Teacher Directions

UNIT: DNA

LESSON: ARSENIC – THE SILENT TOXIN THAT KEEPS ON GIVING

ACTIVITY 1B: *TO DRINK OR NOT TO DRINK: EVALUATING WATER QUALITY*

TEXAS BIOMEDICAL RESEARCH INSTITUTE
HEALTH STARTS WITH SCIENCE

Objectives:

The Student Will Be Able To:

1. Describe how toxins get into water sources.
2. Evaluate data to assess presence or absence of toxins from water samples.
3. Analyze the effects of runoff on sources of drinking water.
4. Discuss potential adverse effects of toxins in water on generational health (epigenetics).
5. Design, test, and evaluate a water treatment strategy.

> **!**
>
> **IMPORTANT**
> Scientists make predictions or hypotheses, then conduct experiments to test predictions or hypotheses. When a prediction or hypothesis is not supported by the data from the experiment, it is not a failure. Learning occurs in the laboratory and the classroom even when the outcomes do not match predictions.

Activity Summary

In this activity, students work as teams of scientists who have been hired to test sources of drinking water for rural communities. After conducting water quality tests, students will consult a topographical map to identify sources for any toxins found in the tested water samples. Based on their analysis of the landscape and test results, students will generate evidenced-based public health policies for the communities.

Extension

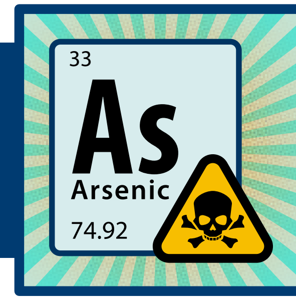
Assign specific areas and communities (A, B, or C) to each team. The team will generate a policy recommendation for their specific community.

Activity Prep

(based on 50 ml of each solution per group; 8 groups/class; 5 classes)

- ***Water Sample A:*** 2 Liters baking soda solution
  - Mix *150 g baking soda* ($NaHCO_3$) with *2 L distilled or deionized water*.
  - ***Saturation Warning:*** Do not exceed 150g of baking soda per 2 L of water. The solution is saturated at higher amounts, causing the baking soda to be less soluble, meaning the baking soda will "drop out" of solution.

NIH SEPA Project #1R25GM142021-01A1



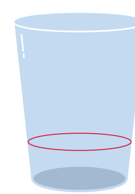
- ***Water Sample B:*** 2 Liters diluted white vinegar
  - Combine 500 ml white vinegar with 1.5 L distilled or deionized water.
- ***Water Sample C:*** 2 Liters distilled or deionized water.
  - Sample C is a control and provides opportunity to discuss the purpose of a control in an experiment. A control is used as a comparison. When using the terms dependent and independent terms, the independent variable is "manipulated" or "treated" in some way. Scientists then observe the impact of the treatment on a dependent variable. The control is not manipulated or treated. In this case, the control is water that does not contain a toxin, enabling students to make observational comparisons.

- ***Purple Cabbage Indicator:***
  - Cut 1 head purple cabbage cut into small pieces.
  - Place cabbage in large bowl or pot (2L capacity).
  - Pour 2L hot water over cabbage.
  - Stir and let sit for 10 minutes.
  - When cool, strain to remove cabbage from indicator solution.

Activity Supplies: (per group)

Activity Set Up:

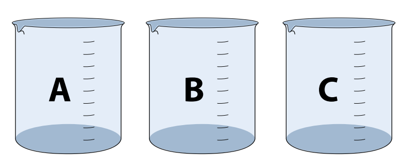
- Water sample supplies (in an easy pour container)
- **Option 1:**
  - Three 100 ml beakers, labeled A, B, and C.
- **Option 2:**
  - Three clear plastic cups, labeled A, B, and C. Draw a line on each cup which indicates 50 ml.



- Disposable pipettes: if available, provide each group with 3 pipettes to avoid cross contamination.
- To avoid cross contamination, label each pipette: A, B, or C.
- 50 ml beaker for indicator.
- Paper towel or napkins.

Activity Directions:

Step 1: Select an option for students to follow for measurement.



- **Option 1:** Measure 50 ml of each water sample into the appropriate beaker.
  - 50 ml of water sample A.
  - 50 ml of water sample B.
  - 50 ml of water sample C.
- **Option 2:** The cups have a measurement line. Pour each sample into the corresponding cup (sample A into cup A) until the water sample reaches the line.
  - **NOTE:** Check the volume of the plastic cup. A 9 fl. oz. cup will hold over 250 ml of liquid. If using Option 2, do a test measure of 50 ml of water to determine where the line needs to be drawn on each cup.

