Crops Unit, Packet 1.1

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 improve crop productivity?

Anchoring Phenomenon: In this unit, we will be exploring how we can optimize crop performance - in other words, how can we get plants to grow as quickly and efficiently as possible to maximize food production? We will be using radish seedlings as our model organism to study plant growth.

Deeper Questions

1. How can we optimize plant growth?
2. How do we design experiments to test our ideas and hypotheses?
3. How can we know if our claims are accurate and reliable?

Schedule

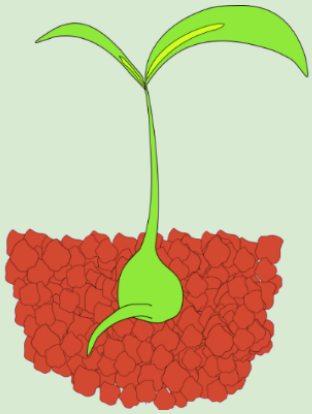
Part 1: Introduction
- Planting Wisconsin Fast Plants

Part 2: Core Ideas - Fact vs. Opinion

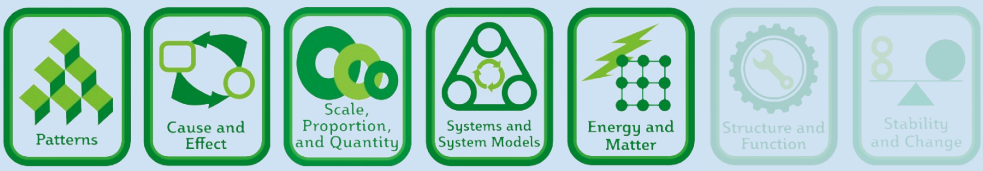
Part 3: Investigation
- Part A: How do we know if info is credible?
- Part B: M&M's and Scientific Practices

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

Part 5: Career Connections
- Career Profiles



AFNR Standards: PS.01.01. Determine the influence of environmental factors on plant growth. PS.02.03. Apply knowledge of plant physiology and energy conversion to plant systems. BS.02.01. Read, document, evaluate and secure accurate laboratory records of experimental protocols, observations and results. CRP.02.02. Use strategic thinking to connect and apply technical concepts to solve problems in the workplace and community. CRP.07.02. Evaluate the validity of sources and data used when considering the adoption of new technologies, practices and ideas in the workplace and community. CRP.08.02. Investigate, prioritize and solve problems in the workplace and community.
NGSS Standards (*PEs* & *CCCs are summarized below. SEPs are noted throughout the packet*). HS-PS1-7. Atoms and mass are conserved during reactions. HS-LS1-5. How photosynthesis transforms light energy into stored chemical energy.



Semester Schedule

1. Crops Unit
1.1: How can we improve crop productivity?
1.2: How can we explain crop growth using atoms?
1.3: How do we design plant experiments?

2. Livestock Unit
2.1: Why do different types of livestock need different feed?
2.2: How do digestive tracts of livestock differ?
2.3: How do we design animal experiments?

3. Genetics Unit
3.1: How can we predict genetic inheritance?
3.2: How do genetic outcomes vary in more complex cases?
3.3: How do we design genetic experiments?

4. Biotech Unit
4.1: How can DNA be modified to enhance species?
4.2 How do we design biotech experiments?

5. Sustainability Unit
5.1: What determines if food production is sustainable?
5.2: What methods improve sustainability in agriculture?
5.3: How do we design sustainability experiments?

These materials were partly developed with assistance from artificial intelligence.

Resource Links: Class Website; Reading; AgExplorer; AgCareers; Research Vocab

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Part 1A: Introduction – Optimizing Crop Growth (1.1.1a)

Overview: In this unit, you will begin by discussing your initial ideas about how to optimize plant growth. 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; Asking Questions & Defining Problems

1. Students are having a competition to have the most productive gardens that produce the most food. **What are some things you could change to make a plant grow more rapidly and/or grow larger? What could you change about the soil and the environment to optimize plant growth? Why do you think these options might be effective?**
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.

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…***

Initial Explanations - *Record your ideas in the spaces below.* *SEP: Constructing explanations*

What changes can improve crop growth and performance? Why might this be effective? 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.

