3.1 - Plants Unit, Packet 1

Score
□ Above & Beyond
□ Meets Expectations
□ Near Expectations
□ Incomplete – *fix the following pages:*

First & Last Name: _____ Period/Hour:_____

NOTE: Packets are due after completing Part 5. Check each page to be sure all blanks are completed.

Driving Question: How are plant cells different from animal cells?

Anchoring Phenomenon: We know all living things are made from cells. In this unit, we will focus on how plant cells function, and how this compares to animal cells. In particular, we will focus on the largest tree in the world, the General Sherman sequoia. How did it grow from a tiny seed into a tree weighing millions of kilograms?

Deeper Questions

1. What organelles are found only in plant cells?
2. How does a plant cell acquire the chemical energy it needs to function?
3. How do plants function without organs found in many animals (like a skeleton, a heart, or a kidney)?

Schedule

Part 0: Planting Seeds
Part 1: Introduction
- Initial Ideas & Data Dive
- Discussion & Developing Explanations

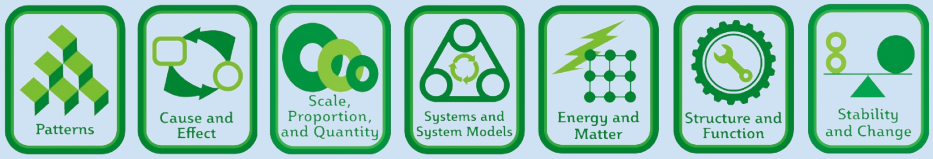
Part 2: Core Ideas
- Core Ideas
- Revisions of Part 1 Explanations

Part 3: Investigation
- Part A: Bright/Dark Investigation Set-up
- Part B: Seedling Mass
- Part C: Bright/Dark Investigation Data Collection

Part 4: Review & Assessment
- Ranking Your Readiness, Formative Assessment & Mastery Check

Part 5: Life Connections
- Life Connections - Plant Cell Microscopy

NGSS Standards (*PEs* & *CCCs are summarized below. SEPs are noted throughout the packet*).
HS-LS1-2. Organization of interacting systems in multicellular organisms. HS-LS1-6. How carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules. HS-LS1-5. How photosynthesis transforms light energy into stored chemical energy. HS-LS1-7. Cellular respiration is a chemical process whereby food molecules and oxygen molecules form new compounds resulting in a net transfer of energy.



Semester Schedule

1. Matter & Energy
1.1: What happens when something burns?
1.2: How does burning change matter & energy?
1.3: Unit Assessment

2. Animals
2.1: How do animal cells use food?
2.2: What happens to food when it is consumed?
2.3: How do cells acquire atoms from food?
2.4: Unit Assessment

3. Plants
3.1: How do plant cells differ from animal cells?
3.2: How do plant cells obtain matter and energy?
3.3: How can we investigate plant growth and function?
3.4: Unit Assessment

4. Ecosystems
4.1: Why do different places have different amounts of species?
4.2: How does human activity affect species?
4.3: Unit Assessment

Resource Links: Class Website; Core Ideas; Summary Video; Practice Test; Part 1 Video 1 - Video 2 - Video 3; Xylem Video; Part 3A,C Data; Part 3B Data; Poster - Comparing CR & PS;

Part 0: Planting Seeds (3.1.0)

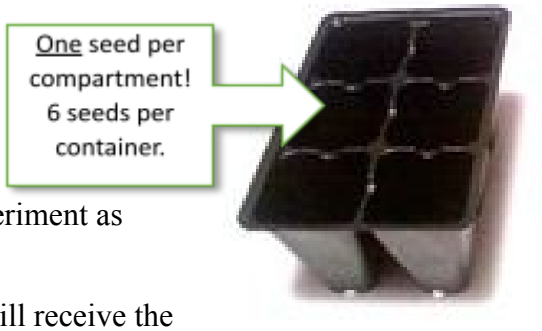
Overview: In this activity, you will plant radish seeds under two different conditions. You will use these plants for investigations that you will be conducting in Packet 3.

Materials: radish seeds; planting containers; potting soil; markers & tape or sticks for labeling.

