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# K-12 Partnership Lesson Plan

# Emily Grman

# *Mycorrhizae:*

# *Mutualism or parasitism?*

## Overview

Students will explore one example of a symbiosis (mycorrhizae) and examine whether it is a mutualism or a parasitism. They will review the life requirements of producers (plants) and consumers (mycorrhizal fungi) and play a game simulating trade between the two organisms in two different environments.

**Objectives**

At the conclusion of the lesson, students will be able to:

* Define symbiosis, mutualism, parasitism, consumer, producer
* Explain how plants and mycorrhizal fungi obtain their life requirements (air, food, water)
* Understand that changes in the environment, including changes caused by humans, can change the way organisms interact

**Length of Lesson**

Two 55-minute class periods (one to do have introductory discussion, the other to play the game and discuss)

**Grade Levels**

6th grade

**Standards Covered**

Disciplinary Core Ideas:

* **MS-LS2-1**: analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations or organisms in an ecosystem
* **MS-LS2-4**: construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations
* **MS-LS2-2**: construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems

Cross Cutting Concepts:

* Patterns
* Systems and system models

Science and Engineering Practices

* Developing and using models
* Analyzing and interpreting data
* Engaging in an argument from evidence
* Stability and change of systems

***Previous Michigan Standards Met:***

* **S.IP.06.16**: identify patterns in data
* **S.IA.06.11**: analyze information from data tables and graphs to answer scientific questions
* **S.RS.06.15**: demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities
* **S.RS.06.17**: describe the effect humans and other organisms have on the balance of the natural world
* **L.OL.06.51**: classify organisms (producers, consumers, and decomposers) based on their source of energy for growth and development
* **L.EC.06.21**: describe common patterns of relationships between and among populations (competition, parasitism, symbiosis, predator/prey)
* **L.EC.06.22**: explain how two populations of organisms can be mutually beneficial and how that can lead to interdependency
* **L.EC.06.32**: identify the factors in an ecosystem that influence changes in population size

**Materials**

* Student worksheet and answer key (found on “Mycorrhizae: mutualism or parasitism” lesson page on GK-12 website)
* Squares of black, green, and yellow constructions paper
* Paper clips
* Overhead of student worksheet

**Background**

Mycorrhizae (“my-co-rye-zee” like “rye” bread) are associations between land plants and a specific group of soil fungi (called mycorrhizal fungi). The vast majority of land plants (including trees, grasses, flowers, and crop plants such as corn, soybean, wheat, and others) depend on mycorrhizae for taking up soil nutrients. The mycorrhizal (rhymes with “gal”) symbiosis is very old—fossils show that the very first land plants had mycorrhizae.

Mycorrhizae are probably most useful for plants because fungi are very good at taking up soil nutrients. Fungal hyphae (root-like structures) are smaller than roots, so they can get inside tiny pockets of soil to access nutrients hidden there. Fungi may also have chemical means of increasing the availability of soil nutrients, perhaps by decomposing organic material. However, this specific group of fungi can ***only*** obtain carbon (sugars) from plants—they cannot make a living as decomposers. They are therefore “obligate” symbionts—they are obligated to participate in the symbiosis.

Plants, on the other hand, are not obligate symbionts. Sometimes, they do just fine living alone, without mycorrhizal fungi. In nutrient poor environments, plants can gain huge benefits from the mycorrhizal symbiosis. In these environments, it is a good idea to give away lots of sugar (carbon) to fungi in exchange for scarce nutrients. They grow much larger and have much greater concentrations of nutrients (especially nitrogen and phosphorus) in their tissue. However, if nutrients are abundant (as in a fertilized agricultural field, for example), plant roots can take up enough nutrients to satisfy the plant’s requirements. In this case, giving away large amounts of sugars to fungi doesn’t help the plant grow larger. There are documented examples of mycorrhizal fungi acting like parasites in nutrient-rich environments. My dissertation research is exploring whether the mycorrhizal symbiosis is a mutualism or parasitism, and why.

### Activities of the Session

1. Begin filling out the student worksheet, asking for students to volunteer guesses about the answers to the questions. Example answers are provided in the answer key.
2. Go through the rules of the game, as described on the student worksheet.
3. Make sure the students understand what the cards represent, and which organisms can take up which cards. Review the differences between producers (can take up CO2 to photosynthesize and make food) and consumers (can’t use CO2 to make food).
4. Demonstrate the goal, to make units of biomass by combining carbon and nutrient cards with a paper clip. The ratio of carbon to nutrient required to make a unit depends on whether organisms are participating in the symbiosis or not.
   1. Plants alone: 1 carbon, 1 nutrient makes 1 unit of biomass
   2. Fungi alone: 1 carbon, 1 nutrient makes 1 unit of biomass
   3. Plants + fungi: 2 carbon, 1 nutrient makes 1 unit of biomass
5. To play the game, have the students count off by 3s. Number 1 will be a plant who gets a fungus partner (number 1 gets to choose a number 2 who will be their fungus partner). Number 3 is plant working alone.
6. Pass out carbon and nutrient cards to the groups, according to the table below. All groups get 6 yellow cards (carbon dioxide); the number of green or black cards (soil nutrients) depends on the environment. Half the groups should be high nutrients and half should be low nutrients.

|  |  |  |
| --- | --- | --- |
|  | High nutrient environment | Low nutrient environment |
| Plant alone | 6 yellow, 6 brown, 6 black | 6 yellow, 2 brown, 2 black |
| Fungus alone | 6 yellow, 6 brown, 6 black | 6 yellow, 2 brown, 2 black |
| Plant + fungus | 6 yellow, 6 brown, 6 black | 6 yellow, 2 brown, 2 black |

1. Play the game, asking students to record their data on their worksheets
2. If time allows, you can play the game again, reassigning students to new groups.
3. Discuss your results: is the symbiosis between plants and mycorrhizal fungi a mutualism or a parasitism? Review definitions of the terms and answer the last questions on the student worksheet.

**Assessment**

Assessment questions included on student worksheet (found on “Mycorrhizae: mutualism or parasitism” lesson page on GK-12 website)