Decomposition Lesson 3 – "Who Decomposed Our Leaves?"

Objectives:

Students will know that fungi and microbes are present on leaves and will be able to identify and quantify bacterial and fungal colonies.

Overview:

1. Students will create a microbial / fungal petri dish on the leaf that they explored in Lessons 1 and 2
2. After approximately 24 hours students will notice colonies forming on the plate. After three days, students should observe and count the colonies on the petri dish to determine the percent cover of decomposers (bacterial or fungal) and compare class data on varying species.

Time: Two 40 minute periods, a few days apart

Note: After Day 1, the leaf plates will need approximately 1 – 3 days time to grow large enough colonies to be seen with the naked eye.

Setting: Classroom

Materials:

- Student Handout
- Nutrient broth petri dishes
- Leaves
- Scissors
- Labeling tape or markers
- Forceps
- Overhead transparencies printed with graph to overlay

Engage – Day 1:

Ask students: Who did the decomposing of your leaves? How could we find out what the differences were between the tree species? Have students make some predictions, based on the data from their decomposition experiment, about which tree species will have the most abundant bacteria/fungi, or most diverse bacteria/fungi, and write a hypothesis after reading the background information.

Explore – Day 1:

Place students into their prior lab groups and provide them with leaves, a petri dish and forceps. Have students break off 3 – 4 small pieces of their assigned leaf and place gently on the petri dish using the forceps. Remind students not to breathe or touch the petri dish as it could affect the results of the experiment. Continue on to the **Explain** part of the lesson and come back during the last 5 minutes of class to have students remove the leaf pieces using forceps and place the petri dishes in a safe place.

Explain – Day 1

Put students into groups of 3 and give each a piece of poster paper. Write the following instructions on the board.

You have been learning about different parts of the carbon cycle while studying trees. Using your knowledge and last night's reading, create a drawing of the carbon cycle making sure to include the important processes involved.

Give the students approximately 15 minutes to complete this task. Walk around and give "nudges" where necessary. Have them refer back to the prior two labs and to the reading. Students often forget about respiration and may not know that decomposers respire. Hang the posters around the room and allow students 5 minutes to take a "gallery walk" and 2 minutes to go back and add anything they forgot to their group poster.

Explore – Day 2:

Have students return to their lab groups and view their petri dish. Remind them not to open the cover! Students should complete a drawing of their petri dish. Have students gently place a graph overlay (a graph printed on transparency film) on the petri dish. They should count all of the boxes that cover the whole dish and the number of boxes that are covered in bacteria vs. fungi. Students will then use that data to calculate a percent cover. Have students share out and graph the class data.

Explain – Day 2:

The big take-home messages with respect to microorganisms are these:

1. Microorganisms are everywhere and they are present in numbers so large we can't even comprehend them.
2. Bacteria and fungi are evolutionarily and morphologically different, but perform many of the same metabolic functions. They are the true decomposers—they release nutrients and carbon back into the environment from dead organic material, so that other organisms can use those compounds again (e.g. plants).

Students can usually name "bacteria" and "fungi" as examples of microorganisms. It is important to stress that there are many more "good" or harmless bacteria than there are "bad" or pathogenic ones. You may also want to highlight the major differences between bacteria and fungi. Bacteria are in their own domain of life, whereas

Note: Students typically do not recognize (1) the existence of microorganisms (both decomposers and other microscopic organisms) and (2) the role those organisms, decomposers in particular, play in ecosystems. Students tend to think of organisms such as earthworms or small invertebrates as decomposers – this lesson helps clarify that idea to include the broader suite of microorganisms. When it comes to nutrients like nitrogen, it is sufficient to think of decomposers as "messy eaters." This will help students understand how microbes affect the abiotic components of the ecosystem.

fungi are in the same domain we are—Eukarya. Thus, humans are more closely related to fungi than they are to bacteria. Bacteria are single-celled organisms, whereas most fungi are multicellular. Bacteria do not have a nucleus in their cells, but fungi do. What they do have in common is that their genetic information is contained and transferred in DNA.

