LESSON 12

Planning and Setting Up Germination Experiments

Overview

This lesson and the next take advantage of the rapid life cycle of Wisconsin Fast Plants™. Students begin the cycle once again, with seeds harvested from their first set of plants. First, students individually plan and set up a seed germination experiment using seeds harvested in Lesson 8. Then in Lesson 13, students analyze the data from their experiments and draw some conclusions.

This lesson is a good opportunity for the students to review the elements of a soundly based experiment: forming a hypothesis, devising an experiment to test the hypothesis, and setting up an experiment, including the controls.

The experiment should run for 4 or 5 days, so try to begin it on a Monday or Tuesday. The next lesson should take place 5 or 6 school days from now.

These experiments are an opportunity for you to make individual assessments of what the students have learned about the experimental method.

Objectives

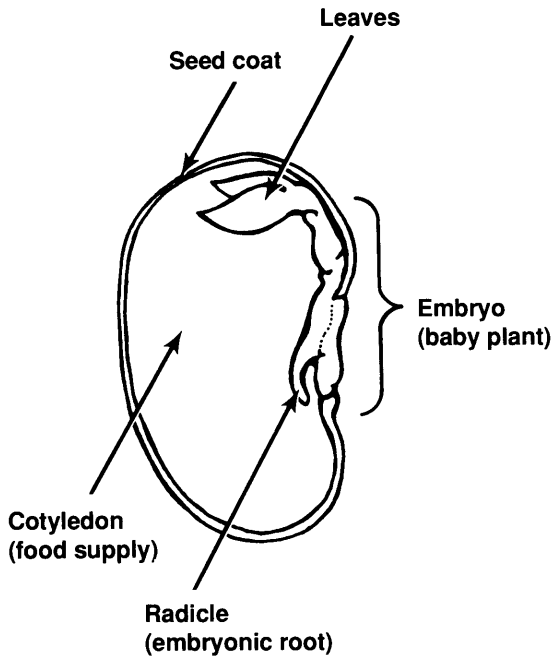
- Students review techniques and reinforce skills learned in planning experiments.
- Students use these skills to set up a controlled experiment in seed germination.
- The teacher evaluates how well the students can plan and set up a controlled experiment.

Background

Germination, otherwise known as sprouting, is the beginning of growth of a new plant from a seed. A seed is the ripened ovule of a flowering plant containing the embryo and **cotyledon**, or food supply, packaged inside a protective seed coat. Seeds remain **dormant**, or temporarily inactive, until conditions are suitable for the first stage of plant growth—germination. The parts of a bean seed are shown in Figure 12-1.

Figure 12-1

Parts of a bean seed

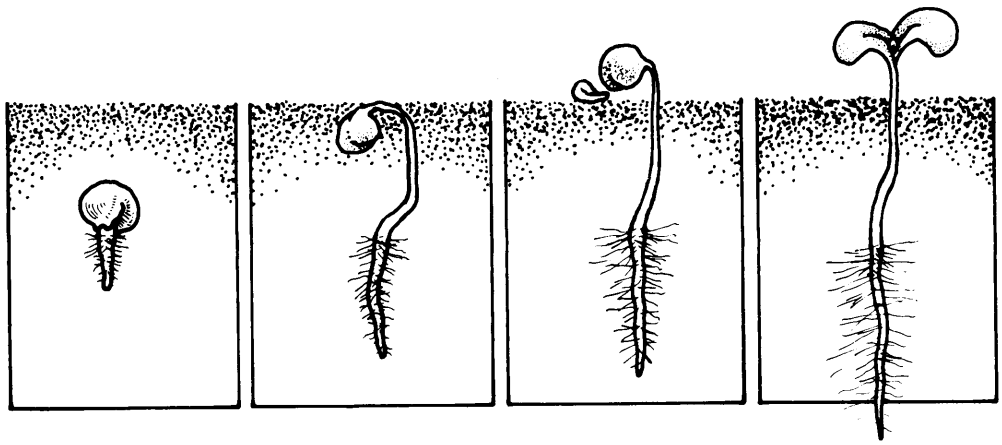


Several physical and chemical factors determine how quickly a seed germinates. The most important factors are temperature, moisture, light, oxygen, and genetic makeup. Some of these factors are potentially appropriate variables for experiments.

