THE UNSEEN WORLD AROUND YOU

LESSON 4 - TEACHER'S GUIDE

EYE
Extreme Yellowstone Expedition

LESSON SUMMARY

(Estimated time: three ~30 minute sessions)

In this lesson, students will devise and test a hypothesis about microbes by collecting samples in different environments and monitoring microbial growth. Students will monitor the samples for growth and diversity, and answer questions about factors that might impact microbial populations.

Extension: Creating Microbial Mats

You can grow your own microbial mat in your classroom using this NASA lesson plan. If you do this in conjunction with these lessons, prepare the mat a few weeks in advance so it has time to grow for observation. To find the lesson plan, do an internet search for **"NASA how to grow a microbial mat"** or see the website: ***http://microbes.arc.nasa.gov/download/pdf/how%20to%20make%20a%20microbial%20mat.pdf***

LESSON OBJECTIVES

- Students will develop the concept that microbes are everywhere.
- Students will be able to identify a range of conditions where microbes can grow.
- Students will compare the metabolic rate (growth) of bacteria in different environments.
- Students will understand that changing the physical or biological state of an ecosystem will affect the metabolic rate and type of organisms that exist in the ecosystem.
- Students will develop and test a scientific question or hypothesis.
- Students will collect, organize, and record data.

NEXT GENERATION SCIENCE STANDARDS

NGSS: Matter and Energy in Organisms and Ecosystems

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- **MS-LS-1.** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
- **MS-LS1-6.** Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.
- **MS-LS2-4.** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

NGSS: Growth, Development, and Reproduction of Organisms

- **MS-LS1-5**. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

MONTANA STATE UNIVERSITY | Thermal Biology Institute

LESSON PREPARATION

This lesson can be conducted in a variety of ways depending on the availability of resources, size of the class, and the physical setup of the classroom. Students can do the lab in small groups.

You will need to order agar plates that are either pre-prepared or order supplies to make your own. If you make your own, you will need to make them at least a day in advance.

For best results, have students streak plates and then set them aside for at least three days. Students should monitor microbial growth two different times several days after collecting the samples, for example, on days four and eight.

Note: Students should use proper lab safety precautions including eye protection and gloves.

MATERIALS

- 4 – nutrient agar, 125 mL
- 20 – sterile petri plates
- 20 – sterile cotton applicator sticks
- Markers to label plates
- Scotch tape
- Masking tape
- Plastic sandwich bags
- Student worksheets **"Extreme Yellowstone Expedition – Lesson 4: The Unseen World Around You Student Activity Book"**
- If possible, have students wear rubber gloves while collecting samples

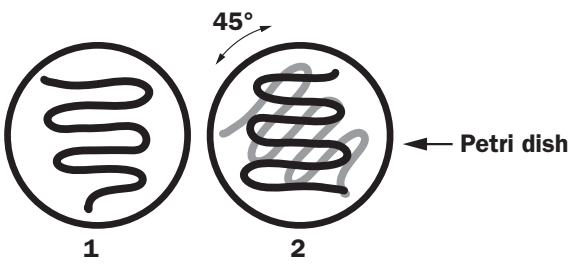
TEACHER INSTRUCTIONS FOR THE LAB

1. Obtain required materials. Either purchase premade agar plates or materials to create your own. If you need to prepare the plates, follow the instructions on the packaging and make the plates at least a day before the lesson. Preparing plates with agar can take 1.5 to 2 hours. During preparation, let plates with agar sit overnight before classroom use. Agar is generally sold as a powder and mixed in boiling water (much like JELL-O) before being added to the plates.
2. Review with students how to collect bacteria from various environments and how to streak plates.
3. Have students create a hypothesis or question to test.

   Here are some possibilities:

   - What area could you sample that you think will yield the most microbial growth?
   - What area could you sample that you think will yield the widest variety (different types) of microbial growth?
   - Will samples taken from inside and outside yield different results if incubated in total darkness and a light room? Will indoor samples put in the dark grow lots more microbes than outdoor samples? (i.e. take samples from a door knob inside and one outside, a water fountain inside and outside, etc.)
   - Where will you find the most microbial diversity, on surfaces animals come into contact with or those humans come into contact with? (i.e. take samples from a dog's water bowl and a human water bottle, or even take a sample from a dog's mouth and a student's mouth, or a dog's paw and a human's hand)
   - What works better, soap or hand sanitizer? (Take samples from hands before and after using soap and hand sanitizer to see the difference.)
   - Does using an oven impact microbes in the short term? (Take a sample from an oven before and after using it.)
   - Are there more microbes that can live at room temperature in your freezer, or in your oven or microwave?

   Teacher Note: *Each student could pick an area, and see who in the class had the best guess. (i.e. keyboards, a light switch, a stapler, the toilet, a phone, a water bottle, etc.)*
4. Plan how to divide up plates within groups based on student questions. Half of the plates should be placed in sunlight (windowsill) and the other half should be place in complete darkness (inside a box or a cabinet).
5. Distribute lab materials to students (safety equipment, prepared Petri plates, and sterile cotton applicator sticks). If possible have students wear gloves when working with the swabs and agar plates to avoid contamination of the samples. If gloves are not available, have students thoroughly wash their hands.
6. Students should collect two samples from each site (one side of the cotton applicator can be used for each sample). Swab test area for 10 seconds with a cotton swab. Make sure the petri dish is exposed to the air for the least amount of time possible to avoid airborne microbes falling onto the agar.
7. Rub swab gently across plate many times in a zigzag pattern (as shown above). Rotate the plate



45 degrees and swab again for maximum coverage. Repeat as needed to cover the entire surface area of the agar. When streaking plates, **students should streak two plates per sample site.**

8. After each plate has been streaked, it should be taped with scotch tape on each side to seal it. Flip the plate upside down so that the air and moisture are on the bottom (this helps prevent the agar from drying out and promotes bacterial growth).

Teacher Note: At no time should students break the seal of their Petri dishes.

9. Each plate should be labeled with masking tape of the sample location and name(s) of group members. Then each plate should be placed in a clear plastic sealed sandwich bag and left in the bag for the duration of the experiment.

10. Have students place one plate from each sample site in a totally dark area in the classroom (such as in a box) and place the other in a light area. Colonies grow best at constant temperature between 70° and 98.6°F, they will grow at lower temperatures but much more slowly. Consider placing the plates on a hot water heater or in a warm room/ closet. Incubators are great if you have access but otherwise get creative; try to maintain a constant warm temperature. Let plates sit for at least 72 hours before beginning to monitor growth.

11. Have students return their safety materials before moving on.

12. Distribute the student worksheets. Have students do the following:

Day 1

- Write a hypothesis about what they think will happen. Encourage students to be precise in what they write.
- Have students collect samples following the directions on the worksheets.

First Observation

(at least three days after samples were taken)

- Have students answer the questions on their worksheets as they examine their samples.

Second Observation

(at least three days after the first observation)

- Have students answer the questions on their worksheets as they examine their samples.
- Discuss the lab with your students and find out what conclusions they had and what surprised them about the results.
- Safely dispose of the plates as per instructions found in the preparation kit. Be careful not to open the plates once cultures have begun growing as you never know what they are. Some could be disease causing pathogens! If a plate does accidentally get opened be careful what you touch and be sure to wash everything that comes in contact with the opened dish with a good disinfectant.