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Part 1B: Planting Seeds (1.1.1b)

Wisconsin Fast Plants®—Fast, Fun, and Easy Planting

Plants play an integral part in the world by taking in carbon dioxide and producing oxygen. They can also be used to gain an understanding of genetics and how organisms respond to environmental changes. Wisconsin Fast Plants® are rapid-cycling *Brassica rapa* plants developed by Dr. Paul Williams at the University of Wisconsin. Dr. Williams selectively bred *Brassica rapa* that were small in size, had high seed production and a short growth cycle, and would grow easily in a readily available potting mix under continuous fluorescent light. Originally developed as a research tool for improving disease resistance in cruciferous plants such as mustard, radish, cabbage, and broccoli, Fast Plants® have also proven to be an excellent tool for classroom investigations due to their rapid life cycle, small size, and easy care.

This activity will help you understand how easy it is to plant and care for Wisconsin Fast Plants®. As quickly as your plants grow, you will develop multiple ideas for using Fast Plants® with your students to discover and investigate many aspects of plant growth and development. This activity supports 3-dimensional learning and builds toward the following:

- NGSS Scientific and Engineering Practices: Constructing Explanations
- NGSS Core Idea: Life Science 1: From Molecules to Organisms: Structures and Processes

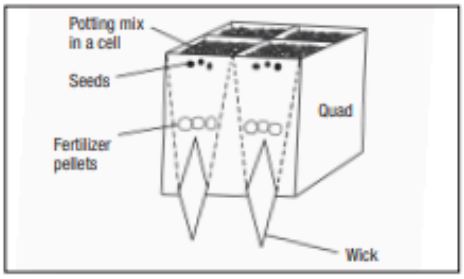
Materials Required

Wisconsin Fast Plants® Trial-Sized Get Acquainted Kit (158690)

Potting Soil (158965)

Activity Procedure

1. Premoisten your bag of soil by adding 20 mL of water. Mix water and soil thoroughly.
2. Place a paper wick into each of the 4 cells of the foam quad. Pull each wick down through the opening at the bottom of each cell so the wick extends halfway out (about 2 cm).
3. Loosely fill each cell about half full with moistened soil from your bag.
4. Add 3 fertilizer pellets to each cell.
5. Fill each cell to the top with soil.
6. Make a shallow depression at the top of each cell. Do not press hard and compact the soil.
7. Add 2 to 3 seeds to each cell.
8. Cover seeds lightly with soil.
9. Use a pipet to add water to each cell until water drips from the wick.
10. Plants will need a continuous watering system and 24 hours of light at room temperature. One way to create a watering system for the plants is to fill a small (8 oz) deli container half full of water and place the foam quad in the water. Replenish the water as necessary.



Results/Summary

Seedlings will emerge after a few days (see the Fast Plants® life cycle graph on the back of this sheet). Flowering will begin around day 12. When flowers open, cross-pollinate them using a cotton swab or small artist paintbrush to transfer pollen back and forth among different plants (these plants do not self-pollinate). Plants can be removed from water on day 30, and seed pods can be removed from the plant around day 35.

Additional Information

View more information, content links, and products related to this activity at **www.carolina.com/takeaways.**

Part 2: Core Ideas - Fact vs. Opinion (1.1.2)

Overview: In this activity, you will use this reading to explore how scientists make evidence-based arguments by collecting and analyzing data. You will also explore the differences between fact and opinion and how scientists check to make sure their data are accurate and reliable.

Driving Questions - *Record your ideas separately (e.g., on a white board or scratch paper).*	
1. What is the difference between a *fact* and an *opinion*? What factors determine whether a claim is a fact or an opinion? 2. Summarize the six criteria that enable a reader to determine if a source is credible & reliable. 3. What is a *peer-reviewed journal*? How does peer review affect the credibility of a source? 4. What is an *evidence-based argument*? How does this affect the credibility of a claim? 5. Summarize the practices that researchers use to collect data and make evidence-based arguments.	6. What is the difference between *validity* and *reliability* in regards to data? 7. How is validity and reliability in data similar to target practice for an archer? 8. What is the *mean value* of data? What does this value indicate? 9. What is *standard deviation*? What does this measurement indicate? 10. What determines if data is valid and reliable? 11. What is *calibration*? Why does it matter? 12. How do land grant universities and extension agencies affect industries like agriculture?

Use the space below to record notes:

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Part 3A: What determines credibility? (1.1.3a)

Pre-Investigation Questions - *Work as a group to prepare verbal responses for these questions. When you think you are all ready to provide responses, raise your hand. Your instructor will listen to your explanations, provide feedback, and determine if you are ready to move on to the investigation.*
SEP: Developing & Using Models

1. What is the difference between facts and opinions? How do we know if something is a fact or opinion?
2. What makes something a credible source of information?
3. How do we know if information from an internet source is credible?
4. What is an evidence-based argument? Why is this important?

