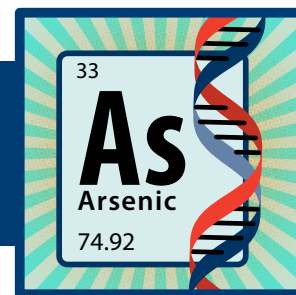


**UNIT: DNA**

**LESSON 1: ARSENIC AND EPIGENETICS: A DNA STORY**



**Overview**

The following activities provide bridges between environmental science, biology, and chemistry concepts, reinforcing the connectivity between science disciplines. Students will explore various aspects of genetics, including the molecular structure of DNA and genetic changes caused by environmental toxins. Activities introduce epigenetics: the study of how behaviors and environmental conditions change how our genes work. Unlike mutations, epigenetic changes can do not change the DNA sequence. Instead, it changes how the body reads the DNA sequence, primarily affecting when gene are activated or not activated. In other words, changing when genes are turned on and off. These “mis-readings” can impact offspring, making them susceptible to metabolic diseases, such as type 2 diabetes (T2D), later in life.

**Education Standards**

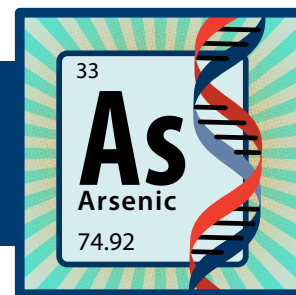
**Texas Essential Knowledge & Skills (TEKS): Implement 2023 & 2024**

Middle School TEKS	
<b>7<sup>th</sup> Grade</b>	7.1 A,B,C,D,E,F,G; 7.2 A,B,D; 7.3 A,B,C; 7.5 A,B,C,D,G; 7.6 A,B,C; 7.11 A; 7.13 A,B
<b>8<sup>th</sup> Grade</b>	8.1 A,B,C,D,F,G; 8.2 A,B,D; 8.3 A,B,C; 8.5 A,B,D,G; 8.6 A,B,D; 8.13 B,C

TEKS: Vertical Alignment	
Scientific & Engineering Practices	
<b>7<sup>th</sup> Grade</b>	7.1 A,B,C,D,F,G; 7.2 A,B,D; 7.3 A,B,C; 7.5 A,B,C,D
<b>8<sup>th</sup> Grade</b>	8.1 A,B,C,F,G; 8.2 A,B; 8.3 A,B,C
Biology Concepts	
<b>7<sup>th</sup> Grade</b>	7.3 A
<b>8<sup>th</sup> Grade</b>	8.13 C

**UNIT: DNA**

**LESSON 1: ARSENIC AND EPIGENETICS: A DNA STORY**



Chemistry Concepts	
7 <sup>th</sup> Grade	7.6 A,B,C
8 <sup>th</sup> Grade	8.6 B,D
Earth & Space	
7 <sup>th</sup> Grade	7.11 A

**Middle School NGSS**

Physical Science	
High School	PS1-2; LS1-3; LS1-5; LS2-1
Middle School	LS2-2; LS3-2

**Lesson Rationale**

These activities engage students in evidence-based decision making, using the transformed article to find evidence that supports their responses on the game board (Activity 1A: Conga Line) and interpreting environmental influences on body systems (Activity 1B: To Drink or Not To Drink). The activities and transformed article provide opportunity to connect classroom content to real-world applications and demonstrate the interconnectedness of science disciplines and careers. In this case, the science careers include: *geneticists, microbiologists, environmental scientists, public health researchers, geologists, chemists, and physicians.*

**Activity Summaries**

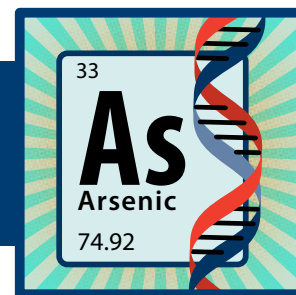
**Transformed Article: Arsenic – The Silent Toxin that Keeps on Giving**

Exposure to low levels of arsenic (**As**) has been shown to increase the chronic diseases, such as type 2 diabetes (**T2D**), in American Indian communities. In this study, scientists sought to determine if the rate of type 2 diabetes in adults from American Indian communities could be connected to their mothers’ exposure to arsenic at low to moderate levels during pregnancy. Through data from the long-running Strong Heart Study (**SHS**), scientists studied mothers and their adult offspring. Exposure to arsenic causes a methyl group (CH<sub>3</sub>) to attach to the mothers’ DNA (**maternal DNA**). The **methylated** maternal DNA is passed on to the offspring. Scientists are trying to determine if the presence of this methyl group in offspring contributes to insulin-resistance in the adult offspring.



## UNIT: DNA

### LESSON 1: ARSENIC AND EPIGENETICS: A DNA STORY



#### Activity 1A: Conga Line – Investigative Vocabulary Game

**Students will** engage with familiar and unfamiliar vocabulary terms through an investigative game featuring terms found in the transformed article. The game scaffolds familiar terms with new vocabulary terms, showing the connectivity of systems and system functions within the body. To play the game, students will read the definition in the **“START”** box. From Conga Line Vocab Cards, students will select the vocabulary term which they believe best fits the definition in the start box. This new card will have another definition and the vocabulary chain continues until students reach the **“END”**.



Students should read the transformed article before completing the activity. Students apply Claim, Evidence, and Reasoning (**CER**) strategies to the activity. Beginning with the **“START”** card, students are to identify key terms from the definition on the card. Referring to the article, students are to find “evidence” which supports placement of each vocabulary term on the game board. Using the Processing Out: My Evidence (included), students record the key words and indicate the page, paragraph, and sentence in the transformed article to support their “claim” for vocabulary card placement on game board.

**SUGGESTIONS:** This activity can be an individual or group activity. Laminating the game boards and vocabulary cards is strongly suggested. There are multiple ways to use this activity:

1. Prior to reading the transformed article, the activity can be a pretest/posttest assessment to gauge student understanding of DNA and genetics or as an introduction to genetics or DNA unit.
2. Encourage students to peer-review one another’s game boards and Processing Out. To help support critical thinking skill development, limit the number of “teacher questions” students may ask during the activity. Teachers may decide to deduct points for groups that exceed the limit of questions.

#### Activity 1B: To Drink or Not to Drink: Evaluating Water Quality

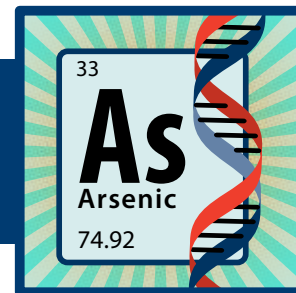
**Students will** engage in a critical thinking experiment which models water quality testing. Working as teams of scientists, students have been hired to test sources of drinking water for rural communities. After conducting water quality tests, students will consult a topographical map to identify and indicate sources for any toxins found in the water. Based on their analysis of the landscape, test results, and information from the transformed article, students will generate evidenced-based public health policies for the communities. Their suggested policies are reflected in the Processing Out.



**SUGGESTIONS:** In this activity students will need to recall prior knowledge about watersheds and the effects of runoff on various water sources. It may be necessary to review how to read a topographical map. This can be done within the activity or as a pre-activity.

# UNIT: DNA

## LESSON 1: ARSENIC AND EPIGENETICS: A DNA STORY



1. Provide an extension activity to explore acids/bases (vinegar is an acid; baking soda solution is a base). Use litmus paper to test the pH levels of each “water sample” from the activity. Include terms such as **solutions and solute**. For example, vinegar bought in the store is a solution as it is water (**solvent**) mixed with acetic acid ( $\text{CH}_3\text{COOH}$ ). The baking soda water sample is also a solution as the baking soda (**solute**) is mixed with water (**solvent**). Explain the solvents “dissolve” solid solutes. At the micro level, the solute separates individual components of the solid from one another. In other words, if the solute is an organic compound, like sugar, the solvent, like water, separates individual molecules of glucose from one another. If the solute is an inorganic compound, like salt, the solute breaks the ionic bond that holds atoms together. Individual ions are separated from one another ( $\text{NaCl} \rightarrow \text{Na}^+$  and  $\text{Cl}^-$ ). Liquids mixed together can also be solutions. But unlike organic and inorganic solids, the solvent does not “dissolve” the liquid solute. Instead, the solvent separates solute molecules from one another creating a “**miscible**” solution.
2. In the Processing Out, students are asked to assume the role of scientists and draft two options for treating toxins found in the watershed. Consider having groups present one or both of their recommendations.
3. As a group activity, you can assign different scientist roles to students. Below is a list of potential roles:
  - a. Environmental scientist
  - b. Chemist
  - c. Biologist
  - d. Geneticist
  - e. Public Health Researcher
  - f. Medical doctor