Investigation Directions:

1. □ You will plant two containers of radishes. One container will be altered to enhance radish growth; the class will decide on the treatment. The other container will remain untreated and serve as a control for comparison.
2. □ Acquire two planting containers (with six-compartments) like the one shown here →
    a. If your experimental methods call for something else, acquire the specific kind of planting tray that you'll need.
2. □ Add soil to the containers so that it is level with the top of the tray. Lightly pat the soil. *Image Source*

3. □ Make a pinky-fingernail-sized depression in each compartment of the planting containers.
    a. Each of the six compartments of the containers should have only one depression.
4. □ Add ONE radish seed to each fingernail-sized depression. Each compartment should have only ONE seed.
5. □ Fill in the soil on top of the seed. Pat lightly with your hand.
6. □ In a location with drainage, lightly water the soil so that it is moist (not soaking wet).
7. □ Label your radish trays with your…
    a. Class Period & Teacher
    b. Group Names
    c. *Treated* or *Control* labels



8. □ Move your radishes to the appropriate location for your experiment as indicated by your instructor.
9. □ Repeat these instructions for the container of radishes that will receive the treatment you decided as a class.
10. □ Give your radishes 3-4 weeks to grow before recording your data. Determine your plan as a class to care for your plants.

Part 1: Introduction – The General Sherman (3.1.1)

Overview: In this activity, you will begin by discussing your initial ideas about how plant cells acquire matter and energy. You will then analyze data and work in teams to develop your initial explanations.

Initial Ideas - *Record your ideas separately (e.g., on a white board or scratch paper).*
SEP: Engaging in Argument from Evidence

1. A group of students are asked to explain how plants acquire their mass. Read the following responses from students. **Do you agree or disagree with each student's claim**?
    a. Avery: "I think a growing plant gets most of its mass from nutrients in the soil." Agree/ Disagree
    b. Bristol: "I think a plant gains most of its mass from gasses in the air." Agree / Disagree
    c. Chandra: "I think a plant gains most of its mass from the sunlight." Agree / Disagree
2. **Work in your small groups to discuss your ideas.** How are your ideas similar or different? Decide as a group whether each statement is correct (and why). Be prepared to present your ideas to the class.

Data Dive 1 - *Read the directions below.* *SEP: Analyzing & Interpreting Data*

Videos: Next, watch the following videos individually or as a class (based on your teacher's instructions):
Video 1 – Comparing heights of trees: https://www.youtube.com/watch?v=JyjHtxAOhP4
Video 2 – The General Sherman: https://www.youtube.com/watch?v=S9LIFRwE8Jo
Video 3 – National Geographic: Photographing Sequoias: www.youtube.com/watch?v=vNCH6uhB_Bs

Data Dive 1: Here you can see data comparing the mass of the General Sherman to a sequoia seed. How did this tree get so big? Where did the atoms in this tree come from?

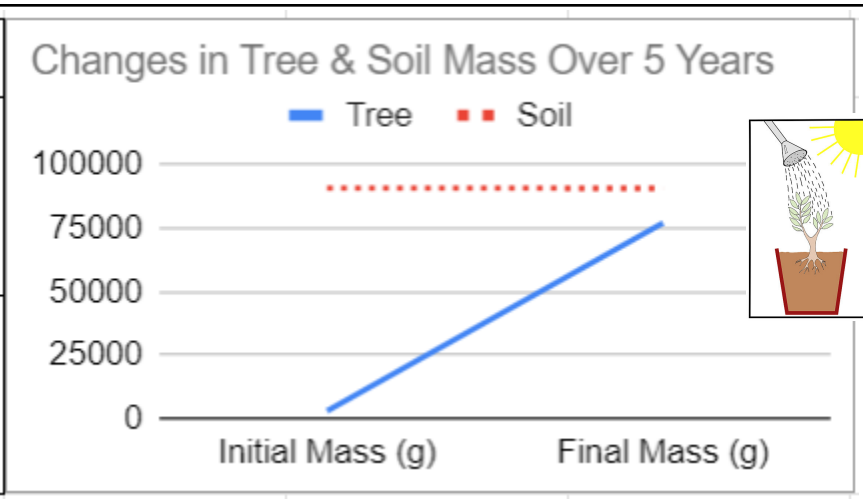
General Sherman (Sequoia Tree)
Live Weight: 5.6 million kg (12.4 million lbs.).
Dry weight: 3.1 million kg (6.8 million lbs.).

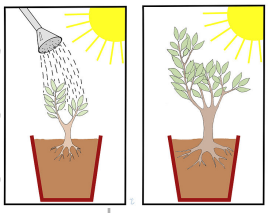
Sequoia Seed
Weight: 0.005 g.