The first sign that the process of germination has begun is that the seed swells from having taken in water. Then the seed coat splits open. The first part to emerge from the seed is the embryonic root, called the **radicle**. It grows quickly downward, putting out fine root hairs that absorb minerals and water. Then the embryonic stem, or **hypocotyl**, pushes upward, pulling the seed leaves, or cotyledons, with it above the soil line. In Wisconsin Fast Plants™, all of this happens in 3 short days! Figure 12-2 shows these stages of growth.

Figure 12-2

How a seed germinates



A. The seed coat splits and the embryonic root, or radicle, emerges.

B. The radicle grows downward and develops root hairs.

C. The stem grows upward and pulls the cotyledons above the soil. The seed coat falls off.

D. The cotyledons open.

Materials

For each student

- 1 student notebook
- 1 **Activity Sheet 7, Planning the Germination Experiment**
- 1 **Activity Sheet 8, Observations and Data Collection for Germination Experiment**
- 1 sheet of transparency film
- 1 paper towel
- 2 small resealable plastic bags
- 4 *Brassica* seeds (harvested in Lesson 8)
- 1 toothpick

For each four-member team

- 1 cup of water (or other liquid provided by the students)
- 1 dropper

For the class

- 1 Planning Board
- Blank index cards cut to 1½" x 5"
- Staplers
- Scissors
- 3 thermometers

Preparation

1. Set up the distribution center for easy collection of materials.
2. Try to borrow extra staplers and scissors.

Procedure

1. Open a discussion on germination to find out what the students know about the subject already. You will also want to establish the variables for this experiment.

   Ask, "What is germination?" (The sprouting of a seed, the beginning of seed growth.) Then ask, "What time of year do seeds germinate in nature?" (Spring.) Discuss the fact that spring is the time of year when conditions of light, moisture, and temperature are favorable for plant growth. Light, moisture, and temperature also make good variables to test in a germination experiment.

2. Display the planning board. Students have used this technique several times before, and they now should be accustomed to the pattern of thinking that it represents. Using the same procedures as before, ask the students to list the variables that it might be important to consider in a germination experiment.
3. Write these variables on the blank cards and attach them to the planning board under "Variables we will not change." Then transfer one of the variables to the left-hand column, "Variable we will test."
4. Discuss this variable and the kinds of testable questions you might ask about it. The planning board and variables are shown in Figure 12-3.

