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 can we investigate plant growth and function?

Anchoring Phenomenon: Throughout this unit, we have explored how plant cells function. We explored how plants can use water and carbon dioxide to produce glucose, and how enzymes can change glucose into other molecules. In this unit, we will explore this more deeply through an investigation that compares growth in treated and untreated plants.

Deeper Questions
1. How do scientists design experiments to answer questions?
2. How can we analyze data to identify patterns and develop explanations?
3. How do scientists communicate their ideas using standardized formats?

Schedule

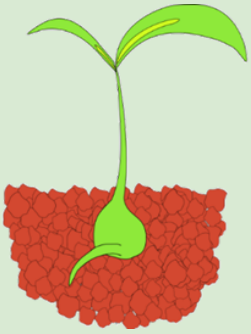
Part 1: Introduction
- Review of Core Ideas
- Planning & Carrying Out Investigations

Part 2: Data Collection & Analysis
- Data Collection
- Analyzing Data

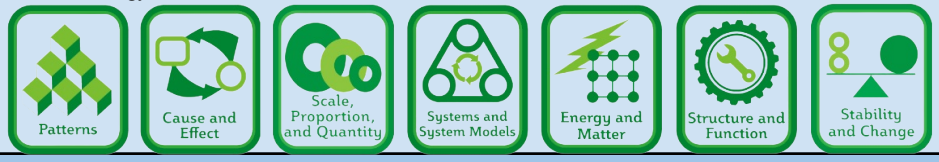
Part 3: Scientific Writing
- How Scientists Communicate
- Project & Presentation Checklists

Part 4: Work Time
- Preparing Your Presentation and Peer Review

Part 5: Review & Assessment
- Presenting Your Findings
- Mastery Check - Planning & Carrying Out an Investigation



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; Practice Example; Academic Integrity - Video 1 & Video 2; Research Presentation Example; Research Presentation Template;

Part 1A: Review of Core Ideas (3.3.1a)

Overview: In this activity, you will review key concepts from this unit to prepare for your investigation. You will work in small teams to answer the questions listed below. You should take notes in a notebook, on a dry erase board, or on scratch paper so that you are prepared to deliver your responses during the class discussion that will follow. Note: your instructor may assign specific questions to your group if time is limited.

3.1 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?

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

1. How do plants acquire carbs, fats, & proteins if they cannot consume other organisms?
2. How do plant cells produce carbohydrates?
3. How do plant cells produce fatty acids?
4. How do plant cells produce amino acids?
5. How do the atoms in glucose and soil minerals relate to all the molecules found within a plant cell?
6. True or false: an enzyme has a completely different molecular structure after a reaction is completed. Explain.
7. How many different types of enzymes are found in plant cells? Why?
8. How do some enzymes assemble macromolecules from individual molecules?
9. How do some enzymes disassemble macromolecules into individual molecules?
10. How do enzymes enable species to interact with each other?
11. What are decomposers? Provide examples.
12. Why are decomposers important for species interactions?

Part 1B: Planning & Carrying Out an Investigation (3.3.1b)

Overview: You will use standard components of scientific investigations to organize your investigation and prepare for data collection.

Research Question - *What are we wondering? What do we want to figure out?*
SEP: Asking questions (for science) and defining problems (for engineering).,

1. What question were you trying to answer with your experiment? Reach a consensus as a group or class and record a **research question** below.

   We wonder if _____

   _____

Hypothesis, Rationale, Variables, etc. - *Make a testable prediction based on evidence.*
SEP: Planning and carrying out investigations; Developing & using models.

2. Turn your **research question** into a **hypothesis**. A hypothesis is like a guess or a prediction – it is how you would answer your research question based on your existing knowledge. Fill in the blanks below:

   We predict that _____

   _____

3. Now provide a **rationale** for your hypothesis. A rationale states why you think your hypothesis might be right; it provides some evidence and/or logic that supports the validity of your hypothesis.

   We think this because: _____

   _____

   Note: it's totally ok if your hypothesis ends up being wrong. Either way we'll gain more info. We just need to take a stance for now.

