Name _____ Teacher _____ Date _____

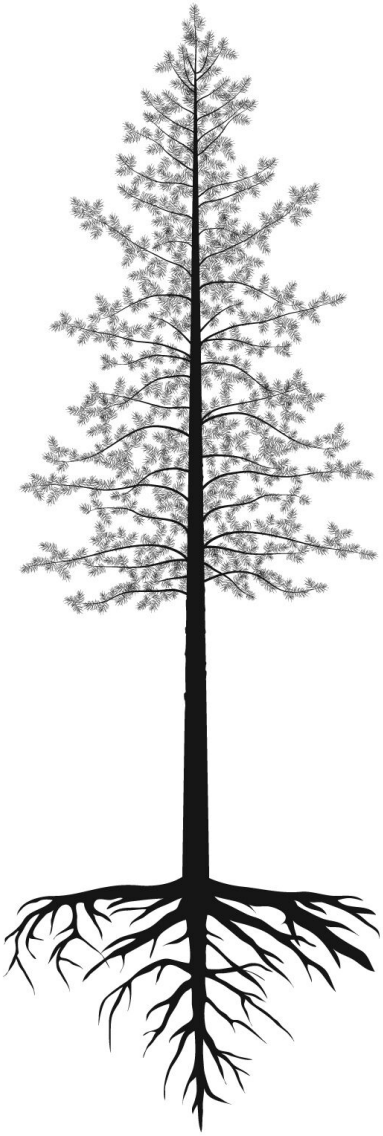
Activity 6.1: Grading Lodgepole Pine Worksheet

*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 20 points total on this worksheet.

Draw and label arrows that represent the molecules that carbon atoms are in as they move into, through and out of the Lodgepole Pine as it moves and grows.

Label each arrow to show the kind of molecules that the carbon atoms are in: large organic molecules (LOM), small organic molecules (SOM), or carbon dioxide (CO_2).



Your ideas about a Lodgepole Pine's needs. Four things that Lodgepole Pines need to live and grow are water, soil nutrients, air, and sunlight. What are your ideas about what happens to those four things *inside* a Lodgepole Pine?

What happens to *water* inside a Lodgepole Pine?

Level 4 responses could mention two main functions that water has inside the pine: 1) Water is a key reactant in the process of photosynthesis. The H atoms in glucose (and all other molecules in plants) come from water. 2) Water carries materials to plant cells; soil minerals move through the roots to all the cells of the plants dissolved in water; sugars move from leaf cells to all the cells of the plants dissolved in water.

What happens to *soil nutrients* inside a Lodgepole Pine?

Level 4 responses could mention that soil nutrients are non-organic minerals, that soil minerals dissolved in water move through the roots to all cells of the plants or that cells combine the atoms in soil minerals (N, K, P, S, etc.) with glucose molecules to make proteins and other large organic molecules.

What happens to *air* inside a Lodgepole Pine?

Level 4 responses could describe two main functions that air has inside plants: 1) Carbon dioxide is a key reactant in the process of photosynthesis. The C and O atoms in glucose come from CO_2. 2) Oxygen is a key reactant in cellular respiration. All plant cells get their energy from the energy that is released when oxygen reacts with glucose and other organic molecules.

What happens to sunlight *light* inside a Lodgepole Pine?

Level 4 responses will identify light as the ONLY source of energy for plants and describe how the energy in light is converted to chemical energy through the process of photosynthesis.

1 point for each correct answer. 4 points total.

A. Investigating how Lodgepole Pines grow and function

A class is investigating how Lodgepole Pines grow. The teacher asks the students, "Where does most of the mass of a Lodgepole Pine come from?"

a. Three students shared their ideas about what happened. Do you agree or disagree with what each student claims?

Agree	***Disagree***[1]	Trevor: "I think a growing Lodgepole Pine gains most of its mass from nutrients in the soil."
Agree	Disagree	Jasmine: "I think a Lodgepole Pine gains most of its mass from gases in the air."
Agree	***Disagree***	Jin: "I think a Lodgepole Pine gains most of its mass from the sunlight."

1 point for each correct answer. 3 points total

[1] *On the basis of their studies in the Plants unit, students should know that soil minerals provide only a small part of a plant's mass. But Trevor's hypothesis is reasonable, so you may want to give students credit if they agree.*

b. Provide an explanation. Why did you agree or disagree with each student's claim that you did?

Level 4 responses disagrees with Jin because matter cannot be converted into energy; agrees/not sure with Jasmine that air/gases can provide mass to plants; agrees or disagrees with Trevor because soil nutrients and/or water provide mass to plants. *Level 3 responses says: i) sunlight is a source of matter for plants (agrees with Jin) AND/OR ii) disagrees with Jasmine's claim that air could account for the tree's increased mass. Level 2 responses only reason about 1 or 2 of the claims. Level 1 responses reason about the claims in a force-dynamic way; e.g., i) the plant needs light, soil, water to grow, ii) air/gas cannot provide mass to the plant.*

c. The class does an experiment to investigate how Lodgepole Pines grow. They started by selecting six **identical** pines. Three of those pines were grown in regular soil. The other three plants had extra soil nutrients added to the soil in the pots. They put all six pines under **identical** conditions (i.e., the same light conditions, the same watering conditions) and let them continue growing for one month. At the end of the month, the class weighed each of the six Lodgepole Pines and recorded their weights in the table below. They also recorded the weight of the soil nutrients added to three of the pots.

