

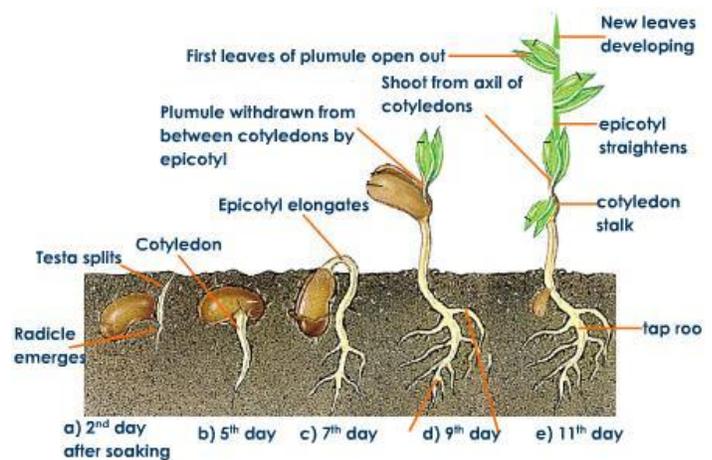
## Student

### Seed Germination Inquiry Lab

#### NGSSS:

**SC.912.N.1.1** Define a problem based on a specific body of knowledge, for example: biology, chemistry, physics, and earth/space science, and do the following: 1) pose questions about the natural world, 2) conduct systematic observations, 3) examine books and other sources of information to see what is already known, 4) review what is known in light of empirical evidence, 5) plan investigations, 6) use tools to gather, analyze, and interpret data (this includes the use of measurement in metric and other systems, and also the generation and interpretation of graphical representations of data, including data tables and graphs), 7) pose answers, explanations, or descriptions of events, 8) generate explanations that explicate or describe natural phenomena (inferences), 9) use appropriate evidence and reasoning to justify these explanations to others, 10) communicate results of scientific investigations and, 11) evaluate the merits of the explanations produced by others. **(AA)**

**Background:** A seed is essentially a baby in a suitcase carrying its lunch. "Baby" refers to the embryo, or immature plant, that will grow and develop into the seedling and ultimately the mature plant. The "suitcase" is the seed coat that surrounds the seeds and "lunch" refers to the nutritive source for the germinating seedling. The food for the germinating seedling may be stored in part of the embryo itself, such as the fleshy cotyledons of a bean seed, or it may take other forms including endosperm, which is a special starch-rich storage tissue that surrounds the embryo.



It's not easy to tell if a seed is "dead." Only if it fails to germinate when provided the proper conditions and any dormancy mechanisms are broken can we consider a seed "dead." Seed companies typically test the germination of seeds before sale. The results of these tests, the germination percentage, are typically provided on a seed packet.

Many different factors can affect the germination percentage of plants. Think about what conditions are needed for seeds of the type you selected to germinate. The germination percentage tells you what fractions of seeds germinate out of a population of seeds. The equation to calculate germination percentage is:

$$GP = \text{seeds germinated} / \text{total seeds} \times 100$$

The radish (*Raphanus sativus*) is an edible root vegetable of the Brassicaceae family that was domesticated in Europe in pre-Roman times. They are grown and consumed throughout the world. Radishes have numerous varieties, varying in size, color and duration of required cultivation time. There are some radishes that are grown for their seeds; oilseed radishes are grown, as the name implies, for oil production. Radish can sprout from seed to small plant in as little as 3 days.

## Student

**Purpose:** The purpose of this lab experience is to provide an opportunity to:

1. Synthesize an original problem statement and hypothesis
2. measure seed germination percentage and rate
3. learn the requirements for seed germination
4. study the effect of various treatments on seed germination

## Instructions:

1. Choose problem statement.
2. Complete Experimental Design diagram.
3. Design experiment. **Do not proceed until you receive approval from your teacher.**
4. Obtain supplies needed.
5. Record data in provided data tables.

## Problem Statement:

Identify the question (problem to investigate) and state it clearly. (See below for guidelines)

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Inquiry questions might be categorized according to the main factors affecting seed germination. Choose only **ONE** question to research. (Feel free to choose an original problem statement.)