Data Dive 2 - *Read the directions below.* *SEP: Analyzing & Interpreting Data* *(Image Source)*

Data Dive 2: Jean Baptista van Helmont (1577-1644) planted a tree in a large container and recorded the initial mass of the tree and soil. After five years, he recorded the final mass of each item. His data is shown below.

	Tree	Soil
Initial Mass (g)	3000	90700
Final Mass (g)	77000	90643





Data Dive Questions - *Record your ideas separately (e.g., on a white board or scratch paper).*

1. **Begin by individually attempting to make sense of this data**. What trends or patterns do you notice? How does this relate to any prior knowledge or experience that you have?
2. **Next, work in your teams to discuss your ideas**. Where do you agree? Where do you disagree? Can you use this data to reach an agreement? Do others have prior knowledge/experience that could help?
3. **Based on this data, what is one conclusion that would be supported by this data?** How is this conclusion supported by this data? What specifically suggests that your claim is accurate?
4. **Based on this data, what is a second conclusion that would be supported by this data?** How is this conclusion supported by this data? What specifically suggests that your claim is accurate?
5. **Does this data support or refute any of the initial claims on the previous page?** If so, explain.

Discussion - *Record your ideas in the spaces below.* *SEP: Asking Questions & Defining Problems*

As a class, discuss your ideas about this data. What are the ideas that most agreed on? Where did your ideas differ as a class? Record your ideas in the spaces below.

We generally agree that…	***We disagreed or were unsure if…***

Continued on Next Page

Initial Explanations - *Record your ideas in the spaces below.* *SEP: Constructing Explanations & Designing Solutions*

How did the General Sherman get so big? Where does the most of the mass (atoms) of a plant come from? Write down an initial explanation in the space below. Don't worry if you aren't completely sure about this. You will come back and revise this explanation as you gain more information during this unit.

Part 2: Core Ideas (3.1.2)

Overview: In this activity, you will use a short presentation to provide you with information that will help you improve and revise your initial ideas. Your instructor will decide on how to implement this portion. You will then work in small teams to address the questions listed below.

Driving Questions - *Record your ideas separately (e.g., on a white board or scratch paper).*
SEP: Developing & Using Models

1. True/false: animal & plant cells function similarly and are made from the same macromolecules. Explain.
2. Do plant cells have mitochondria? What process occurs here? Why is this needed?
3. What are three organelles found in plant cells that are not found in animal cells?
4. What is a cell wall? What is cellulose? How do these affect plant function & plant cells?
5. What is a vacuole? What is its purpose and function in a plant cell?
6. What is a chloroplast? What process occurs here? Why is this needed for cell function?
7. Most of the glucose produced during photosynthesis is used for what purposes?
8. True or false: like animal cells, plant cells are organized into tissues, organs, and systems.
9. What is xylem? What's its purpose/function?
10. What is phloem? What's its purpose/function?
11. How do plants transport molecules like glucose and water without a heart to circulate fluids? Include: *xylem, phloem, evaporation.*
12. Plant cells in roots and stems lack access to light; how do they obtain glucose needed for cell respiration and other functions?

Revising Explanations - *Record your ideas in the spaces below.* *SEP: Constructing Explanations & Developing Solutions*

Where does most of the mass (atoms) of a plant come from? Based on this new information, how would you now respond to this question?

Part 3A Investigation: Bright/Dark Set-up (3.1.3a)

Adapted from materials by Carbon TIME

Overview: In this experiment, you'll investigate how BTB changes when plants are exposed to light or darkness. Some plants will be in well-lit areas, while others will be in the dark, all within sealed containers containing blue and yellow BTB.

Materials: radish seeds; aluminum pans; BTB; disposable cups; resealable bags; markers & tape.

Directions - *Carefully read the directions below before beginning. Record info where prompted.*
SEP: Planning & Conducting an Investigation

1. □ **Hypothesize how levels of CO_2 will change for each treatment.**

   I think that CO_2 levels in bags with plants in a bright location will: *increase / decrease / not change*

   I think that CO_2 levels in bags with plants in a dark location will: *increase / decrease / not change*

2. □ **Explain your prediction for the plants in bright conditions.** Why do you expect these outcomes? What evidence or reasoning supports your ideas?