NIH SEPA Project #1R25GM142021-01A1

UNIT: DNA

LESSON: ARSENIC – THE SILENT TOXIN THAT KEEPS ON GIVING

ACTIVITY 1B: TO DRINK OR NOT TO DRINK: EVALUATING WATER QUALITY

Step 2: Initial Observations

- In the data table, record your observations before testing each water sample. Because these water samples have not yet been tested for toxins, observations are limited to what you see.
- **CAUTION:** When dealing with an unknown solution, chemical, or sample of any kind, follow established safety protocols.

Step 3: Testing the water samples

- Carefully place only one pipette into the indicator solution, squeeze then release the bulb to draw indicator into the pipette.
- **CAUTION:** the indicator will stain clothing!
- To test water sample A, hold the pipette over Cup A and gently squeeze the pipette bulb to put the indicator into the water sample.
- Use a clean pipette and repeat the process for Cup B.
- Use a clean pipette and repeat the process for Cup C.

Step 4: Record your observations. Use the "legend" to identify possible toxins in each water sample.

LEGEND	
Color	**Toxin**
Blue/Purple	**No metal toxins present**
Pink	**Arsenic (As) is present**
Green	**Lead (Pb) is present**

WATER SAMPLE	Pre-testing Observations	Post-testing Observations
A		
B		
C		

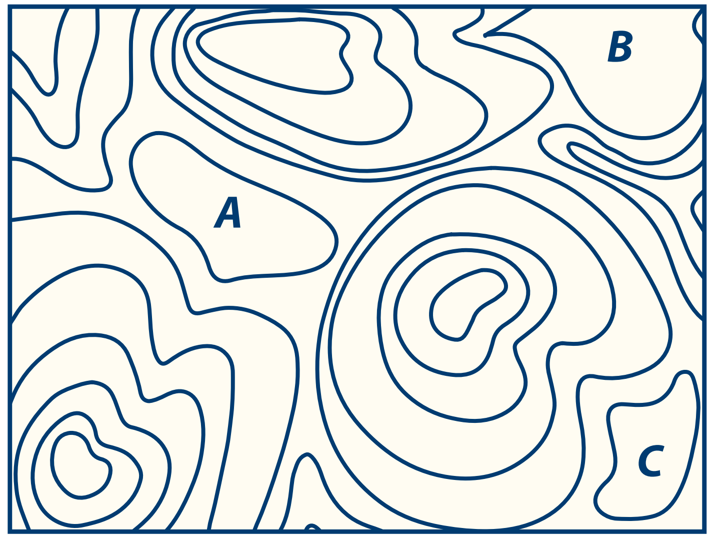
NIH SEPA Project #1R25GM142021-01A1

UNIT: DNA

LESSON: ARSENIC – THE SILENT TOXIN THAT KEEPS ON GIVING

ACTIVITY 1B: TO DRINK OR NOT TO DRINK: EVALUATING WATER QUALITY

Water Sample Locations



Topographic maps show the physical features of land areas, representing mountains, hills and valleys. These maps also indicate rivers and streams which carry water from higher elevations to areas of lower elevation such as valleys and lakes. Topographic maps help identify the path water takes to reach lower elevations.

Watersheds are areas that channel rainfall, snowmelt, and runoff from higher elevations to lower elevations. Water samples taken from lower elevations can be tested to reveal any toxins that may be in the water. Knowing the directional flow of a watershed helps scientists locate the source of toxins which may contaminate drinking water. Many of the toxins which occur naturally in the environment are metals and metalloids. Toxins include lead (Pb) which is called a "heavy metal" due to its high density (atomic number 82). Another toxin commonly found in the environment is arsenic (As). Arsenic is a metalloid, meaning it has properties of both metals and nonmetals.

Making Connections

Water treatment plants are important facilities which ensure safe drinking water for communities. Water treatment plants use different methods to remove pollutants and toxins. This includes filtration, aeration, and chemical reactions. Once treated, water from a water treatment plant is safe to drink. But what if you live in a community without a water treatment plant?

There are many pollutants and toxins that are man-made, but toxins, such as arsenic ***(As)*** and lead ***(Pb)*** occur naturally in our environment. Water quality tests reveal that water sources in rural Western US states commonly contain arsenic. The Strong Heart Study ***(SHS)*** is a longitudinal study that has shown long-term exposure from various levels of arsenic is associated with metabolic conditions, including type 2 diabetes ***(T2D)***. Based on evidence from the SHS data, scientists hypothesize children born in communities where arsenic is found in the drinking water have a higher risk of developing metabolic diseases such as **T2D** later in life.

NIH SEPA Project #1R25GM142021-01A1