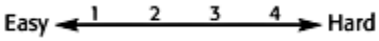
UNIT PROJECT WORKSHEET

# Investigating Plant Systems

**TIME REQUIRED** One 45-minute class period; up to 3 weeks of observation

## LAB RATINGS




Teacher Prep–3
Student Setup–3
Concept Level–2
Cleanup–2

## SAFETY INFORMATION

Review the soil and plant materials students intend to place in their ecosystems. Organisms should be handled with care. Students should use gloves when handling any seeds, soil, or fertilizer. Check to see if any student has a latex allergy, and supply non-latex gloves. If gloves are not available, have students wash their hands immediately after handling these materials.

## SETUP AND PROCEDURE

- At least two weeks before the scheduled lab, plant a sample of seedlings. Demonstrate ideal conditions for a control group (measured watering, light for 8–10 hours per day, good soil, and so on). Then show some options for variables, such as very cold conditions in a refrigerator.
- Encourage students to discuss and plan variables they would like to test as they grow seedlings.
- Provide germinated seeds that sprout quickly, such as those of the cabbage family (bok choy, broccoli, kale, lettuce, cauliflower, etc.). If students are bringing in seeds, make sure they are packaged for the current year.
- Some students may need encouragement to maintain the necessary conditions (watering, temperature, etc.) to test certain variables. You may make a checklist for students to run through each day.
- Encourage a range of variables to be tested as long as the plants have a chance for survival.
- Assist students who need help distinguishing the subtle changes as a plant grows or the small variations in the growth of plants in each group.
- Some students may request Internet resources to research additional information about plant systems and homeostasis.
- Students can work in groups or independently.

## ANSWER KEY

### Predict

1. What environmental factors will affect the growth of your seedlings?

*Answers will vary but should include many of the following conditions: amount of water, light, soil quality, nutrients in the soil, air quality, temperature.*

2. What role will homeostasis play in their growth and development?
*Answers will vary but should reflect on the possible stabilizing effects of homeostasis on a plant's growth, even in poor conditions.*

3. What evidence do you need to gather to answer Questions 1 and 2?
*Answers will vary but might include the survival, height, color variations, and other characteristics of each plant grown under different conditions.*

## Lesson 1: Life in the Earth System

In your Evidence Notebook, draw a diagram demonstrating how various systems affect the growth of your seedlings.
*Diagrams will vary but should show the effects of one or more systems on plants. For example, they could show biotic and abiotic factors such as sunlight, water, soil, and nutrients present in the soil.*

Answer the following questions in your Evidence Notebook:

1. What different systems interacted to influence the growth and development of your seedlings? How did abiotic parts of the ecosystem affect the plants?
*Systems that interacted could include the sun, soil, atmosphere, systems inside the seedling, or systems inside the school building. The abiotic components could include light, water, gases in air, soil, and containers used to house plants.*

2. What energy and matter inputs led to the growth and development of your seedlings? Use evidence to support your claims.
*Students should recognize that light is an energy input for the seedling. Water and nutrients from the soil, as well as gases from the air, are matter inputs. Students' evidence could include observations such as reduced plant growth when a factor such as light, water, or nutrients was limited.*

## Lesson 2: Organisms: Cells to Body Systems

In your Evidence Notebook, draw a model of a plant cell. In your model, explain the roles of cell walls, vacuoles, and chloroplasts in maintaining the cell.
*Students' models should show that cell walls maintain a cell's shape, while chloroplasts are organelles that capture energy from light and convert it to a form of energy the cell can use. Vacuoles store materials needed by a cell and maintain cell shape. All cell parts should be accurately labeled with their functions listed.*

Answer the following questions in your Evidence Notebook:

1. Describe the hierarchical organization in organisms, from cells to organ systems. What levels of organization are present in your plant? Use evidence to support your claims.
*Organisms may have levels of organization including cells, tissues, organs, and organ systems. Systems work together at different levels to maintain the organism. In the plant, there are cells, which can be observed under a microscope, tissues for transporting water and nutrients, and organs such as leaves, stems, and roots.*

2. How do different systems in the plant interact to carry out functions such as water uptake, photosynthesis, and growth? How did the variable you tested affect these functions?
*Sample answer: Vessels in the stem transport water from the roots to cells in the leaves. The leaves then collect light and use the energy for growth. In the group of plants that were not exposed to light, the seedlings did not grow at the same rate. Therefore, the leaves were not able to collect the energy needed for plant growth.*