4. Every experiment has two important components: a **dependent variable** & an **independent variable**.

   An **independent variable** is the thing you purposely changed to test your hypothesis and answer your research question. Generally speaking, an experiment should only have one independent variable.

   What is your independent variable? _____

   A **dependent variable** is what you measure to answer your research question and determine if your hypothesis is correct. You can have multiple dependent variables as long as they are relevant.

   What is your dependent variable(s)? _____

5. A **control** is a part of your experiment that does not receive any treatment so that we have something to compare to. It enables us to confirm if what we changed had any impact on the outcomes.

   In this experiment, what is your control? _____

6. **Sample size** and **trials** affect the validity of your findings. **Sample size** refers to how many points of data will be collected. **Trials** refer to the number of times you will repeat the experiment under the same conditions. The larger the sample size and the more trials you perform, the more useful and valid your findings are for answering your research question.

   *What is your sample size (how many points of data are being collected)?*_____

   *How many trials did you have?*_____ *How might your sample size and number of trials affect the validity of your findings?*_____

   _____

7. **Constants** are the conditions that are kept the same between each replicate. If possible, an experiment should not be performed under changing conditions. This would make it impossible to determine whether our results were affected by our independent variable or by other changes. This would make our results less useful for answering our research question.

   *What is being kept constant in this experiment?*_____

   _____

   _____

Methods & Materials - *How did you test your hypothesis?* *SEP: Planning and carrying out investigations.*

8. What materials did you need to test your hypothesis? Record all these items below.

   We used the following: _____

   _____

9. On the next page, summarize all of the steps that were needed to complete this experiment. Remember, your methods section should read like a recipe in a cookbook - you should provide clearly written steps that specifically outline everything that someone would need to do to repeat your experiment. You may not need all of the space provided.

Part 2: Data Collection & Analysis (3.3.2)

Overview: You will be collecting data to answer your research question and address your hypothesis.

Results & Data - *What do our data indicate?*
SEP: Analyzing and interpreting data. Using mathematics and computational thinking.

Directions:

1. Acquire your group's experimental radishes.
2. Use a ruler with cm & mm measurements to determine the height of each radish plant.
    a. Place the ruler at the base of each plant.
    b. Gently stretch out the plant as far as it will go without breaking. Record the maximum distance the plant will stretch
3. Record the data for each plant in each container (treated & control) in the table provided in this section.
4. As a class, determine the average size of the plants for each treatment. To do so…
    a. Add up the measurements for each plant in each treatment for your group. Then divide each sum by the total number of data points.
        i. *For example, if the data for one container of radishes were: 4, 5, 3, 5, 4, 3 then the sum would be 4 + 5 + 3 + 5 + 4 + 3 = 24. Then divide this value by the total number of data points 24 ÷ 6 = 4. Your average plant height in this case is 4 cm.*
5. If feasible, measure the mass of each plant using a digital balance. Record the average mass for each treatment.
6. Record your data in the space below.

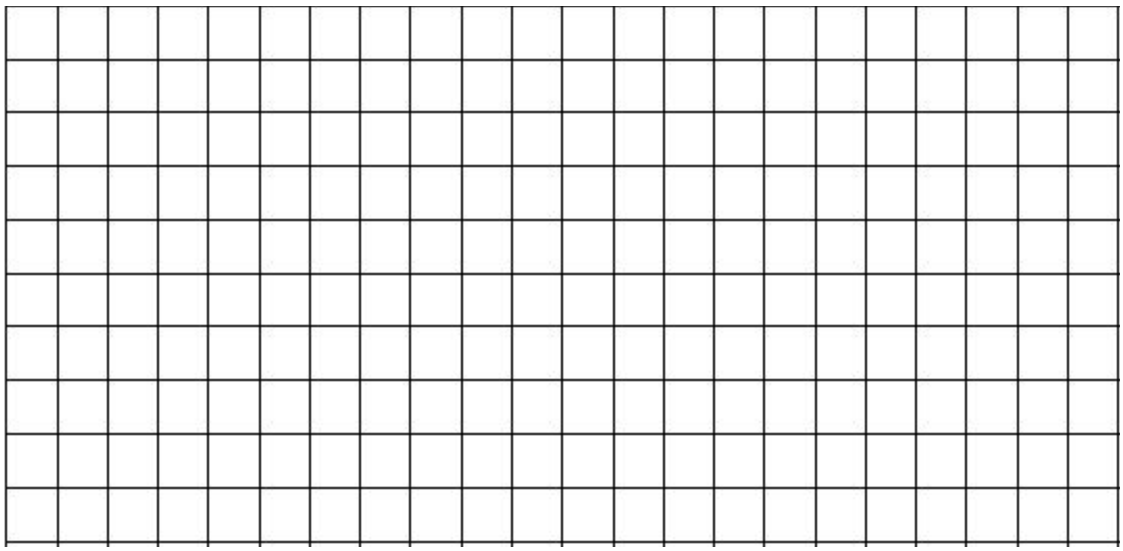
	Plant Height (cm)	**Average Height for your Group**	**Class Avg**
Control	____ + ____ + ____ + ____ + ____ + ____ = ____		
Treated	____ + ____ + ____ + ____ + ____ + ____ = ____		

