

Bio/Diversity Project Lesson Title: Soil Exploration

Teachers: Kelly McHugh and Skylar Batty Edited by: Elena Greenberg Grade Level: *9th* Time: *50 minutes*

Т

AZ State Science Standard:	Essential HS.L2U1.19 Develop and use models that show how changes in the transfer of matter and energy within an ecosystem and interactions between species may affect organisms and their environment.	
Content Objective: Math, Reading, Science, Writing, Other:	 Students will be able to describe the importance of soil. Students will be able to explain why plants/pollinators need organisms present in soil. Students will be able to identify soil microbes and understand how they affect the development of plants. Students will be able to explain how different soil contents impact plant fitness and ultimately pollinators. 	
Language Objective: (Optional)	N/A	
Scientist of the Week:	 Bashiru Ademola Raji Soil Scientist Nigeria Nigerian professor of soil science, Pedologist, geologist, an environmental impact assessment expert and incumbent Vice-chancellor of Fountain University, Osogbo. He is the second substantive Vice-chancellor of the University. 	

Vocabulary	Materials	
 Fungi Bacteria Protozoans Nitrogen-Fixing Bacteria 	 Soil samples Collect soil samples ahead of time in various areas around the school, making sure to collect both near plants and far away from plants Microscopes slides, cover slips, tweezers, pipets, paper towels Flowers soak in food coloring and water for 24 hours up to 3 days 	
	PowerpointStudent worksheet	
Seasonality: (If more specificity is required, please note date/time range under the season)		



Highlight which season(s) your lesson would be most suited to. When working with the natural world, it is important to keep this in mind for your planning! Some activities are possible for a brief window of time while others may be appropriate during any time of year.

Guiding Questions:

- How is soil affected by microorganisms?
- How are plants affected by soil development?
- How does plant development depend on microorganisms?
- If plants develop poorly, what effect will that have on pollination and corresponding pollinators?
- How do humans contribute to soil formation? In both good or bad ways.

Engagement/Introductory Activity:

- Teacher background: individual soil microbial environments alter developing flower morphology
 - Teacher preparation: soak white flowers and celery stalks in different water with food coloring 24 hours -3 days ahead of time
 - Ask students:
 - Is this the natural color of this flower?
 - How do you suppose the color changed?
 - How do you think this color change might affect the flower health? (Flower colors are generally pollinator-specific and intentional)
 - What does this tell you about how plants get their nutrients?
 - Refer to the powerpoint to introduce different organisms that make soil more viable for plants to grow in
 - Fungi, bacteria, protozoan
 - Show students images of how one plant could look very different from what its supposed to look like based on soil, whether that's because of pollution or some other challenge that those ecosystems face.
 - Show image of basic bacteria structure and an example picture of a desert soil bacteria under microscope for students to reference

Exploratory Activity: https://askabiologist.asu.edu/explore/desert-microbes

- In a lab setting, set out soil samples at different stations
- Briefly remind students how to properly use the microscopes to investigate the different soils
- Have students prepare their own slides for the soil dissection
 - Preparing slides:
 - First
 - Weigh out 0.5 grams of soil
 - Add drops of water in order to make a liquid mixture
 - Second
 - Pipet liquid mixture of soil onto center or slide
 - Use tweezers to adjust mixture accordingly
 - Third
 - At an angle, place one side of the cover slip against the slide making contact with outer edge of the liquid drop
 - Lower cover slip slowly, avoiding air bubbles



- Fourth
 - Remove excess water with paper towel
- Give each group of students a different soil to investigate
 - Ask students:
 - Why do some of these soil samples have many organisms while others do not?
 - What environmental factors can play a role in this?
 - Discuss the relationship of organisms location in soils to plants
- Have student fill out worksheet throughout lab with the following questions:
 - Is there movement in your sample?
 - What type of movement do you see?
 - Where would this type of soil be found in relation to plants?
 - 0 If no movement, where would this type of soil be located in proximity to plants?
 - More urban settings
 - Drier soils
 - Nutrient deficient soils
 - What physical attributes may affect this soils development?
 - Difference between increase and decrease in the following:
 - Temperature?
 - pH?
 - Water availability?
 - Oxygen content?
 - How do soil microorganisms affect plant development?
 - Soil formation
 - Flow of nutrients towards plants
 - Availability of nutrients
 - How does that development of plants affect pollination and in turn, pollinators?
 - Deformations in plant growth
 - Development of reproductive structures
 - Access to pollen by pollinators