## Lesson 3: Mechanisms of Homeostasis

In your Evidence Notebook, make a chart indicating the development of your seedlings, including your control group and variable groups.
*Student charts should show several stages of growth and indicate which drawings correspond to the control and variable growths.*

Answer the following questions in your Evidence Notebook:

1. Describe conditions that must remain relatively stable for ideal plant growth. Explain how you altered these conditions in your experiment.
   *Conditions could include water, light, nutrient concentrations, or soil quality. Students should explain how they altered one factor in their experiment.*

2. Explain how plants use homeostasis to maintain balance over a period of less than ideal conditions. What evidence of homeostasis do you observe in your seedlings?
   *Examples may include closing stomata to decrease water loss or increased root growth during drought. Student observations could include alterations to plant size, shape, or coloration due to limited water, light, or nutrients. Encourage students to do further research as necessary when completing this section.*

## Lesson 4: Bioengineering

Answer the following questions in your Evidence Notebook:

1. What problems did you experience in the course of growing your seedlings?
   *Answers will vary but may include problems related to water application, soil testing, or space limitations.*

2. How can the engineering design process be used to solve problems related to growing seedlings? How can the design solution be optimized?
   *Students may suggest the engineering process could be used to design solutions such as automatic water dispensing systems, growing containers, or soil quality monitoring systems. The design process should include defining and delimiting the problem, suggesting and testing a solution, analyzing results, retesting, and optimizing the design based on findings.*

# Scoring Rubric

| Scoring Rubric for Unit Project | |
|---|---|
| 0 – 5 | The worksheet, lab write-up, and/or presentation states a claim supported with detailed evidence to show how plants grow under different conditions. |
| 0 – 5 | Each model created accurately shows how different conditions affect plant growth. |
| 0 – 5 | The worksheet, lab write-up, and/or presentation presents work in a well-organized format that is logical, easy to understand, and informative. |
| 0 – 5 | The worksheet, lab write-up, and/or presentation uses photos or art pieces as evidence to show how different conditions affect plant growth over the course of the project. |

**FINAL PERFORMANCE EVENT**

# Investigating Plant Systems

We depend on growing plants to sustain life on Earth. What factors contribute to seeds sprouting and growing into healthy plants? What happens inside the seed, and how does homeostasis regulate this process? In this performance event you will be given data from an experiment where plants were grown in different conditions.

## Background Information

When you plant a seed, you probably know you must bury it in soil and water it. But what else affects how a seed grows? Different seeds need different conditions to grow and thrive. This data will be about Wisconsin Fast Plants, a plant that has been bred to grow very quickly. To do this it needs: bright light 24 hours a day, a temperature between 70-80 degrees, and readily available water. When properly pollinated, the Wisconsin Fast Plant can go from seed to producing seeds in 40 days. In this experiment, two different conditions will be tested: pH of the soil (is the soil acidic or basic) and temperature.

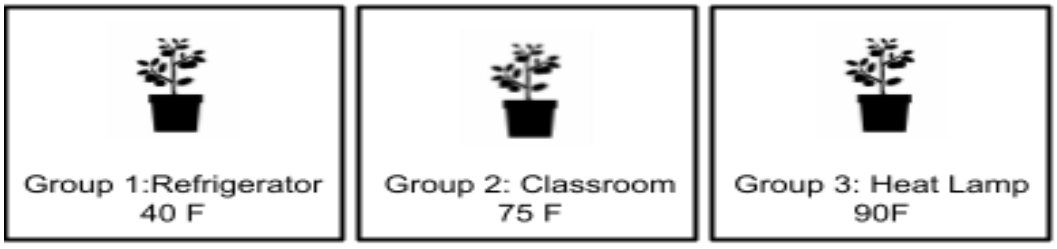
## Predict

1. What role will homeostasis play in their growth and development?

2. What evidence will you look for in the data to show that the Fast Plants are maintaining homeostasis?

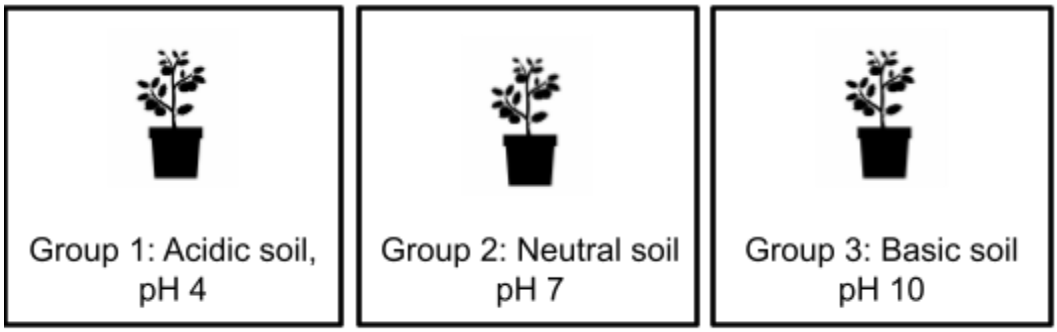
## Procedure

Test Group 1: Temperature




Constants: grow light, water, soil type, planting depth, soil pH, same plastic planters used for each plant