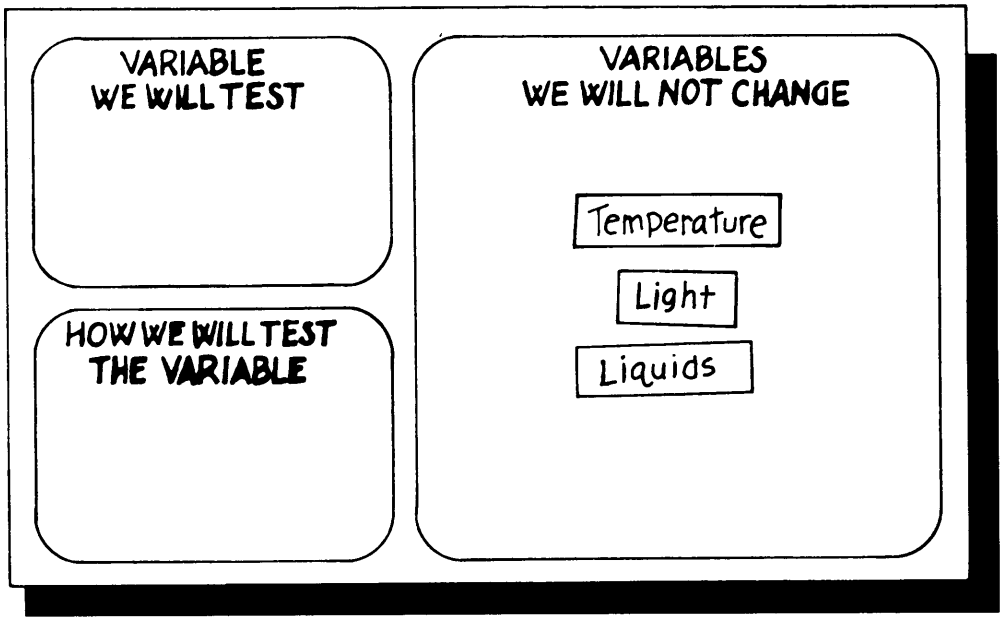


Figure 12-3

Planning board for the germination experiment

5. Below are some examples of germination topics that students have investigated successfully:

Variable to be tested: LIGHT

Questions:

- Do seeds germinate faster under lights or in the dark?
- Do seeds germinate faster in a different color light? (The student can test for this by putting a colored sheet of transparency film over the experimental germination chamber.)

Variable to be tested: MOISTURE

Questions:

- Will seeds germinate in liquids other than water?

Note: Students love this one. They delight in dousing their seeds with everything from ammonia to beer. Be prepared to set limits on what you can live with for 3 or 4 days.

Variable to be tested: TEMPERATURE

Questions:

- Will seeds sprout in the refrigerator?
- Will seeds sprout on the radiator?

Note: You may find that several students want to investigate the same variable in the same way. This is fine; in fact, this is best. Scientists often try to replicate each other's experiments. And the students will collect more data on the same variable, which makes for a more convincing set of evidence.

6. Distribute **Activity Sheet 7, Planning the Germination Experiment**. Preview the sheet with the students, then allow them time to work on it to plan their individual projects. You may want to use this sheet as an evaluation tool to find out how well the students have mastered the technique of planning an experiment. (See the **Evaluation** section at the end of this lesson.)

7. Either distribute **Activity Sheet 8, Observations and Data Collection for Germination Experiments**, or use it as a model to show the students how to set up their notebooks.

8. Direct the students to the distribution station to pick up the supplies for putting together their two germination chambers. Tell them to follow the directions for assembling and labeling the chambers (one experimental, one control) on pg. 59 in their Student Activity Book. These directions are reproduced for you on pg. 97.

9. Encourage independent, creative work:

   - Allow the students to set up their experiments in any reasonable location. These might include tacking the plastic bags to the classroom bulletin board, hanging them from the warm cafeteria ceiling, setting them on a dark library shelf, or even snuggling them under a pillow at home.
   - Also, tell the students that the data charts are only suggestions of how to collect data; they are free to make improvements.

10. Ask for the students' ideas on where to keep the control germination chambers that they have set up. In order for this to be a fair test, all of the control chambers should be kept together in a location that gets light, is reasonably warm (60°F or 15°C or above), and is monitored easily. You may want to make a corner of the bulletin board or a spare table top available.

Final Activities

1. Make it clear that the students are to continue their germination experiments independently for the next 3 or 4 days, depending on what fits into your class schedule. They are expected to make daily observations and keep records. After that time, the class will come together to share data and draw conclusions.

2. Select three individuals experimenting with different variables to give brief descriptions of their experimental plans. Ask the class to comment on the strengths of the plans, to offer alternative plans, and to predict the outcome of the experiments.

Extensions

Do germination experiments with other seeds. Students may be interested in knowing if Wisconsin Fast Plants™ are faster germinators than other seeds. Try bean, radish, or grass seeds for a quick response or collect free seeds from the playground or lunch boxes. These might include acorns and dandelions or apple and orange seeds.