	Plant Mass (g)	**Average Mass for your Group**	**Class Avg**
Control	____ + ____ + ____ + ____ + ____ + ____ = ____		
Treated	____ + ____ + ____ + ____ + ____ + ____ = ____		

Results & Data - *What do our data indicate?*
SEP: Analyzing and interpreting data. Using mathematics and computational thinking.

Create a graph based on your instructor's guidance and the steps below.

1. **First, label each axis. The x-axis is horizontal (*back & forth*); the y-axis is vertical (*up & down*).**
    a. Usually the independent variable (*what was changed*) is on the horizontal x-axis and the dependent variable (*what was measured*) is on the vertical y-axis.
2. **Next, determine the type of graph you are making.**
    a. Bar graphs work well for comparing changes in quantities, while line graphs work well for comparing changes over time.
    b. Each component should be labeled with the type of treatment (e.g., *treated* and *control*).
3. **Third, determine the scale (*range of numbers*) you will use on the y-axis (vertical axis).**
    a. Determine your highest and lowest values for the data you will be graphing.
    b. Your scale should be large enough to encompass all of the values of data but should also be small enough to make it easy to compare the differences in data.
    c. Usually your scale starts at zero (but does not need to).
    d. Values on the y-axis usually increase by the same amount with each line.
4. **Fourth, create a graph based on the data you collected.**
5. **Finally, create a caption that explains what kinds of trends and patterns are present in this graph. Then explain what these trends indicate for your research question and hypothesis.**
    a. Often a caption includes phrases like “In this graph you can see” and “This indicates that”.



In this graph, you can see _____

_____

_____

Questions: Discuss in small groups. Your instructor will determine how to record your ideas (e.g., whiteboards, scratch paper, online document, etc.). Prepare to discuss your ideas for each question. Determine who will serve each of the following roles for each question: speaker, writer, information seeker, facilitator & fact checker.

1. **Summarize your findings.** Based on the class averages, what happened? What were the key findings?

2. **What do these data indicate regarding your research question?** Explain.

3. **Do your findings support or refute your group's hypothesis?** Explain.

4. **How could these findings be explained using the core ideas from the curriculum?** Specifically, how might differences in plant growth and reproduction be explained by…
    a. Rates of Photosynthesis
    b. Rates of Cellular Respiration
    c. Rates of Biosynthesis
    d. Activities of Cellular Enzymes
    e. Availability of CO_2, H_2O, Soil Minerals, etc.
    f. Any other information from the course.

5. **How do these findings relate to real world considerations (such as food production)?** How might this expand our understanding of this issue? How might we design solutions for this problem using this information?

6. **How valid are these findings?** Do our data provide a definitive answer for our research question? How could we improve this experiment to optimize the validity and reliability of our data?

7. **What questions remain unanswered?** What is still unclear to you or members of your group? What questions emerged as a result of this work? (If a scientist is doing their job effectively, their work will almost always result in new questions).

8. **What are the next steps?** If time and resources allowed, would it make most sense to a) repeat the experiment in exactly the same manner; b) change the experiment to improve the data it can produce; c) develop a new investigation based on these findings; or d) something else?

