- Natural resources
- Environmental quality
- Natural and human-induced hazards
- Science and technology in local, national, and global challenges

History and Nature of Science Standard

- Science as a human endeavor
- Nature of scientific knowledge
- Historical perspectives

▶Assessing the Lesson

Students should have a number of factual points about arsenic exposure under each of the four subheadings. These facts should be consistent with information from the article, and, if outside sources are used, they should be listed in a References section. A brief sample case study adapted from an ASTDR training exercise for physicians (see Resources) is given below.

The kids can use their own language to tell their stories; the language below is a rough approximation of the style used in public health and medical literature.

SAMPLE CASE STUDY

Background: Jacob Petersen is a fair-skinned man in his early 30s who lives in a rural area of Washington State. He is a carpenter and built his own cabin and does work for other people in the area. He moved with his wife, who is a schoolteacher, into their newly built cabin about 10 months ago. The cabin is supplied with water from a well on the property and is heated by a woodstove. Mr. Petersen is an active person in generally good health taking no medications. He has recently quit smoking but had smoked about 10 packs a year for the previous 10 years. His wife, parents, and siblings are in good health.

Signs and Symptoms/Lab Results: Mr. Petersen came to his doctor complaining of tingling in his hands and feet, spreading from his toes and fingers initially. Recently the tingling has turned to numbness and weakness, especially when trying to grip



tools. His palms and the soles of his feet show dark and pale spots, and some areas also have raised areas of thickened skin between 4 and 10 millimeters in diameter. His reflexes also seem to be slightly weak, especially in the ankles. Mr. Petersen's urine test showed 6,000 micrograms of arsenic per deciliter instead of the normal levels, which are usually below 50. His wife's urine contained 300 micrograms of arsenic per deciliter.

Environmental Findings: Interviews by health officials revealed that Mr. Petersen had been bringing home scrap wood from his various job sites and burning it in the woodstove of his cabin. This wood was often pressure-treated with chromated copper arsenate (CCA), a wood preservative. The water in his well was also found to have a level of arsenic at 250 micrograms per liter.

Treatment/Recommendations: Mr. Petersen was told to stop burning scrap wood in his woodstove and to use caution when handling treated lumber. He was also urged to get a filter for his well that would remove arsenic, and to change the filters frequently. His wife was urged to avoid pregnancy until the arsenic had cleared from their systems, approximately one year. Mr. Petersen was also urged to get screened regularly for lung and/or skin cancer due to his elevated risk. Area residents were also notified to test their wells for arsenic by local public health officials.

► Authors and Reviewers

Authors: Wendy Stephan and Lisa Pitman, University of Miami Rosenstiel School of Marine and Atmospheric Science, NIEHS Marine and Freshwater Biomedical Sciences Center

Reviewers: Susan Booker, Laura Hemminger, Stefani Hines, Liam O'Fallon, Barry Schlegel, Kimberly Thigpen Tart



Arsenic: An Element of Suffering

- Step 1:** Read the article "Arsenic: In Search of an Antidote to a Global Poison," *EHP Student Edition*, September 2005, p. A379. As you read, be sure to note signs and symptoms of arsenicosis (arsenic poisoning), sources, possible sources of exposure, and standards for exposure.
- Step 2:** Based on your reading, create a profile of a fictional person suffering from arsenicosis (arsenic poisoning). Use your imagination to fill in the details of this individual's case history, using the following headings:
- Background: Age, gender, physical description, place of residence, etc.
 - Signs and Symptoms/Lab Results: Describe the hypothetical lab findings, and signs and symptoms of arsenicosis as suffered by your fictional patient.
 - Environmental Findings: Where was the arsenic coming from and how does it get into the body? Detail the source.
 - Treatment/Recommendations: How did health officials proceed or intervene?
- Be creative, tell a story. Make sure that your facts are plausible and consistent with your readings.
- Step 3:** Share your case study with your class.