This activity was completed _____ (*instructor signature*)

Overview: We will determine how we can use internet sources to find credible sources to address a question or a problem. In this case, we are trying to determine how our treatment that we applied to our radish seeds might affect their growth and development.

Hypothesis - *Discuss your ideas and record your predictions in the spaces below.*
SEP: Planning and Carrying Out Investigations

1. What criteria matter most when trying to determine if an internet source is credible?

   _____

   _____

2. Explain your reasoning: _____

   _____

Directions - *Carefully read the directions below before beginning. Record info where prompted.*

1. ☐ Use an instructor-approved device to access an internet search engine (such as Google).
2. ☐ As a class, work together to decide what information you want to find and choose a common search phrase. Carefully select two sources that appear to contain the information you need. Or you can opt to use this existing option as your sources for comparison.
3. ☐ Use the table on the next page to create a score for each source of information.
4. ☐ As a group, evaluate each source based on this information and then determine which source is most reliable for our needs.
5. ☐ Be prepared to discuss your group's findings as a class.

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First Source Name:			
Item	**No (0 points)**	**Somewhat (1 point)**	**Yes (2 points)**
Credibility - Is the author listed? Is the author sufficiently qualified to provide this information?			
Accuracy - Is this accurate based on your prior knowledge? Does it seem to give you full confidence (e.g., absence of errors)?			
Reliability - Is this website completely free of bias? Does it avoid an overly narrow viewpoint? Is the information totally objective?			
Relevance - Does this website enable you to address questions you have about this topic?			
Date - Does the website have a publication date? Is this source up to date and still relevant?			
Sources - Does the author cite their sources? Are their sources generally credible and reliable?			
Overall Score			

Second Source Name:			
Item	**No (0 points)**	**Somewhat (1 point)**	**Yes (2 points)**
Credibility - Is the author listed? Is the author sufficiently qualified to provide this information?			
Accuracy - Is this accurate based on your prior knowledge? Does it seem to give you full confidence (e.g., absence of errors)?			
Reliability - Is this website completely free of bias? Does it avoid an overly narrow viewpoint? Is the information totally objective?			
Relevance - Does this website enable you to address questions you have about this topic?			
Date - Does the website have a publication date? Is this source up to date and still relevant?			
Sources - Does the author cite their sources? Are their sources generally credible and reliable?			
Overall Score			

Part 3B: M&M's & Scientific Practices (1.1.3b)

Pre-Investigation Questions - *Work as a group to prepare verbal responses for these questions. When you think you are all ready to provide responses, raise your hand. Your instructor will listen to your explanations, provide feedback, and determine if you are ready to move on to the investigation.*
SEP: Engaging in an Argument from Evidence

1. What practices do scientists regularly use to answer questions and solve problems?
2. How do scientists know whether they can trust the findings of their experiments?
3. What does it mean to have valid and reliable results in an experiment?

This activity was completed _____ (*instructor signature*)

Overview: We will explore the practices that scientists & engineers use to make sense of the world. While we are waiting for our plants to grow, we will be using a bag of M&Ms. Read the directions in each section to complete this activity. Each box notes the specific Science & Engineering Practice (SEP) that it addresses.

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 questions do you have about the M&Ms inside this bag? Consider questions that are feasible for your class to investigate. Reach a consensus as a class and record a **research question** below.
   Examples could include: A) Does every bag have an equal amount of each color? B) Does the ratio of different colors vary from bag to bag? C) Does each bag have an equal amount of M&Ms?

   We wonder if _____

   _____

Hypothesis & Rationale - *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.

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Methods & Materials - *How will we test our hypothesis?*
SEP: Planning and carrying out investigations.

4. What materials do we need to test our hypothesis? Record all these items below.

   We will need the following: _____

   _____

5. As a class, determine how you will investigate your research question and confirm whether your hypothesis is correct. This section should provide all of the steps and materials needed to successfully complete the experiment (similar to how a recipe provides all of the ingredients and steps needed).

   _____

   _____

   _____

   _____

   _____

   _____

6. Decide as a class what data will be collected and how it will be recorded. Create a table in the space below for the data you will be collecting. Also decide if you will need multiple trials (repeats) and whether or not you will be using individual group data or class data. Your instructor should guide your discussions on these topics to help you understand how to obtain the most valid and reliable results.