<b>Water</b> <ul style="list-style-type: none"><li>○ Is water essential for germination?</li><li>○ If we used hot water, would the seeds germinate?</li><li>○ Does water salinity affect seed germination?</li><li>○ How do pollutants affect seed germination?</li></ul>	<b>Soil</b> <ul style="list-style-type: none"><li>○ Is soil necessary for seed germination?</li><li>○ What type of soil is best for seed germination?</li></ul>
	<b>Temperature</b> <ul style="list-style-type: none"><li>○ How does temperature affect germination?</li></ul>
<b>Light</b> <ul style="list-style-type: none"><li>○ Is light or darkness essential for seeds to germinate?</li><li>○ How does light intensity affect seed germination?</li></ul>	<b>Seed Structure</b> <ul style="list-style-type: none"><li>○ Is the seed coat necessary for germination?</li><li>○ Can a seed germinate in soil if it is placed upside down?</li><li>○ How does the number of seeds affect germination rates?</li><li>○ What is the effect of radiation on seed germination?</li></ul>
<b>Air</b> <ul style="list-style-type: none"><li>○ Do seeds need air to germinate?</li></ul>	

## Experimental Design: Variables

Based on the problem statement selected identify the following variables that may affect germination:

Independent Variable: \_\_\_\_\_

Dependent Variable: \_\_\_\_\_

Controlled Variable(s): \_\_\_\_\_

Constant Variable(s): \_\_\_\_\_

**Student**

**Hypothesis(es):**

Write your prediction as to how the independent variable will affect the dependent variable. You may use an **IF-THEN-BECAUSE** statement to help you:

**If** (state the independent variable) is (choose an action), **then** (state the dependent variable) will (choose an action), **because** (describe reason for event).

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**Materials:** Identify any materials you might need to complete the experiment.

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**Procedures:** Design an experiment to test your hypothesis.

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**Student**

**Data:**

**Part I. Species Selection and Research.** Record as much data about the seeds as possible.

Common name: \_\_\_\_\_ Scientific name: \_\_\_\_\_

Family Name: \_\_\_\_\_

**Part 2: Tables (Quantitative Data)**

Table 1. Germination data for seeds in <b>Control</b> Group			
Independent Variable	Total Seeds in Treatment	# Seeds Germinated	% Seeds Germinated

Table 2. Germination data for seeds in <b>Experimental</b> Group			
Independent Variable	Total Seeds in Treatment	# Seeds Germinated	% Seeds Germinated

**Part 3: Observations (Qualitative Data)**

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## Student

### Part 4: Graph

Use the graph provided that is provided at the end. **Remember** the **D**ependent variable is the **R**esponding variable that in a graph is recorded on the **Y**-axis; the **M**anipulated variable is the **I**ndependent variable and is graphed on the **X**-axis.

### Analysis:

1. What was the final germination percent of your seeds for the Control and Experimental groups? Were either/both of them what you expected? Explain.
2. On a separate sheet of graph paper, plot Percent Germination per Day for both the Experimental and Control groups on the same graph. Be sure to include a key.
3. What did the graph you created in #2 above tell you about seed germination?
4. Write a summary of the experiment that explains what you did. In your summary, address questions you had during the experiment, conclusions you made, and opportunities for further research. Use additional paper if necessary.

