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| **Lesson Title : Bioremediation** | **Unit #:**  **1** | **Lesson #:**  **2** | **Activity #:**  **3** |
| **Activity Title: Sugar Spill! Bioremediation Cleanup Experiment** |

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| **Estimated Lesson Duration:** | **9 days (70 minutes)** |
| **Estimated Activity Duration:** | **1-2 days (70 minutes)** |

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| **Setting:** | **8th grade classroom** |

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| **Activity Objectives:** |

Students will…

* Investigate the process of bioremediation.
* Explain how engineers make sure bacteria have everything they need to help degrade harmful compounds.
* Gain experience with mass and volume measurements.

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| **Activity Guiding Questions:** |

* What is bioremediation?
* How do you clean up pollution?
* What is a microorganism?
* What do basic things do organisms need to survive?

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| **Next Generation Science Standards (NGSS)** | |
| **Science and Engineering Practices (Check all that apply)** | **Crosscutting Concepts (Check all that apply)** |
| ☒ Asking questions (for science) and defining problems (for engineering) | ☐ Patterns |
| ☒ Developing and using models | ☒ Cause and effect |
| ☒ Planning and carrying out investigations | ☐ Scale, proportion, and quantity |
| ☒ Analyzing and interpreting data | ☐ Systems and system models |
| ☒ Using mathematics and computational thinking | ☐ Energy and matter: Flows, cycles, and conservation |
| ☐ Constructing explanations (for science) and designing solutions (for engineering) | ☐ Structure and function. |
| ☐ Engaging in argument from evidence | ☒ Stability and change. |
| ☒ Obtaining, evaluating, and communicating information |  |

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| **Ohio’s New Learning Standards for Science (ONLS)** |
| **Expectations for Learning - Cognitive Demands (Check all that apply)** |
| ☐ Designing Technological/Engineering Solutions Using Science concepts **(T)** |
| ☒ Demonstrating Science Knowledge **(D)** |
| ☒ Interpreting and Communicating Science Concepts **(C)** |
| ☒ Recalling Accurate Science **(R)** |

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| **Common Core State Standards -- Mathematics (CCSS)** | |
| **Standards for Mathematical Practice (Check all that apply)** | |
| ☐ Make sense of problems and persevere in solving them | ☒ Useappropriate tools strategically |
| ☒ Reason abstractly and quantitatively | ☒ Attendto precision |
| ☐ Construct viable arguments and critique the reasoning of others | ☐ Look for and make use of structure |
| ☒ Model with mathematics | ☒ Look for and express regularity in repeated reasoning |

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| **Unit Academic Standards (NGSS, ONLS and/or CCSS):** |

Topic: Species and Reproduction

Standard: This topic focuses on continuation of the species.

Content Statements:

* 8.LS.1: Diversity of species occurs through gradual processes over many generations. Fossil records provide evidence that changes have occurred in number and types of species.
* 8.LS.2: Reproduction is necessary for the continuation of every species.

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| **Materials**: (Link Handouts, Power Points, Resources, Websites, Supplies) |

* This lesson was adapted from Teach Engineering: Sugar Spill! Bioremediation Cleanup Experiment (<https://www.teachengineering.org/activities/view/cub_lifescience_lesson04_activity1>)
* Activity 3 handout: Sugar Spill! Bioremediation Cleanup Experiment 1.2.3a
* Each group needs
  + 3 small test tubes or small plastic water bottles (small enough for a balloon to fit over the opening)
  + 3 balloons
  + 9 grams of yeast
  + 9 grams of sugar
  + Graduated cylinder
  + Triple beam balance or digital scale
  + Enough goggles/safety glasses for each group member
  + Sugar Spill! Activity Yeast Experiment Worksheet (1 per group member)
* To share with the entire class
  + Vinegar
  + Water
  + Hot plate or Bunsen burner
  + Heat lamp or light source
  + Other materials students could add to yeast that may hamper or help yeast grow (i.e., lemon juice, chocolate powder, soda, etc.)