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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 we put the focus of our experiment (or the *research question*) on the x-axis, and what we measure to address this question on the y-axis.
    b. For example, if you measured the average number of each color in a bag of M&Ms, you would put each color option on the x-axis, and the average amount of each color on the 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. In this case, a bar graph is likely the best option.
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. Your scale should be large enough to include all of the values of data but should also be small enough to make it easy to compare the differences in data.
    b. Usually your scale starts at zero (but does not need to).
    c. 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 the trends and patterns that are present in this graph.**
    a. Explain how these trends relate to your research question and hypothesis.

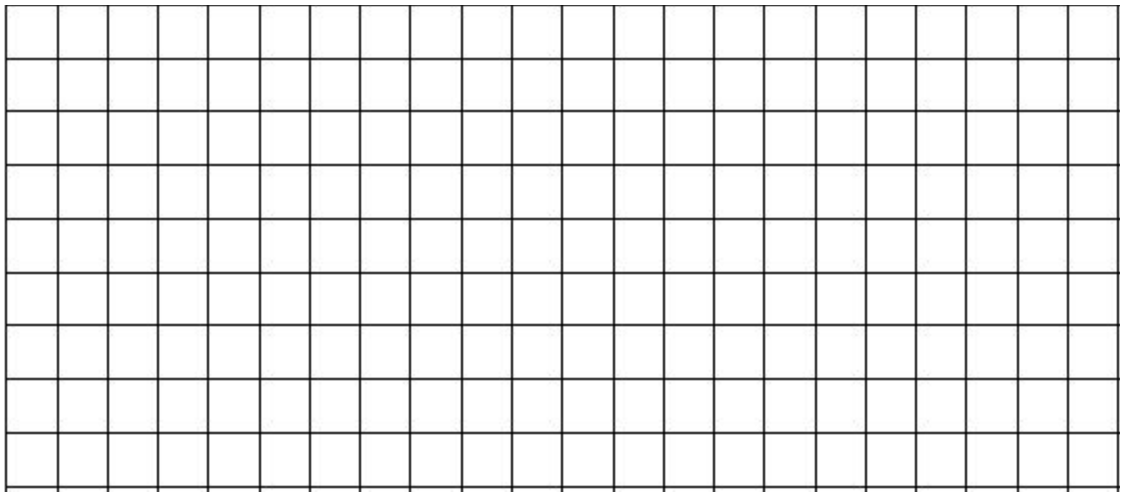

Figure 1: *This figure shows* _____

The key trend in this data is _____

This suggests that _____

_____

Discussion & Conclusion - *Is our hypothesis supported by our data? How does this relate to our research question? What conclusions can we reach based on this investigation?*
SEP: Constructing explanations & designing solutions. Making evidence-based arguments. Obtaining, evaluating, & communicating information.

1. Restate your research question and hypothesis.

   We wondered if: _____

   _____

   We predicted: _____

   _____

2. Was your hypothesis supported by your data? Yes / No / Not sure (*circle one*).

   Explain: _____

   _____

   _____

3. Are these results reliable & valid? Would a second trial have the exact same results? Explain.

   _____

   _____

   _____

4. What could we change to make our experiments have more valid and reliable findings?

   _____

   _____

   _____

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Part 4: Review & Assessment (1.1.4)

Step 1: Review the content for this packet. Identify any concepts that are still unclear to you.
Step 2: Identify and discuss any remaining confusion with your instructor.
Step 3: Complete the Lesson Check (individually or small groups). Compare responses as a class.
Step 4: If your responses show more help is needed, your instructor will provide further support.

Part 5: Career Profiles (1.1.5)

Overview: In this activity, you will explore a career that interests you and is related to the topic of this unit.

Directions - *Carefully read the directions below before beginning. Record info where prompted.*

1. ☐ Visit the AgExplorer website: (or just type "FFA AgExplorer" into a search engine like Google).
   a. You can also use the Bureau of Labor Statistics (www.bls.gov) if you can't find a career that works for you on the original website.
2. ☐ Click "View All Careers". Use the filters to narrow down your search to careers related to this unit and based on your interests and goals.
3. ☐ Click on a profession to gain more information.
   a. If you are satisfied with that choice, complete the questions below.
   b. You can continue looking at other jobs but be mindful of limited time.
   c. Talk with your instructor if you encounter difficulties.

Questions - *Record your responses in the spaces provided.*

1. What is the name of the career? _____
2. Why did you choose this one? _____

   _____
3. What is the job market (*number of job openings*) like for this career? _____
4. What is the average income for this career? $_____/year
5. What level of education is needed for this job? See "Education/Training Required".

