

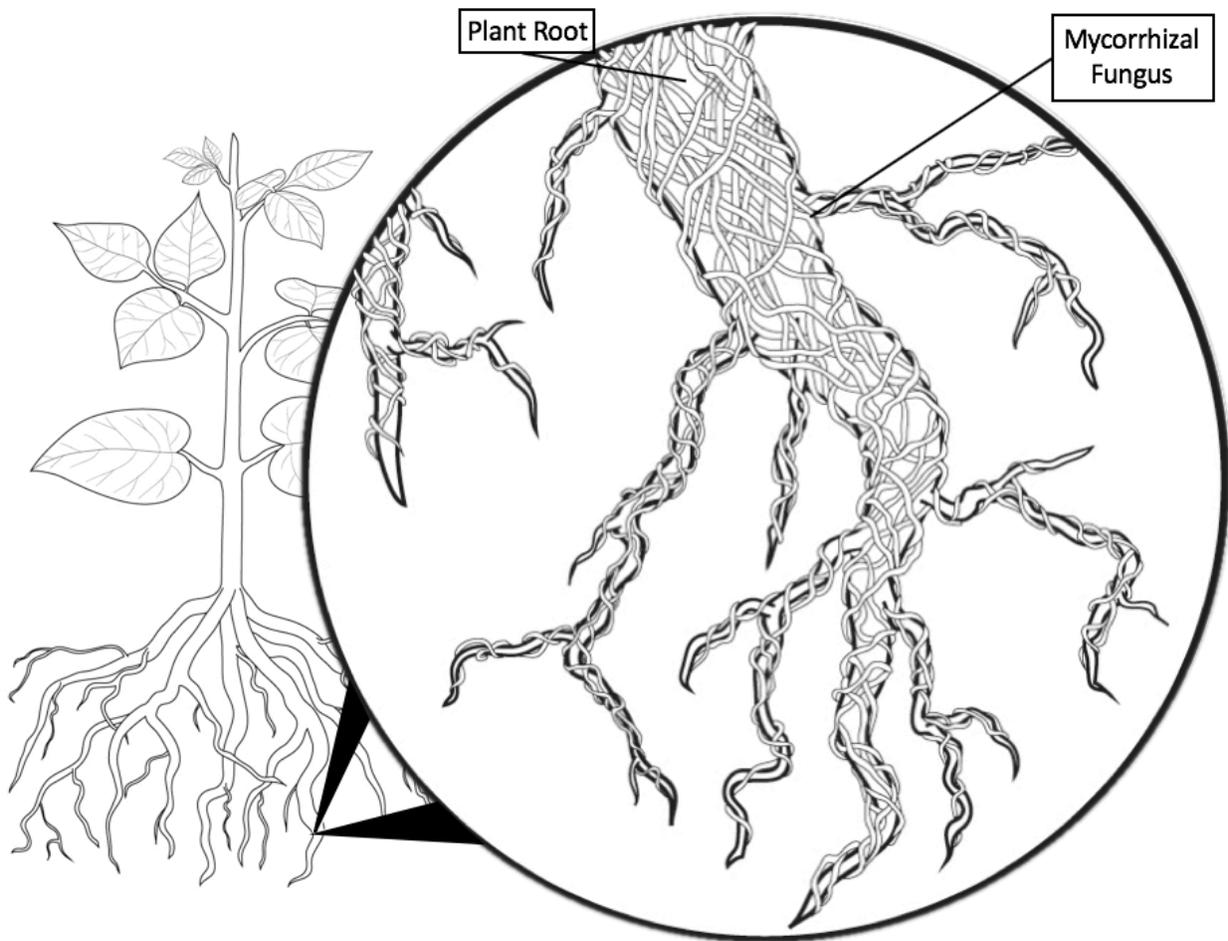
6.2: Grading the Mycorrhizal Fungi Worksheet

*This worksheet has “grading” in the title because at this point, students can be held accountable for correct answers. Level 4 (correct) responses to the questions are in **blue bold italics** below.*

Red italics suggest ways to grade student responses by giving them points for correct or partially correct answers. There are 26 points total on this worksheet.

A. Draw and label arrows that represent the molecules that carbon atoms are in as they move into, through and out of the mycorrhizal fungus as it grows.

Label each arrow to show the kind of molecules that the carbon atoms are in: large organic molecules (LOM), sugar, or carbon dioxide (CO₂).



Arrows should show:

- ***Sugar moving from roots into the hyphae of the mycorrhizal fungus***
- ***Sugar moving throughout the hyphae***
- ***(Optional: LOM in hyphae)***
- ***CO₂ leaving hyphae***

1 point for each correct answer (3 points total)

1. Mycorrhizal fungi use sugar from plant roots to live and grow. Where did the sugar come from, and how did it get to the plant roots?

The sugar was made in the leaves of the plant (through the process of photosynthesis). It moved from the leaves to the roots (through the phloem).

1 point for sugar made in leaves; 1 point for moving from leaves to roots (2 points total)

2. How do the cells of mycorrhizal fungi get oxygen when they grow and function? What do the cells do with the oxygen?

Mycorrhizal fungus cells get oxygen from air pockets in the soil and sugar from the plant roots. Mycorrhizal fungus cells use the oxygen as one of the reactants as they perform cellular respiration. (Some of those oxygen atoms end up in water molecules that stay in the Mycorrhizal Fungi, so a tiny percentage of oxygen atoms in the Mycorrhizal Fungi do come from air.)