Explain:

- Reference the diagram in the powerpoint slides to discuss the interrelationships of soil, bacteria, plants, and pollinators
 - Revisit idea of biodiversity and importance within the food web
 - Discuss the normally unseen organisms that live under the soil and their that affect the food web in depth and their effects on pollinators
- Display the slide providing information of specific bacteria that live in the soil and rely on soil through its contents, salinity, moisture, temperature etc.
 - Bacteria from Sonoran Desert example: Microcoleus desiccates
 - Specifically talk about nitrogen fixation -- a limiting nutrient to plants

Extension Activity/Questions:

0

0

- Lead a short game/brainstorm activity to reflect on the importance of pollinators and a healthy ecosystem
 - Start by drawing a map of human effects (examples below):
 - Have the starting point be the human activity
 - Have the end point be the ultimate consequence



college of social & Behavioral sciences Women in Science & Engineering

Allow the middle portion of the map to be student-directed:

- Building on top of soils → compacted soils → decrease in symbiotic microorganisms→ lack in plant growth/plant deformations → pollen development not fully formed → pollinators can't pollinate plants → decrease in plant production → less food supply for HUMANS
- Excess farming → multiple transportation vehicles compression soil → decrease in symbiotic microorganisms→ lack in plant growth/plant deformations → pollen development not fully formed → pollinators can't pollinate plants → decrease in plant production → less biodiversity → ecosystem collapse → climate affects/food affects/water availability
- Road vehicles multiple transportation vehicles compression soil → decrease in symbiotic microorganisms→ lack in plant growth/plant deformations → pollen development not fully formed → pollinators can't pollinate plants → decrease in plant production → less biodiversity → indirect plants affected → decrease in scarce food products that rely on certain plant development
- Any variation that is suitable/logical that they determine and must be more than 3 steps

Evaluation Activity:

• As an exit ticket, ask students to write down a 5-sentence summary on soil development by microrganisms, such as nitrogen-fixing bacteria, on plant growth and pollination.



Soil Dissection Lab

1. Is there movement in your sample? If so, what type of movement do you see? Describe the motion.

2. Where would you expect to find soil that contains bacteria? Where would you expect to find soil that lacks bacteria?

3. What physical attributes may affect soil development and bacteria presence?

4. How do soil microorganisms affect plant development?

5. How does the development of plants affect pollination and pollinators? (Think about the effects of poor plant development)



Scientist of the Week:

- Nigerian Soil Scientist
- His research interest area includes soil survey, land-use planning, environmental impact assessment of natural resources utilization
- Expert on environmental impact on soils
- Vice Chancellor of Fountain University, Osogbo

Bashiru Ademola Raji



Soil/Plant Interactions

- Microbes in soil help plants grow efficiently and correctly
- Certain traits that plants possess to attract pollinators can be deformed if the soil lacks the microbes that help with plant growth
- Nitrogen -fixing bacteria live in the soil of plants and convert Nitrogen in the air for plants to use to make the proteins that they need to grow









Did you know...

• that a spoonful of soil contains more microorganisms than there are people on earth? And that many of these microorganisms are key indicators of soil quality





Cryptobiotic Soil

- A soil crust created with algae, cyanobacteria, and fungi
- Bacteria releases a gelatinous material that binds soil together and makes it more dense
- Dense soil is less susceptible to erosion and absorbs water more efficiently in dry environments
- Impedes evaporation (important in the desert) and contains nitrogen fixing bacteria







Microcoleus desiccates

- Cyanobacteria adapted to the Sonoran Desert
- Lives in desert soils to fix nitrogen and help plants develop fully and efficiently
- Has adapted to the deserts intense UV rays and heat with a form of "sunscreen" (these bacteria produce a special goldenbrown compound called scytonemin that protects that bacteria from harmful UV rays)
- These bacteria adapted to go dormant in hot summe months (essentially they are dead), and are revived again in monsoon season when they come in contac with water
- Forms crusted plates so desert sand doesn't blow around





Soil Dissection

 Looking for bacteria in the soil under the microscope! (*Microcoleus desiccates* below)