The majority of true decomposition (i.e. the conversion of dead organic material back into inorganic components like CO_2 and ammonium/nitrate) is performed by bacteria and fungi. The way in which bacteria and fungi accomplish this task is different from animal metabolism—we have our digestive enzymes inside us, whereas these microorganisms excrete their enzymes into the environment. Once the enzymes are out in the environment, they act on the detritus, releasing smaller, soluble organic molecules that these microorganisms can transport into their cells, where they (like us) use those compounds for energy (through cellular respiration) and to build biomass. Cellular respiration results in CO_2 production, completing the carbon cycle and putting the C from detritus back into the atmosphere where plants can use it for photosynthesis.

In some cases, the compounds released by the enzymes don't get back to the bacteria or fungi that made the enzymes, and instead can get taken up by other organisms, like plants or photosynthetic protists. However, plants and algae (generally, there are exceptions) can't take up organic compounds from soil or water, so it is safe to say that most organic molecules are going to be processed by a bacterium or fungus sometime during decomposition.

So, why do bacteria and fungi release nitrogen into the environment instead of having evolved a more efficient feeding mechanism that will not "waste it"? Microorganisms need carbon and nitrogen in particular ratios (typically about 20:1); if the compounds they are eating differ from that ratio, they can either release excess N (because they don't have enough C to go with it; called mineralization) or compete with plants for N in the environment (because they don't have enough N to go with their C; called immobilization). Some microorganisms can use nitrogen compounds instead of oxygen for cellular respiration (called denitrification), which converts the N back into a gaseous form that goes back into the atmosphere, completing the N cycle).

This may be more complicated than you want for your students. For most students, it is probably a good step forward that they understand that bacteria and fungi are responsible for decomposition and that these processes are chemical in nature and take place outside the cell. However, like all other broad groups of organisms, there are differences in "food preference" between bacteria and fungi. Generally, bacteria prefer easier-to-degrade compounds like sugars whereas fungi are better at decomposing complex compounds like wood. You may want to push your students to extend some of their conclusions about "different organisms have different biotic and abiotic requirements" to bacteria and fungi. Students could learn that decomposer organisms, bacteria and fungi, have specific biotic (easy and difficult to digest organic matter) and abiotic requirements (different bacteria and fungi require difference amounts of dissolved oxygen).

Extend:

Students could research different types of decomposers, and create a presentation for the rest of the class.

Evaluate:

Use students' responses to the laboratory questions, graph and optional extension homework assignment to evaluate how well students understand the stated objectives.

BIBLIOGRAPHY

Internet Bio Ed Project. "The Ecotree." 16 March 2015. http://www.bcb.uwc.ac.za/ecotree/leaves/decidu.htm

Trees for Life. "Decomposition and Decay." 18 March 2015. http://treesforlife.org.uk/forest/forest-ecology/decomposition-and-decay/

"Carbon Cycle- Cellular Respiration." 11 June 2015. http://science.jrank.org/pages/1204/Carbon-Cycle-Cellular-respiration.html

NYS Standards
MST 4- Physical setting, living environment and nature of science
MST 6- Interconnectedness of mathematics, science, and technology (modeling, systems, scale, change, equilibrium, optimization)
MST 7- Problem solving using mathematics, science, and technology (working effectively, process and analyze information, presenting results)

Next Generation Science Standards:
Cross-Cutting Concepts:
2. Cause and effect: mechanism and explanation
3. Scale, proportion, and quantity

Science and Engineering Practices:
1. Asking questions
3. Planning and carrying out investigations
4. Analyzing and interpreting data
6. Constructing explanations
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Disciplinary Core Ideas:
LS2: Ecosystems: Interactions, energy, and dynamics
LS4: Biological evolution: Unity and diversity