Evaluation

Activity Sheet 7, Planning the Germination Experiment, may be used to evaluate how well individual students have mastered the skills involved in planning a good experiment. Check that students have done the following:

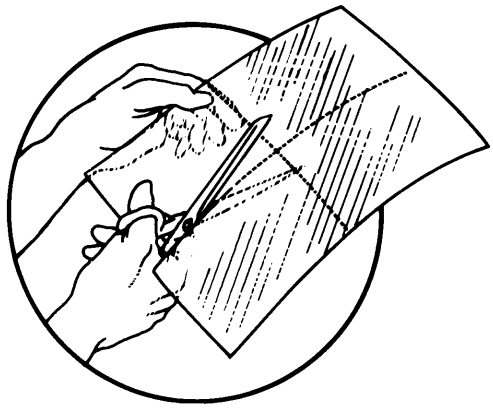
- selected only one variable to test

- identified a specific testable question involving that variable
- listed something to count and something to measure
- listed some observable characteristics of the germinating seedling to record, such as color, shape, size, and time to develop
- stated a reasonable hypothesis

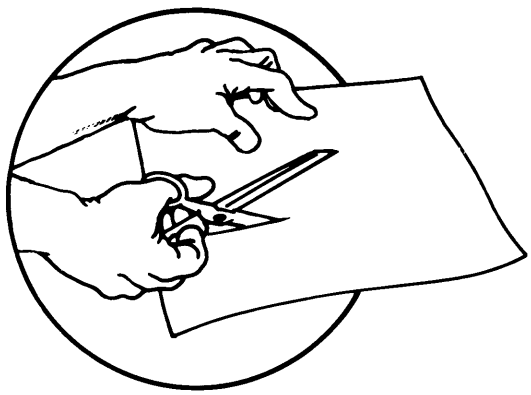
INSTRUCTIONS FOR HOW TO MAKE GERMINATION CHAMBERS

You will make two germination chambers, one for your control seeds and one for your experimental seeds. Follow these instruction step by step.

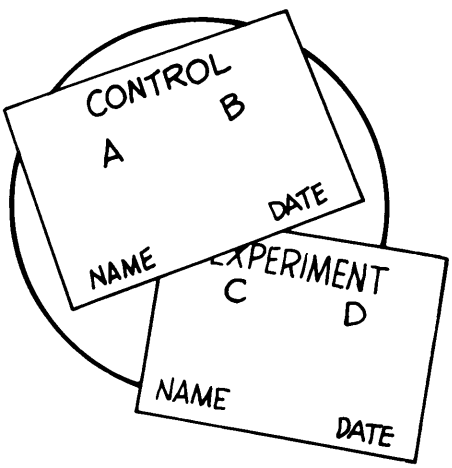
1. Cut the sheet of transparency film into four pieces the same size.



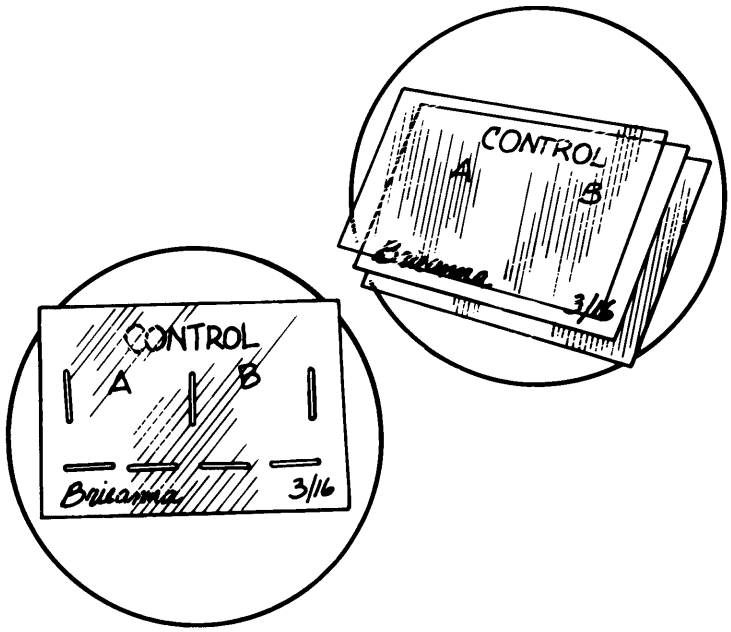
2. Cut the paper towel into two pieces the same size as the transparency film.