   _____

   _____

3. □ **Explain your prediction for the plants in dark conditions.** Why do you expect these outcomes? What evidence or reasoning supports your ideas?

   _____

   _____

1. □ **Acquire a large resealable bag. Label the bag** with your A) class period, B) group number, C) last names, and D) today's date.
2. □ **Acquire a foil tray with radish seedlings**. Make sure the soil is moist.
3. □ **Place the tray of radish seedlings into a large resealable bag.**
4. □ **Label a cup with a "Y". Pour yellow BTB into this cup. Place this cup inside the bag.**
5. □ **Label a cup with a "B". Pour blue BTB into this cup. Place this cup inside the bag.**
6. □ **Tightly seal the bag.** Make sure some air remains inside the bag so that the seedlings are not crushed.
7. □ **Carefully move your bag of seedlings and BTB to the location chosen by your instructor.** Half of the bags will be placed in dark conditions; the other half will be placed in conditions with lots of light.
8. □ **Keep your plants inside the sealed bags for at least 24-48 hours.** Complete Part 3C after this time.

Part 3B Investigation: Seedling Mass (3.1.3b)

Adapted from materials by Carbon TIME

Pre-Investigation Questions - *Prepare verbal responses as a group for these questions. Raise your hand when you're ready to present your explanations. Your instructor will provide feedback and decide if you can proceed to the investigation.* *SEP: Developing & Using Models*

1. What process occurs in plant cell mitochondria? How does this relate to the functions of a plant cell?
2. What process occurs in chloroplasts? How does this affect the function of plants and plant cells?
3. How does a plant cell use the glucose it produces in its chloroplasts? Describe two purposes.
4. How do plants move molecules like glucose and water if they lack a heart to pump fluids? Include the following terms in your response: xylem; evaporation, leaf pores; phloem; gravity

This activity was completed _____ (*instructor signature*)

Overview: In this activity, you will compare the mass of radish seeds to the mass of seedlings that have sprouted. You will then develop evidence-based arguments to explain your findings.

Materials: radish seeds; resealable bags; digital balance; paper towel.

Background: 1-2 weeks ago, your instructor placed moist paper towels and 12 radish seeds in a sealed plastic bag, ensuring they stayed moist and received light. Most seeds should have started to germinate and grow.

Directions - *Carefully read the directions below before beginning. Record info where prompted.*
SEP: Planning & Conducting an Investigation

1. □ First, acquire 12 radish seedlings and 12 radish seeds from your instructor.
2. □ Place a cup (or other container) on a digital balance. Zero out the balance (press T, or "tare").
3. □ Place 12 seeds in the container and record the mass (in grams) in the space below.
4. □ Place a new cup on the balance and press tare. Place 12 seedlings in the container. Record the mass.

   Total Seed Mass: _____ g **Total Seedling Mass**: _____ g

5. □ Next, calculate the average mass of the seeds and seedlings by dividing the total mass by the number of individual seeds or seedlings.

   Average Seed Mass: _____ g (*Total Seed Mass* ÷ 12)

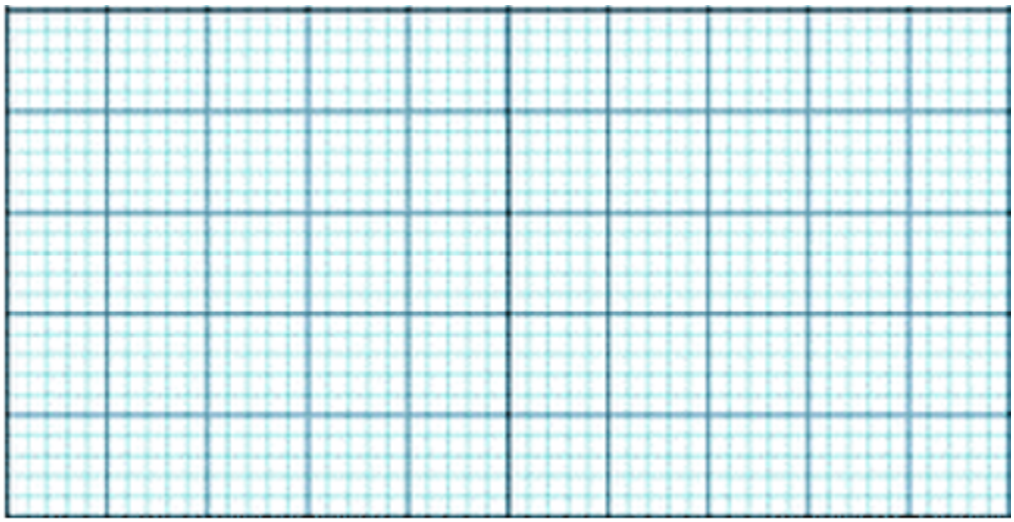
   Average Seedling Mass: _____ g (*Total Seedling Mass* ÷ 12)