   _____

6. What classes can you take in high school to prepare for this kind of job?

_____

7. Summarize this career. What do people with this job do on a daily basis?

_____

_____

8. Use AgCareers or the University of Wisconsin System website to find a college or university that could prepare you for this career. List the school and a related major in the space below.

   School, College, or University: _____

   Major, Degree, or Program: _____

9. What is the tuition to attend this school? Use an internet search engine to obtain this info if it is not available on the resources listed above.

_____

10. Create three questions about this career or about life after high school in general. If time allows, talk with your instructor individually, in small groups, or as a class to get more information.

_____

_____

_____

_____

_____

_____

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Packet 1.1 Lesson Check (1.1.4)

Name: _____Hour____Date:_____Score:_____

Directions: Your instructor may allow you to work in assigned groups. If so, have a different person write each response while others assist. If you are stuck, refer to your work in this packet and the resources linked on pg. 1.

Background: *1) A group of students wonder if coffee can increase the size of growing radishes. 2) They predict that the caffeine in coffee may help plants grow larger. 3) They think this because the caffeine might enable the plants to have more energy for growth and development. 4) To test their ideas, they plant six radish seeds in soil treated with diluted coffee, and compare their average final mass to six radishes grown in regular soil.*

1. **What is their <u>research question</u>?** _____

   _____

   Hint: what are they wondering? What question are they trying to figure out with their experiment?

2. **What is their <u>hypothesis</u>?** _____

   _____

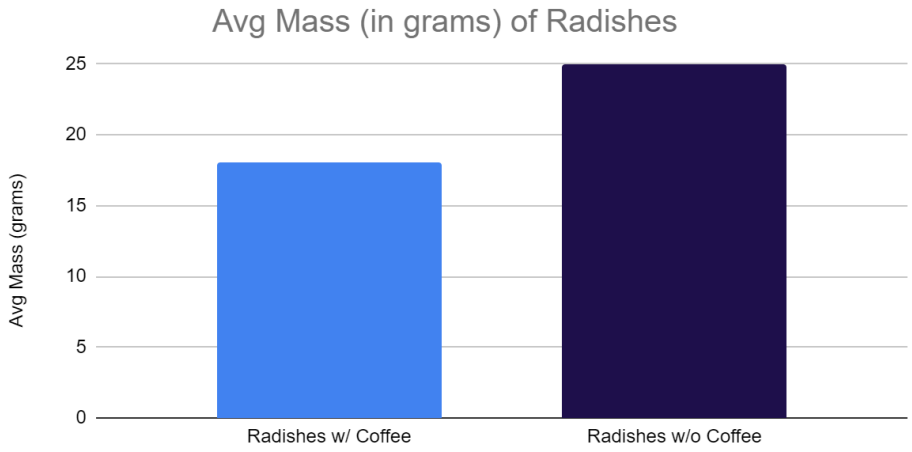
   Hint: what was their prediction?

3. **What is their <u>rationale</u>?** _____

   _____

   Hint: why did they think their prediction would be accurate?

4. **Which of the following claims is supported by the students' data shown below**?
   a. The radishes treated with coffee grew larger than the radishes without coffee.
   b. The radishes treated with coffee grew smaller than the radishes without coffee.
   c. There was no clear difference between the mass of radishes in each treatment.
   d. Coffee helps radishes grow larger.



5. **Write an effective caption:** *This graph shows the following trends*:_____

   _____

   These trends suggest that…_____

   _____

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6. **Was their hypothesis supported by their data?** Yes / No / Unclear (*circle one*) **Explain:**

7. **Based on their data, does coffee improve plant growth**? Yes / No / Unclear (*circle one*)
   Is this more reflective of a fact or an opinion? Fact / Opinion (*circle one*) **Explain**:

8. **Do you think that this experiment yielded valid and reliable results? Why or why not?**
   (Validity: does this experiment measure what it's supposed to measure? Reliability: are the results consistent & repeatable?)

   Note: at this point in the semester, you are still learning what makes data valid & reliable. For now, do your best to respond to this question and support your ideas with logic and reasoning. As you gain more experience, you will be able to provide more effective responses.

9. **Suggest specific ways to improve this experiment in order to get more valid and/or reliable data.**

10. These students want to find additional information online to see if their findings and ideas are accurate. **Summarize at least three criteria that would suggest that an internet source is credible & reliable**.

    1.

    2.

    3.