

Background Information

The goal of science is to understand the world around us. This is done by applying the scientific method. In the scientific method, **hypotheses** are proposed and tested through the use of **controlled experiments**. However, this is often not as easy as it sounds.

You may already have observed that seeds do not germinate, or sprout, unless they are watered. In this investigation, you will form and test a hypothesis about how the amount of water given to seeds affects the number of seeds that germinate. You will compare seeds given a large amount of water with seeds given a smaller amount of water. You should have a controlled experiment, but is it possible that by varying the amount of water, you have introduced a **hidden variable**?

Problem

What effect does the amount of water given to seeds have on the rate of seed germination?

Materials (per group)

200 wheat or mustard seeds	3 Petri dishes with covers
2 50-mL beakers	graduated cylinder
glass-marking pencil	

Procedure**Part A**

1. In this investigation you will determine whether the amount of water given to wheat or mustard seeds has an effect on the number of seeds that germinate, or sprout. Before you begin, propose a **hypothesis** predicting the effect that varying amounts of water might have on seed germination. The steps that follow will help you test your hypothesis.
2. Place 50 seeds in each of the **two Petri dishes**.
3. Using the graduated cylinder, pour 5 mL of water into one Petri dish. Then pour 30 mL of water into the other Petri dish. Cover each Petri dish. Use the glass-marking pencil to indicate the volume of water in each.
4. Set both Petri dishes aside for 48 hours. After 48 hours, count the number of seeds in each Petri dish that have begun to germinate. Record your observations in the data table.

Part B

1. Place 50 seeds in each of the **two beakers**.
2. Using the graduated cylinder, pour 5 mL of water into one beaker and 30 mL of water into the other. Cover each beaker with the top or bottom of the remaining Petri dish. Then, using the glass-marking pencil, indicate on the cover the volume of water in each beaker.
3. Set the beakers aside for 48 hours. After 48 hours, count the number of seeds in each beaker that have begun to germinate and record your results in the data table.

Observations

1. Your Proposed Hypothesis: _____

Data Table

Number of Seeds Sprouting in Different Volumes of Water

Type of Container	Volume of Water		Totals
	5 mL	30 mL	
Petri dish			
Beaker			
Totals			

1. Did the seeds float in any of the containers? If so, were these seeds more likely to germinate?
2. In which container did the germinated seeds have the longest roots, Petri or beaker?

Analysis and Conclusions

1. How did the number of germinated seeds in the Petri dishes compare to the number of germinated seeds in the beakers?
2. Did the amount of water in the **Petri dishes** appear to affect the number of germinated seeds? Did these results confirm your hypothesis?
3. Did the amount of water in the **beakers** appear to affect the number of germinated seeds? Did these results confirm your original hypothesis?
4. Sometimes the results of different parts of an experiment provide different interpretations. When this occurs, scientists often look to see if a hidden variable, which might affect the overall results of an investigation, was introduced. What hidden variable might account for the results you observed in the Petri dishes and in the beakers? (**Hint:** Other than water, what substance may have played a role in the germination of the seeds?)

Critical Thinking and Application

1. A scientist decided to test the hypothesis that the more water seeds are given, the more seeds will sprout. To make sure that the depth of the water remained the same in each container regardless of the volume of water, the scientist varied the sizes of the containers. Is this a controlled experiment? Explain your answer.
2. Based on the results of the experiment you performed to test your hypothesis, what recommendations would you make to a farmer about watering seeds?
3. Why is it necessary to test many seeds in each container and not just a single seed in each container?
4. A scientist performed a controlled experiment in which the volume of water made available to seeds was varied. The experiment was repeated three times. In each of the three trials, 10 mL, 20 mL, and 30 mL of water were used. The results are shown in the accompanying data table.
 - a) What does the data suggest?
 - b) Why does the data differ in the column marked 10 mL for each of the three trials?
 - c) Why is it useful to repeat the experiment many times?

Number of Seeds Sprouting in Different Volumes of Water

Trial Number	Volume of Water		
	10 mL	20 mL	30 mL
1	70	68	69
2	63	69	72
3	71	67	63

5. Find the average number of seeds germinating in each of the different volumes of water.
 - a) 10 mL = _____
 - b) 20 mL = _____
 - c) 30 mL = _____

6. Graph your group's data from this experiment. Use a bar graph to show the relationship between water amounts and germination success.