1 point each for getting oxygen from air and using oxygen for cellular respiration (2 points total)

B. Investigating how fungi grow and function

A class is investigating soil and decomposers in forests. They have a pot of soil from the forest. It has no living plants or animals, but it does have bits of dead leaves and roots, as well as fungi and bacteria. Enough water is added so the soil continues to have the same amount of water. The teacher asks, "What do you think the mass of the soil will be after two weeks?"

3. Three students shared their ideas about what happened. Choose whether you agree, disagree, or are not sure about each claim.

Agree	Disagree	Not sure	Jasmine claims: "I think the whole pot of soil will lose mass because the fungi take in molecules from the dead leaves and roots and convert them into CO ₂ that is released into the air."
Agree	Disagree	Not sure	Monica claims: "I think the whole pot of soil will get heavier because the fungi get bigger as they grow. Nothing leaves the pot of soil."
Agree	Disagree	Not sure	Matt claims: "I think the whole pot will have the same mass because the molecules from the dead leaves and roots will be converted into fungus that stays in the pot."

1 point for correctly answering each line (3 points total)

4. Provide an explanation. Why did you agree or disagree with each student's claim? What are you not sure about?

Level 4 explanations will consider the two things that can happen to the dead leaves as a food source for the fungus (small organic molecules from digested food used either for cellular respiration and energy or for biosynthesis and growth) and use this knowledge to evaluate the students' claims:

- Jasmine's claim correctly recognizes CO₂ as a product of cellular respiration, so mass should be leaving the pot.*
- Monica's claim is incorrect because it violates the principle of conservation of matter: The pot cannot gain mass unless new materials enter the pot.*
- Matt's claim correctly recognizes that matter is conserved but does not consider the possibility that gases are leaving the system.*

1 point for providing a correct explanation for agreement or disagreement with each of the 3 claims (3 points total)

The class does an experiment. They weighed 5 pots filled with soil that contained bits of dead leaves and roots, as well as fungi and bacteria. They put the pots in a warm, moist room and left them alone for two weeks. At the end of that time, they reweighed the pots with their contents. Below are their results.

Sample	Initial mass of the pot with soil including dead plant matter, fungi, and bacteria (g)	Mass of pot with soil including dead plant matter, fungi, and bacteria after two weeks (g)
1	305	301
2	332	320
3	323	318
4	310	309
5	307	299
Average	315	309

5. What patterns do you see in the data?

Level 4 responses will focus on mass differences: On average, the whole pot lost mass over the two weeks, so some of the matter must have gone somewhere else.

1 point for identifying that there was an average overall decrease in mass in the system

6. Which claim do you think is best supported by the data? (Circle one choice.)

Jasmine's claim

Monica's claim

Matt's claim

1 point for correct answer

7. Explain how the patterns in the data support the claim that you chose.

Level 4 responses will recognize that the data support only Jasmine's claim.

1 point for choosing Jasmine's claim due to mass differences

8. What additional evidence would you collect to help show that the claim you chose is the best claim?

Responses at all levels may include generic suggestions about gathering more or more precise data: measure additional systems (pots with dead plant matter and fungus), measure the masses more accurately, measure the masses every day, etc. While these are legitimate ways of collecting additional data, they need to be accompanied by suggestions that identify specific problems with this investigation.

Level 4 responses may focus on the biggest single problem with this investigation: The failure of the procedure to account for water. What part of the "missing mass" might be water that evaporated? Other possibilities:

- They may also mention other variables not accounted for, such as oxygen from the atmosphere or measuring CO₂ as a product.*

1 point for identifying additional evidence that could be collected.

C. A question about how mycorrhizal fungi grow and functions

A mycorrhizal fungus needs energy to live and grow. Where does the mycorrhizal fungus get its energy?

9. Select True or False for the following statements.

Some of the energy in the mycorrhizal fungus:

T **F** comes from the air.

T F comes from sugar in the plant roots.

T **F** comes from water in the soil.

T **F** comes from soil organic matter.

T **F** comes from soil minerals

T **F** is created by the mycorrhizal fungi.

1 point for correctly answering each line (6 points total)

10. Which ONE of the following do you think provides the MOST energy to the mycorrhizal fungi?

a. Energy stored in the air

b. Energy stored in sugar in the plant roots

c. Energy stored in water in the soil

d. Energy stored in soil organic matter

e. Energy stored in soil minerals

f. Energy that the mycorrhizal fungus created

1 point for correct answer.

11. Explain your choices. Where does the energy in the mycorrhizal fungi come from?

Level 4 responses recognize that mycorrhizal fungi are heterotrophic organisms and get their energy from sugar that comes from plant roots and is used for cellular respiration.

1 point for identifying high energy bonds in organic molecules as the source of energy

C. Something interesting about mycorrhizal fungi

12. What is something interesting that you learned about mycorrhizal fungi from your reading and discussion?

1 point for correct fact from the reading or discussion