Test Group 2: Soil pH




Constants: grow light, water, soil type, planting depth, temperature, same plastic planters used for each plant

To set up the two test groups, students planted 10 plants in identical plastic containers for each testing area, for a total of 60 plants. They measured the depth of the seed, the pH of the soil, and the temperature of the environment. The students also set up identical grow lights for each test group and left them on at all times.

For test group 1, students set up 10 plants in the classroom, 10 plants in the refrigerator, and 10 plants under a heat lamp with a thermometer.

For test group 2, students set up 30 plants in the classroom with identical grow lights. They measured the pH of the soil and it had a neutral pH of 7, so the students used this soil for 10 plants. Then, they added powdered limestone to the basic soil group to increase the pH to 10. They added peat moss to the acidic soil group to decrease the pH to 4.

The students checked conditions daily and after 6 weeks of growth they measured the plant heights. They took daily photos to track the condition of the plants. Then, after 6 weeks, students measured the height of the plants. Each cell shows the average growth over all 10 plants in the test group.

**Table 1: Plant Measurements**

| Temperature Test Group | | | pH Test Group | | |
|---|---|---|---|---|---|
| **40F** | **75F** | **90F** | **pH 4** | **pH 7** | **pH 10** |
| **0 cm** | **16 cm** | **3 cm** | **9 cm** | **14 cm** | **10 cm** |

Name: Date:

# Lesson 1: Life in the Earth System

Answer the following questions. Be sure to use complete sentences and use evidence from the data to support your answers when applicable.

1. How did abiotic parts of the ecosystem affect the plants? Which abiotic factor had a greater impact on plant growth?

2. What energy and matter inputs led to the growth and development of your seedlings? Use evidence to support your claims.

# Lesson 2: organisms: cells to body systems

Answer the following questions. Be sure to use complete sentences and use evidence from the data to support your answers when applicable.

1. What levels of organization (from cells to organ systems) are present in your plant? Use evidence to support your claims. (*Hint:* consider what you measured as you

2. How do different systems in the plant interact to carry out functions such as water uptake, photosynthesis, and growth? How did the variable you tested affect these functions?

# Lesson 3: mechanisms of homeostasis

In your Evidence Notebook, make a chart indicating the development of your seedlings, including your control group and variable groups.

Answer the following questions in your Evidence Notebook:

1. Describe conditions that must remain relatively stable for ideal plant growth. Explain how you altered these conditions in your experiment.

2. Explain how plants use homeostasis to maintain balance over a period of less than ideal conditions. What evidence of homeostasis do you observe in your seedlings?

# Lesson 4: BIOENGINEERING

Answer the following questions in your Evidence Notebook:

1. What problems did you experience in the course of growing your seedlings?

2. How can the engineering design process be used to solve problems related to growing seedlings? How can the design solution be optimized?

# CONCLUDE

Write a conclusion demonstrating your findings from this experiment in your Evidence Notebook. Include all data you collected and create at least one graphic representation of your data. In your conclusion, answer the following questions:

1. What variables did you test in growing your seedlings? How did you maintain the variables throughout the experiment?
2. What qualities did you use for the control group?
3. Which changes within each group did you observe?
4. Were your predictions about variables confirmed? Why or why not?
5. Which changes in your experiment surprised you the most? What did you learn from observing the changes?

# EXTEND

**Designing Experiments** Alter your seedling experiment in one of the following ways, and monitor the results of the changes: double the amount of plants in each group to gather more accurate data; change the type of seeds used; increase the intensity of the variables—for example, give each plant even less water for a longer period of time; experiment with a different soil type, such as rocky soil or soil with high salinity; experiment with a type of natural fertilizer.

# PRESENT

Develop a presentation that answers the questions from the beginning of this experiment:

1. What environmental factors will affect the growth of your seeds?
2. What role will homeostasis play in their growth and development?
3. What evidence do you need to gather to answer Questions 1 and 2?

Use evidence gathered over the course of the experiment to support your claims. Photos, drawings, data tables, and graphs may be useful evidence to include in your presentation.