3. Use a pencil (ink might run) to label your paper towels. Include your name and today's date. Label one towel "control," and label its two seed compartments A and B. Label the other towel "experimental" and mark its two seed compartments C and D.

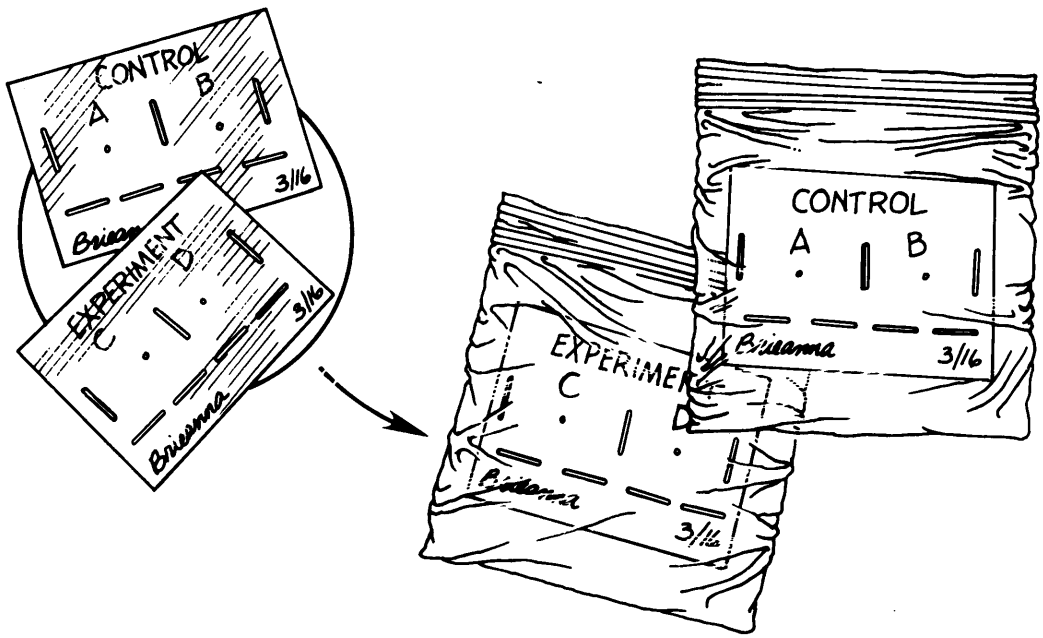


4. Put each labeled paper towel between two pieces of transparency film. Staple the towel and the transparency film together as shown. Don't get carried away; seven staples are plenty.



5. Use the toothpick to place one seed in each of the four compartments you labeled A, B, C, and D.

6. Put each germination chamber into a separate plastic bag and use a dropper to add water (or the liquid of your choice if this is the variable you have chosen to experiment with). Soak the paper towel thoroughly, then stop. Do not leave more than a drop or two of extra liquid standing in the bottom of the plastic bag.



7 Close the plastic bags and place them in the locations of your choice.

8. Be sure to record the starting time of your experiment in your notebook.

Planning the Germination Experiment

Activity Sheet 7

NAME: _____

DATE: _____

1. The one variable I will test is: _____

2. The question I will try to answer about that variable is: _____

3. How I will test that variable: _____

4. What I will measure: _____

5. What I will count: _____

6. What I will observe: _____

7. How I will record the data: _____

8. My hypothesis is (this is what I think will happen to the seeds): _____

Observations and Data Collection for Germination Experiment

Activity Sheet 8

NAME: _____

DATE: _____

The variable I am testing is: _____

I started my experiment on _____ (date) at _____ (am/pm)

	Control Seeds		**Experimental Seeds**	
Changes in the Seed	Time and Date	Observations	Time and Date	Observations
Seed swells	A.		C.	
	B.		D.	
Seed coat cracks	A.		C.	
	B.		D.	
Radicle emerges	A.		C.	
	B.		D.	
Cotyledons appear	A.		C.	
	B.		D.	