Your instructor may choose to meet with individual groups. If so, **raise your hand** when you are ready. Your instructor will listen to your responses. If you are ready to move on, they will sign below.

This activity was successfully completed _____ (*instructor signature*)

Part 3: Scientific Writing (3.3.3)

Overview: Effective communication is vital in science. Scientists must share their findings to allow others to build upon their work and make new discoveries. Without this communication, scientific progress stalls. In scientific writing, a standardized format is followed to ensure consistency and predictability. This enables readers to locate specific information more quickly. Science writing includes the following components:

1. **Title**: a title includes the study subject, independent and dependent variables, and the outcome. Authors are usually listed alphabetically by last name below the title. You should also include your school.
2. **Abstract**: this is a summary of the entire publication. It summarizes key info as succinctly as possible.
3. **Introduction**: this summarizes the study subject, the research question, hypothesis, and rationale. It should also provide a brief summary of the methods.
4. **Background Information**: these are the concepts, facts, and terminology from other sources related to your experiment needed for the average reader to understand your work. All facts should be followed by parenthetical citation indicating the source of that information [(Author, Year) □ (Smith, 2022)].
5. **Methods & Materials**: this summarizes how the experiment was conducted. It should resemble a cookbook recipe. It should be detailed enough that anyone could replicate your work.
6. **Results**: this section provides all relevant data and observations from your experiment. It should also include at least one graph or table summarizing your data. A caption should describe the trends and patterns in the data and their significance. Both the x- and y-axis must be labeled. Your results should also include observations - what did you observe that isn't obvious or evident in the numerical data?
7. **Discussion & Conclusion**: this section summarizes the meaning of your data as it relates to your original question and hypothesis. It should include the following:
    a. Restate the research question and hypothesis.
    b. Explain whether the data support or reject your hypothesis (or if more data is needed).
    c. Describe why you think the data supports/refutes/does not affect your hypothesis.
    d. Discuss the validity of your findings (i.e., what might limit the ability of your data to address your research question; how might this experiment be improved?).
    e. What is the relevance of this investigation and its data? How might this provide insights to questions and provide potential solutions to problems? Why was this work valuable?
8. **Reference List**: this is the alphabetical list of all the sources used to create your paper. All sources used for this experiment should be cited using APA citation (*Last Name. First Name. (Year). Title. Source.*).
    a. Anything cited in this section should also be cited parenthetically (Author, Year) where the information is mentioned in your presentation.
    b. For example, if you cite information from Easton and Glauer about how plants grow, you would cite this information in two places: 1) a parenthetical citation at the end of the sentence containing that information (Easton & Glauer, 2021); 2) a full citation in the Reference List: Easton, J. Glauer, D. (2021). What Makes Plants Grow? *IFAS Extension* - *edis.ifas.ufl.edu*

Part 4: Scientific Writing Checklist (3.3.4)

Overview: You will use your investigation findings to create a research poster, scientific paper, or digital presentation (as directed by your instructor). Ensure your work includes all of the following items.

Title: this section needs to include…
- The study subject (the topic/question you studied).
- The independent variable and the dependent variable(s).
- The final results.
- Your names, class, hour, and school.

Introduction: this section needs to include…
- The research question (*We wondered if*…).
- The hypothesis (*We predicted that*…).
- The rationale, or reason for your hypothesis (*We thought this would be the case because*…).
- Summary of methods (*To test this hypothesis, we*…).

Background Information: this section needs to include…
- Concepts, facts, and terminology from other sources so the average reader can understand your work.
- All facts must be followed with parenthetical citation for the source of the information (Author, Year).
- All sources used in the background information need to also be cited in the bibliography.

Methods & Materials: this section needs to include…
- A materials list of all items used in the investigation.
- A cook-book recipe-style description of how you conducted this experiment.

Results: this section needs to include…
- A written summary of your results, data, and observations.
- A graph/chart/table with…
  - A legend explaining all symbols or abbreviations.
  - Labeled x-axis and y-axis.
  - A caption with a description of all important patterns and trends in the data.