6. □ Find the dry mass of the radish seedlings, which is the mass of radishes without water. This indicates the non-water mass gained by the radish. Calculate the average dry mass by multiplying the average seedling mass by 0.09, as dry mass typically represents 9% of the total mass.

   Average Seedling Dry Mass: _____ g (*Average Seedling Mass* x 0.09)

Post-Investigation Questions - *Record your ideas in the spaces below.*
SEP: Engaging in an Argument from Evidence. Constructing Explanations & Designing Solutions.

Create a bar graph for average seed mass & average seedling dry mass using these steps:
A) Determine the largest value in your data to label the y-axis (left side).
B) Use your data to find the bar height for each item.
C) Create a bar for each item based on your data.



1. **Write a descriptive caption for your graph, summarizing significant data trends or patterns.**

   In this graph you can see… _____

   _____

   _____

2. **Was the average mass of the seedlings greater than the average mass of the seeds?** Yes / No (*circle one*)

3. Our seedlings were grown in sealed ziplock bags without any soil. **Where did the mass of the seedlings come from**? Explain below. Consult your notes and discuss with your group if you are unsure.

   _____

   _____

   _____

   _____

Be prepared to discuss and defend your ideas in small groups and as a class.

Part 3C Investigation: Bright/Dark Data (3.1.3c)

Adapted from materials by Carbon TIME

Overview: In this activity, you conclude the experiment you started in Part 3A. You will observe how BTB changes depending on whether plants are kept in light or dark conditions.

Directions - *Carefully read the directions below before beginning. Record info where prompted.*
SEP: Planning & Conducting an Investigation

1. □ Earlier you placed cups of BTB inside a resealable bag with radish seedlings. Some were kept in the dark; others had access to light. Follow the directions below to conclude this experiment. Acquire your bag of radish seedlings from your instructor. Carefully move it to your group so that you do not spill your BTB. Do NOT open your bag yet.

2. □ Observe the BTB in your bag. Record your observations below in Results. Use another group's data to complete the remaining questions.

Results - *Record your data in the spaces below.*
SEP: Planning & Conducting an Investigation

Plants in Light Conditions

- Date BTB was added to the bright plant bags: _____ Date removed:_____
- Final color of the blue BTB in the bright plants bag: _____
- Final color of the yellow BTB in the bright plants bag: _____

Plants in Dark Conditions

- Date BTB was added to the dark plant bags: _____ Date removed:_____
- Final color of the blue BTB in the dark plants bag: _____
- Final color of the yellow BTB in the dark plants bag: _____

Whole-Class Data: Describe patterns in your class data.

- Final color of the BTB and CO_2 concentrations for plants in the bright plants:

BTB:_____ CO_2: _____ (*yellow = CO_2 increased; blue = CO_2 decreased*)

- Final color of the BTB and CO_2 concentrations for plants in the dark plants:

BTB:_____ CO_2: _____ (*yellow = CO_2 increased; blue = CO_2 decreased*)

Post-Investigation Questions - *Record your ideas in the spaces below.*
SEP: Engaging in an Argument from Evidence. Constructing Explanations & Designing Solutions.

1. **How did your final results in Part 3C compare to your predictions in Part 3A?** Were your predictions accurate or inaccurate? Explain. (*Yellow BTB = CO_2 increased; Blue BTB = CO_2 decreased*).

2. **Briefly summarize the processes that occur in each of the following organelles inside plant cells:**

   Mitochondria: _____

   Chloroplast: _____

3. **Summarize what molecules are absorbed and what molecules are released from each organelle:**

   Absorbed by mitochondria: _____; Released by mitochondria: _____

   Absorbed by chloroplasts: _____; Released by chloroplasts: _____

4. **Can photosynthesis occur if the plants do not have access to light?** Yes / No (*circle one*)

5. **Can cellular respiration occur if the plants do not have access to light?** Yes / No (*circle one*)
   Note: In plant cells, glucose can be stored as starch, which can be broken down back into glucose for later use.