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| **Teacher Advance Preparation:** |

* This lesson was adapted from Teach Engineering: Sugar Spill! Bioremediation Cleanup Experiment (<https://www.teachengineering.org/activities/view/cub_lifescience_lesson04_activity1>)
* Gather materials
  + Provide each group with a container/bind/tray that has all of the materials in it. This will save time and aide in classroom management.
* Print 1.2.3a Environmental Remediation Sugar Spill! Bioremediation Cleanup Experiment (1 per student)
* Print 1.2.3b Environmental Remediation Sugar Spill! Bioremediation Cleanup Experiment Answer Key (1 for teacher)

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| **Activity Procedures:** |

1. Prior to starting the activity, ask students the following questions: What is bioremediation? And What are the four basic needs of living things? This can be completed by providing an entrance ticket followed by a whole class discuss.
2. Pass out 1.2.3a Environmental Remediation Sugar Spill! Bioremediation Cleanup Experiment to each student.
3. As a group, students should plan an experiment that helps determine how to make the yeast thrive. The 1.2.3a Yeast Experiment Worksheet guides them through the process.
4. To complete the first page of their worksheet, it may help if you review the scientific design process with students. Remind them that a testable question should ask how one variable (the independent variable) affects another (the dependent variable). Give some examples (see 1.2.3b Yeast Experiment Worksheet–Answers for suggestions). Students may need to be reminded that scientific experiments require that we control our variables. Explain what the control is for this experiment (to make the yeast thrive).
5. Have students plan their experiment. Quickly check their answers on the first page of their worksheet before they begin their experiment.
6. When ready, allow students to start their experiment. The procedure section of the Yeast Experiment Worksheet guides them through the experimental steps. Students should know the exact amount of yeast, water and sugar that went into their control. (Note: it may be useful to have students measure out yeast, water and sugar using the appropriate measuring devices so that they know exact amounts.)
7. Results can be recorded on the board so that the entire class can see the results of each experiment.
8. Have students clean up and complete the handout.
9. Prior to leaving class, have a class discussion on the following:
   1. Which conditions were the best for the yeast? Why?
   2. Discuss any uncertainties in data and if there is anything else they should re-test.
   3. If they were environmental engineers using yeast for a sugar spill clean-up, what would they add to the yeast so that it would do its job the most effectively?

**Formative Assessments:** Link the items in the Activities that will be used as formative assessments.

* 1.2.3a Environmental Remediation Sugar Spill! Bioremediation Cleanup Experiment
* Class discussion/Exit ticket
  + Which conditions were the best for the yeast? Why?
  + Discuss any uncertainties in data and if there is anything else they should re-test.
  + If they were environmental engineers using yeast for a sugar spill clean-up, what would they add to the yeast so that it would do its job the most effectively?

**Summative Assessments:** These are optional; there may be summative assessments at the end of a set of Activities or only at the end of the entire Unit.

Given at the end of the unit:

* Post-Assessment (1.1.1a)
* Group Presentations with rubric (1.2.5b)
* Cooperative Learning Self Evaluation & Peer Evaluation Form (1.2.5c)

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| **Differentiation:** Describe how you modified parts of the Lesson to support the needs of different learners.  Refer to Activity Template for details. |

* Place students in small heterogeneous groups (3-4) if possible or groups based on their leadership skills.
* Encourage students to ask their peers before asking a teacher.

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| **Reflection:** Reflect upon the successes and shortcomings of the lesson. |

Success

* Be sure to provide a discuss on what bioremediation is as well as the four basic needs of living things. This will activate their prior knowledge and help to guide the current investigation. It helped students to realize the sugar was acting like an ingredient in the coal ash and the yeast is the living organism consuming the pollution.
* Students would get mixed up with their test tubes so I had them mark them as control, #1, or #2.
* I had each group member prepare something; for example, one student prepared the control, one prepared experiment #1, and another prepared experiment #2. This gave every group member and opportunity to have a role. If there were more than three members, they were assigned the role as time manager, data recorder, or in charge of measuring the diameter of the balloons after a certain amount of time.

Shortcomings

* Many of the students did not remember the term homeostasis. It was introduced in sixth grade but I did not add it to the entrance ticket discuss.
* Be sure the test tubes or plastic bottles being used are large enough to hold the yeast, sugar, and water. Initially, I ordered the wrong size plastic test tubes so I had to resort to using the older glass ones. Luckily, no one broke any.
* This lab took longer than anticipated because it was taking too long for the sugar, water, and yeast to produce a reaction.
* A few of the balloons broke while they were placing them on the test tube. Have an extra balloon at the table in case this happens. This will minimize the amount of gas that escapes the test tube.
* Students did not indicate time as a control. They need to measure the diameter of each test tube at the same time; for example, five minutes from the start of putting the balloon the test tube.
* It was difficult to clean out the test tubes so be sure to buy a test tube brush. It is important to have a place to dispose of the yeast mixtures as well.