Discussion: this section needs to include…
- The original research question and hypothesis.
- An explanation of whether the data support or reject your hypothesis (or if more data is needed).
- A summary of why you think the data supports/refutes/does not address the validity of your hypothesis.
- A discussion of the validity of your findings (*i.e.*, what might limit the ability of your data to address your research question; how might this experiment be improved?).
- The relevance of this investigation and its data (*e.g.*, how might this provide insights to questions and provide potential solutions to problems? Why was this work valuable?)

Bibliography: this section needs to include…
- All sources used must be listed alphabetically. Each should include: 1) Author's name (last name, first name); 2) Year of publication; 3) *Title of document*; and 4) Publication source or website.
- *E.g.,* Badger, Bucky; Wolverine, Wally. (2023). *Plant Productivity*. www.usda.gov/horticulture
- Note: All sources cited here also need parenthetical citations wherever they're used in the presentation.

Part 5: Scientific Presentation Checklist (3.3.5)

Overview: You will be presenting your findings as a group to conclude this project. For your presentation, you will need to break up roles below among the people in your group. If you have less than four people, some individuals may need to do multiple sections. Be sure to address all of the following as you present. While you can have speaking notes, try to avoid reading directly from them during your presentation.

Partner 1: Introduction

1. Begin by stating the research question, hypothesis, and rationale.
2. Next, summarize background information that your audience will need to understand in order to comprehend and appreciate your work. For example, if you are discussing plant growth, you need to provide information about how plants grow and how plant cells function.

Partner 2: Methods

1. Begin with a summary of the methods you used to test your hypothesis (*To test this hypothesis, we…*)
2. Then state all the materials used to conduct your experiment (*We used the following materials…*)
3. Address sample size, trial numbers, and constants; explain how these affect your work's validity.

Partner 3: Results

1. Begin with a graph of your data. Summarize the patterns and trends in the data. Be sure to explain how the x-axis and y-axis are labeled to support your audience's understanding.
2. Next, state the significance of these results and how they relate to your research question and hypothesis. Do the results support your hypothesis, or do they refute it?
3. Conclude by addressing other observations made during the experiment that might not be reflected in this data.

Partner 4: Conclusion

1. Begin by restating the research question and hypothesis.
2. Next, explain whether your team has decided that your hypothesis is correct or incorrect based on your data (or if you are unable to determine this at this moment). Justify this stance with evidence/reasoning.
3. Third, state the confidence you have in your results. Is this enough to answer your research question once and for all? Are your methods able to provide data that fully supports valid conclusions?
4. Conclude by stating what should happen next in order to answer your research question. Is more research needed? Should it be the same kind of research and/or should other questions be explored that might have arisen during your work? What are the next steps for addressing your research question?

Questions: You should prepare for follow-up questions from your instructor. Potential examples include:

1. How do plant cells function? How are plant cells similar and different from animal cells?
2. What occurs during photosynthesis? Where does this process occur? Why is it important to plants?
3. How do plants move substances among their cells if they lack a heart and blood vessels?
4. All cells need access to glucose, amino acids, and fatty acids. Animals acquire these molecules by consuming other organisms. How do plants acquire these molecules?
5. How do plants use enzymes to change glucose and soil minerals to produce other molecules?
6. How does your work reflect core principles of scientific investigations? How could it be improved?

Peer Review Form

Name: _____ Date: _____ Hour: _____

Directions: Please evaluate your group as well as yourself on the basis of contributions and effort on a scale of 1 to 5. A group member who makes an outstanding contribution and did their best would receive a score of 5. A group member who did the bare minimum would get a 3, and a group member who did nothing or almost nothing would get a 1 or 2. Provide a reason for your score – why did you give that score? *(5's need no reason)*

1. Group Member's Name: _____ Score: 1 2 3 4 5

Reason: _____

_____

2. Group Member's Name: _____ Score: 1 2 3 4 5

Reason: _____

_____

3. Group Member's Name: _____ Score: 1 2 3 4 5

Reason: _____

_____

4. Your Name: _____ Score: 1 2 3 4 5

Reason: _____

_____

Additional comments or concerns: _____

_____

_____

Changes you would recommend for this activity: _____

_____

_____