6. **How did your data from plants in the light differ from your data for plants in the dark? Explain why any differences occurred.** In your explanations, address how differences in light affected the function of the chloroplasts and/or the mitochondria.

Part 4: Review & Assessment (3.1.4)

Step 1: Rank each Driving Question in Part 2 based on your comprehension (you can rank them as *1,2,3* or *green/yellow/red*, or any other method). Then work in teams to review anything that is still unclear.
Step 2: Identify any remaining areas of confusion or concern. Then review these topics with your instructor.
Step 3: Complete the Formative Assessment (*last page of the packet*). Your instructor will determine if you will work individually, in pairs, or in small groups. Then compare and evaluate your responses as a class.
Step 4: Individually complete a Mastery Check. If your performance indicates that additional support is needed, your instructor will determine how to help you move forward.

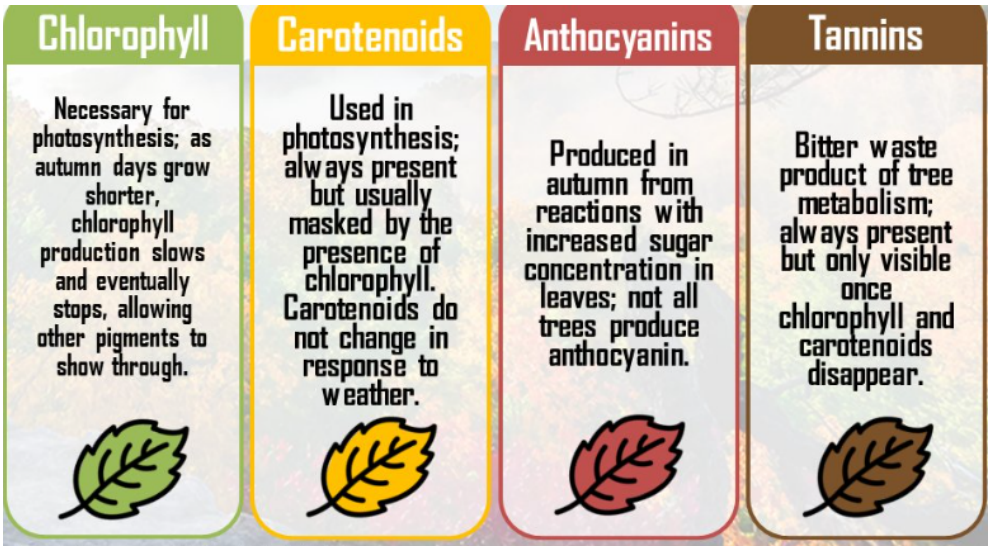
Part 5: Life Connections - Changing Leaves (3.1.5)

Background: For many, autumn means changing leaf colors. Pigment molecules made by plant cells are what determine leaf colors. Usually leaves are green due to chlorophyll. This pigment is found in the chloroplasts. It primarily absorbs light energy needed for photosynthesis. In this process, water and carbon dioxide are rearranged to form oxygen and glucose. The light energy is transformed into chemical energy in glucose.

As daylight shortens, cells stop producing chlorophyll. This allows other pigments to become visible. Carotenoid pigments create yellow and orange colors. Carotenoids are always present but are usually overshadowed by green chlorophyll. Carotenoids capture extra light energy to enhance photosynthesis.

Anthocyanins are the pigment that creates red and purple colors in leaves. As leaves prepare to fall, the base slowly detaches from the stem. This traps some sugars in the leaf. These sugars form the anthocyanin pigments. Anthocyanins protect leaf cells in their final days. They absorb harmful radiation and neutralize acids. Sunny autumn days increase sugar production. This results in more vibrant reds and purples.

Lastly, tannins create brown leaf colors. Tannins only become visible as leaves die. An early frost can cause the tree's colors to rapidly shift from green to brown. *(Image Source)*



Questions:
1. Why do leaf cells produce pigments? Why are these necessary for plants to function?
2. Why do leaves change color in autumn? What is happening at the cellular level to explain this?
3. Which of the following are involved as leaves change color? *Cell respiration, biosynthesis, homeostasis*
4. Predict what changes would occur in xylem and phloem as leaves change color. Support your ideas with evidence and reasoning.