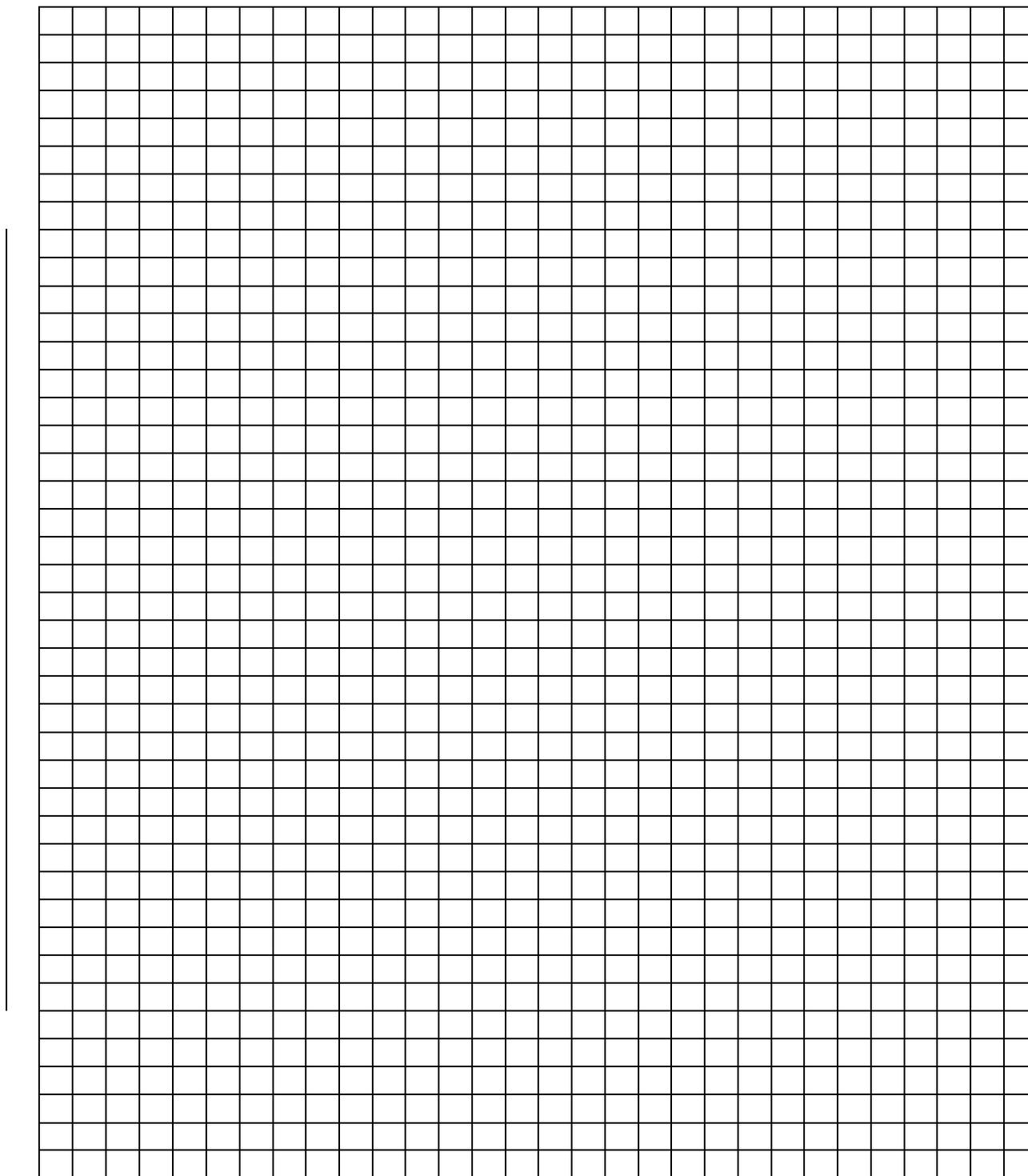
### Conclusion:

Write a conclusion using the "Power Writing Model 2009". Make sure to answer the following questions:

- What was investigated?
- Was the hypothesis supported by the data?
- What were the major findings?
- How did your findings compare with other researchers?
- What possible explanations can you offer for your findings?
- What recommendations do you have for further study and for improving the experiment?
- What are some possible applications of the experiment?

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Graph Title: \_\_\_\_\_



\_\_\_\_\_

Student

### Experimental Design Diagram

*Directions: Fill out the experimental design diagram for the seed germination experiment. You will not begin the experiment until it has been approved by the teacher.*

<b>Title:</b>				
<b>Problem Statement:</b>				
<b>Hypothesis:</b>				
<b>Independent (Manipulated) Variable:</b>				
<b>Number of Tests</b>				
<b>Number of Trials per Test:</b>				
<b>Dependent (Responding) Variable:</b>				
<b>Control Test:</b>				
<b>Variables Held Constant:</b>				

Teacher Signature: \_\_\_\_\_