Lodgepole Pines with regular soil		
Plant	Mass of nutrients added (grams)	Mass gained by plant (grams)
1	0	86
2	0	85
3	0	84
Average	**0**	**85**

Lodgepole Pines with regular soil plus soil nutrients		
Plant	Mass of nutrients added (grams)	Mass gained by plant (grams)
4	3	138
5	3	131
6	3	137
Average	**3**	**135**

Whose idea do you think is best supported by the data? (Circle one choice.)

a. Trevor's
b. Jasmine's
c. Jin's

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

Level 4 responses recognize there is an unaccounted for matter pool between the amount of soil nutrients added and their increase in growth; uses this mass discrepancy to explain why Jasmine's claim is correct. *Level 3 responses identifies all matter pools, or recognizes missing pools, but agrees with Jin's claim that violates principles (Matter to Energy conversion), agrees with Trevor's claim which is inconsistent with the data, or agrees with Jasmine's claim but has flaws in his/her reasoining. Level 2 responses choose Trevor's because the mass of the plant growth with added soil nutrients is greater than the increase in mass of the plant growth without soil nutrients. Level 1 responses explain that the more soil nutrients, the more it grew, recognizes relationships among some matter pools but doesn't relate them to the claims (may provide an explanation about food use for rationale), and /or uses the presence of a matter pool (i.e., added soil nutrients) to justify a claim.*

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

Level 3 responses propose questions that target limitations in the data (recognize there is an unaccounted for matter pool, i.e., gas); they focus on matter tracing and are constrained by principles such as matter to energy conversion. *Level 2 responses propose evidence that partially address limitations in the data. Level 1 responses identify aspects of the system that students are curious about independent of the data, they critique the experimental design, or do not recognize that additional evidence needs to be collected.*

1 point for each correct response. 3 points total

B. A question about how Lodgepole Pines grow and function

The dry wood from a large Lodgepole Pine can weigh 2000 pounds. Where do you think the dry wood of a Lodgepole Pine comes from? Select True or False for the following statements:

T ***F*** Some of the dry wood is *created by the tree.*

T F Some of the dry wood *comes from the air.*

T ***F*** Some of the dry wood *comes from sunlight.*

T F Some of the dry wood *comes from water.*

T F Some of the dry wood *comes from soil nutrients.*

1 point for each correct response. 5 points total.

Which ONE of the following do you think provides the MOST mass to the dry wood of the Lodgepole Pine?

a. Wood created by the tree

b. Air

c. Sunlight

d. Water

e. Soil nutrients

1 point for correct response

Explain your choices. Where do you think the dry wood of a Lodgepole Pine comes from?

Level 4 responses recognize that leaves/needles transform CO_2/air into glucose (through photosynthesis), which is used as a building block for the tree's growth. Level 4 responses recognize that roots take in nutrients (like nitrogen) and/or water from the soil, which provides a small amount of mass to the tree. *Level 3 responses may describe the reactants or products of photosynthesis (e.g., CO_2, glucose, water) without explaining that these directly contribute to the tree's mass. They may also suggest photosynthesis generates energy for tree growth. Level 3 responses explain roots take in nutrients and water. Level 2 responses may suggest that the more leaves/needles the tree has, the more mass it has, or explain that the leaves/needles make food for the tree. Level 2 responses may suggest that the more roots the tree has, the more mass it has.*

1 point for correct response

How do you think MOST of the matter got into the Lodgepole Pine? Select ONE of the following:

a. Most of the matter came in through the tree's roots.

b. Most of the matter came in through the tree's leaves/needles[2]

c. The growing tree made most of the matter when its cells divided to make new cells.

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[2] *A growing Lodgepole pine is about 50% water, so most of the dry mass entered through the leaves, while the water entered through the roots.*

1 point for correct response

Explain your choice. Why did you choose the answer you did about how most of the matter got in the Lodgepole Pine?

Level 4 responses recognize that leaves/needles transform CO_2/air into glucose (through photosynthesis) and recognize that roots only provides a small amount of mass to the tree. Also recognizes that matter cannot be created by cell division. *Level 3 responses may suggest photosynthesis generates energy for tree growth but may also explain roots take in nutrients and water. Level 2 responses may suggest that the more leaves or needles the tree has, the more mass it has or suggests that the more roots the tree has, the more mass it has.*

1 point for correct response

C. Something interesting about Lodgepole Pine

What is something interesting that you learned about the Lodgepole Pine that makes this plant different from the radish plants you grew?

1 point for appropriate response