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Plants Unit, Packet 3.1 Formative Assessment (3.1.4)

Name: _____ Hour____ Date:_____ Score:_____

Directions: A 3x5 notecard with *handwritten* notes can be used to guide your answers. Your instructor may allow you to work in assigned groups. If so, have a different person write each response while others assist.

1. Three students are looking at a tall tree and are discussing how a plant gains mass. Do you agree or disagree with what each student claims? Circle "Agree" or "Disagree" for each of the three claims below.

A) Avery: "I think a growing plant gets most of its mass from nutrients in the soil." Agree/ Disagree
B) Bristol: "I think a plant gains most of its mass from gasses in the air." Agree / Disagree
C) Chandra: "I think a plant gains most of its mass from the sunlight." Agree / Disagree

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

a) _____

b) _____

c) _____

Writer:

3. Plant cells have three organelles that animal cells do not. List these organelles and summarize their function in the space below.

_____

_____

_____

Writer:

4. CO_2 concentrations will increase in a sealed container of plants if kept in the dark; CO_2 concentrations decrease if the sealed container is kept in the light. Why? Explain both outcomes below.

_____

_____

_____

Writer:

5. How do plant cells that lack access to light (like roots) acquire glucose for cellular respiration?
Include and underline the following in your response: *phloem, gravity, leaves.*

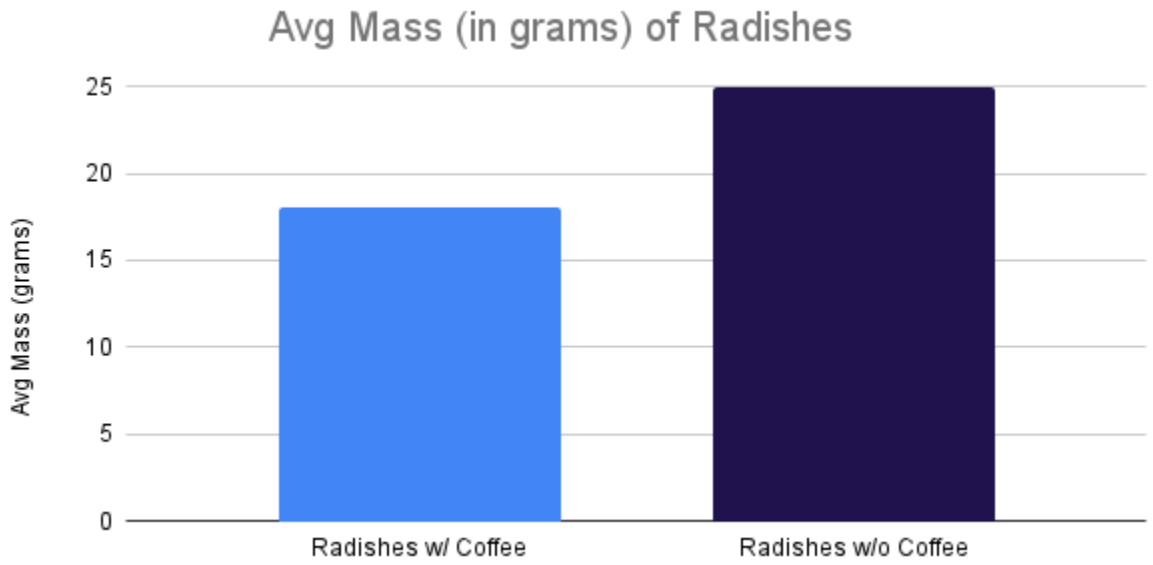
_____

_____

_____

Writer:

Background: A class was curious whether coffee could improve plant growth. They planted some radishes in regular soil and others in soil treated with coffee. They then recorded the final average mass. This is their data:



6. Four students make claims about what happened in this experiment:

Student A: The radishes in soil with coffee had greater rates of photosynthesis.
Student B: The radishes in soil without coffee converted more water & CO_2 into glucose & O_2.
Student C: The radishes in soil with coffee produced less cellulose than the other radishes.
Student D: The radishes in soil without coffee transported more glucose in their phloem.

Determine whether each argument is backed by a) this data and b) your knowledge of plant cell processes, and explain why.

A) Supports/Refutes. Why?

B) Supports/Refutes. Why?

C) Supports/Refutes. Why?

D) Supports/Refutes. Why?

Writer: