April 2021

Lesson Plan - Ecological Impacts of Hazardous Wastes

Center for Urban Resilience

LESSON 3: ECOLOGICAL IMPACTS OF HAZARDOUS WASTES

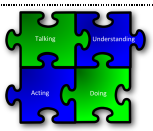
OVERVIEW:

The main purpose of this lesson is to demonstrate the idea that the things we throw away may harm other organisms. This lesson uses a brainstorming activity, and a lab experiment testing the effect of toxins on brine shrimp. This lesson also introduces the major pathways through which hazardous waste enter aquatic and terrestrial ecosystems and provides an overview of the impacts of wastes such as heavy metal ions, strong acids or bases, and persistent organic compounds on plants and animals.

SUB-QUESTION:

How does the garbage I produce impact the plants and animals in our ecosystem?

WAYS OF KNOWING URBAN ECOLOGY:



	Students will…
Understand	• Understand that there are many ways that toxins can enter the bodies of organisms. *(ecosystem state and structure, ecosystem change)* • Understand that there are characteristics that distinguish heavy metals, acids, bases and synthetic organic substances and make them harmful. *(ecosystem state and structure, ecosystem change)*
Talk	*No specific goals connected with acting on urban ecology in this lesson.*
Do	• Do an experiment which will determine the concentration of a toxin which is lethal to 50% of a brine shrimp population.
Act	*No specific goals connected with acting on urban ecology in this lesson.*

SAFETY GUIDELINES

When choosing to use the alternative chemicals please review the following pointers.

- Read all Material Safety Data Sheets (MSDSs) before using chemicals besides the herbal tea. **If any chemical comes in contact with a person's skin you will need to be prepared to flush that skin with clean water for 15 minutes.**
- Whenever possible, conduct chemical tests in an indoor space with appropriate eyewash equipment.
- Caution students to keep all chemicals (and sample water) away from their faces. Students should NEVER directly smell chemicals.
- **Depending on the chemical which is used in the experiment, water samplers may need to wear gloves and goggles at all times** to protect themselves from potentially harmful conditions in the water and from the chemicals used in the tests.
- Wipe all liquid and powder spills as soon as they occur.
- Wash hands thoroughly with soap and water after conducting tests.

PREPARATION:

Time:
2 class periods

Materials:

Activity 3.2
- Poster paper
- Colored markers

Activity 3.3
- Student data/analysis sheets
- Brine shrimp
- Brine salt water
- 100mL graduated cylinder
- 2 plastic forks
- 2 400mL beakers
- Small Petri dishes
- Pipette
- Logarithmic graph paper
- Computers with Excel
- Herbal Tea Bags
- Other substances your students may want to test

INSTRUCTIONAL SEQUENCE

Activity 3.1: Defining "Hazardous Wastes"

1. Write the word, "hazardous wastes" on the board and prompt students to brainstorm the meaning of the term.

Teacher Background Knowledge: A **hazardous waste** is a material that can be harmful to human health or the environment if it is not disposed of properly. A hazardous waste can be in the form a solid, liquid or gas. It can explode or release toxic fumes, have harmful concentrations of one or more toxic materials that can leach out and it can be corrosive to the skin or to metals.

Examples of common household products which are toxic and hazardous materials:

- Disinfectants
- Drain, toilet and window cleaners
- Bleach and Ammonia
- Oven cleaners
- Cleaning solvents and spot removers
- Septic tank cleaners
- Latex and Oil based paints
- Paint thinners
- Pesticides sprays
- Weed killers

- Rodenticides
- Gasoline
- Used motor oil
- Brake Fluid
- Car battery acid
- Batteries
- Glues, paint, cement and inks

2. Try to illicit various ideas on the subject of hazardous waste by accepting all answers first, then eliminating ideas that may cause confusion
3. Have students discuss some of the hazardous waste they have produced and some of the reasons why hazardous waste is a problem in the environment.

Activity 3.2 How does garbage get into the bodies of organisms?

1. 4-square brainstorm and facilitated discussion.
    - Divide class into 4 groups.
    - Give each group a large piece of poster paper. Each poster paper has the question: "How might hazardous wastes get into the body of a(n)_____". And the name of an organism. Possible suggestions are:
        - House Sparrow
        - Human
        - Maple tree
        - Large mouth bass
        - Amoeba
    - Give each group a different colored marker (so that you can identify which responses came from which group) and have them write down their responses to the question for two minutes. After two minutes, have the groups either get up and move to a different table leaving the poster paper where it is or they can simply rotate the poster papers and have the students stay where they are. Repeat until each group has responded to each type of organism.
    - Tape all the papers to the board in the front of the room. Go over the results as a whole class, looking for similarities and differences between organisms.
    - On the board list the major responses, such as: the food an organism eats, the water an organism drinks, the air an organism breathes or absorbs, the soil an organism lives in. Ask students to take the list one step further. How does the toxin get into the food which an organism eats, or the water which an organism lives or the soil an organism lives in?
    - Explain that the following investigation will explore how adding substances to the water of brine shrimp affects the mortality of brine shrimp.

Activity 3.3: Use of Brine Shrimp Assay to Determine LC_{50} of Herbal Teas

Teacher Background knowledge
Toxicity is commonly measured in three ways:

- **Lethal Dose,LD_{50}: which measures the dosage of a toxin that is required to kill 50% of a population**
- **Lethal Concentration, LC_{50}: which measures the concentration of a toxin that is required to kill 50% of a population.**
- **Lethal Time, LT_{50}: which measures the time required to kill 50% of a population**

This experiment is measuring LC_{50} , as it is impossible to say what dosage the brine shrimp are actually receiving.

In this lab we will use a small crustacean, the brine shrimp. It is normally found in brackish water and is a very hearty little organism and able to tolerate high salt concentrations. This lab will use herbal tea as a potential toxin.

Teaching Alternative
You may choose to use some of the following as potential toxins instead of or in addition to herbal tea. Make sure you use the same serial dilution as you would for the herbal tea. Note that pH will be covered more in Activity 6 "Chemistry of Toxins". Solids will need to be dissolved in the salt water first. Household chemicals in the liquid form may be too strong at full strength, so you may want to make a stock that is 1/100 cleaner in salt water water (0.01X) and then create the other dilutions in the same way but considering that they are now 0.001X and 0.0001X.

- Copper Sulfate
- Cigarette butts
- A strong acid such as "The Works" toilet bowl cleaner (contains HCL)
- A strong base such as bleach or Liquid plumber.
- Coca-cola
- Aspirin or other over the counter medicines.
- Or have your students come up with ideas of what toxin to use.

Investigation Alternative:
An interesting experiment may be to have students compare the impact of toxic cleaners to those that are advertised as being non-toxic and/ or environmentally friendly.
Possible questions:

Does the lethal dosage change?
What chemicals are found in the different substances?

Set up ahead of time: Preparation of Tea Extract
A cup of tea contains 200 ml of water per teabag, so that would be considered a 1.0X dosage. You will prepare a 10X dosage by using 4 teabags in 80 ml of brine (seawater).

1. Place 4 teabags flatly onto the bottom of a beaker
2. Place 80 ml of hot seawater water into the beaker and let it seep for 10 minutes, shaking gently every 2 minutes.
3. Squeeze each teabag between two forks. This solution is designated as the tea extract at a 10X solution.
4. Make a serial dilution of the 10X stock in order to make a 1X stock solution. Add 2 ml of 10X stock solution to 18 ml of room temperature seawater water. The resulting 20 ml of solution will be 1X.
5. Make a serial dilution of the 1X stock in order to make a 0.1X stock solution. Add 2 ml of 1X stock solution to 18 ml of room temperature seawater water. The resulting 20 ml of solution will be 0.1X.

Note: The exact volume you need may be adjusted as needed.

6. Label 3 Petri dishes of each of the following solutions: 10X, 1X, 0.1X and Control, 12 total Petri dishes. Control is the brine salt water.
7. Using a pipette, transfer 10 shrimp to each Petri dishes. **You must minimize the dilution error that occurs as a result of shrimp being in a salt solution, so just before you add the tea extract, decant the seawater (brine) from your vial of brine shrimp, leaving the brine shrimp in as little water as possible.**
8. Set aside for 24 hours

Day 2

1. Opener: Write the question on the board and have students respond: "What factors determine whether a substance is to be considered a toxin?"
2. Check on your Brine Shrimp. After 24 and 48 hours, count the surviving brine shrimp. Calculate the % death. Record results on the Student data sheet.
3. Graph the results.

Teaching Alternative
Extra Challenge, technology option: If you have computers available, use Excel, plot a scatter graph of Mortality (Y axis) as a function of Concentration (X axis). Students could also use Logarithmic graph paper.

4. Students should complete the data table and analysis questions.

Concluding the lesson:
Share as a whole class the students responses to the analysis questions.