

Name: _____ Date: _____

Student Exploration: Seed Germination

Vocabulary: controlled experiment, germinate, hypothesis, mean, seed, trial, variable

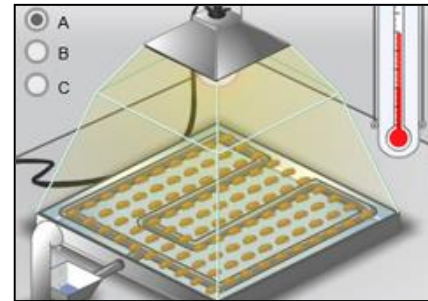
Prior Knowledge Question (Do this BEFORE using the Gizmo.)

Plants that produce fruit or vegetables grow from **seeds**. Suppose you want to start a vegetable garden using seeds. How could you get the seeds to sprout?

Gizmo Warm-up

Seeds are only able to sprout, or **germinate**, under the right conditions. The seeds of different species of plants need different amounts of light, temperatures, and moisture levels in order to germinate successfully.

In the *Seed Germination* Gizmo™, you will perform a series of experiments to determine the best conditions for germinating three different types of seeds.



1. Look at the DESCRIPTION tab. How many seeds are in the germination chamber? _____

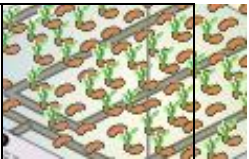
2. Click **Play** (▶), and observe the SIMULATION pane.

A. What happened over the simulated five-day period? _____

B. How does the appearance of a seed on the SIMULATION pane change once the seed has sprouted? _____

C. How many seeds sprouted? _____

D. How many seeds did not sprout? _____

Activity A: Repeating Trials	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> • Click Reset (↺). • Select the BAR CHART tab and turn on Show numerical values. 	
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Question: Why is it important to repeat an experiment multiple times?

1. Collect data: Each time you run an experiment with the Gizmo, you complete a trial. A **trial** is single time that you conduct an experiment.

Make sure **Seed type: A** is selected on the SIMULATION pane. The **Water** level should be set to 50 drops per hour. The **Light** should be at 50%, and the **Temp.** should be 18 °C. At these settings, click **Play** to run the Gizmo and complete the first trial. Record your results in the first row of the table below. Then, use the Gizmo to run two more trials.

Trial	Number of seeds	Number of sprouts
1		
2		
3		
Mean		

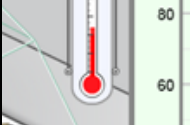
2. Calculate: Find the **mean**, or average, for each trial. Add the number of seeds from each trial together. Then, divide the sum by 3. Record the result in the table, and then repeat the calculation for the number of sprouts from each trial.

3. Compare: How do the results from the three trials compare? _____

4. Infer: What do you think caused the differences between the results of each trial? _____

5. Draw conclusions: Use the data you collected to explain why it is important to repeat an experiment multiple times. _____



Activity B:	<u>Get the Gizmo ready:</u>	
Variables	<ul style="list-style-type: none"> Click Reset. Make sure Seed type: A is selected. 	

Question: In what conditions will seed A have the highest germination rate?

- Collect data: Use the **Water**, **Light**, and **Temp.** sliders on the SIMULATION pane to set up each scenario listed in the table below. Complete three trials for each scenario and record your results in the table. Then, calculate the mean of the three trials for the last column.

Water (drops/hr)	Light	Temp.	Number of sprouts			Mean number of sprouts
			Trial 1	Trial 2	Trial 3	
30	15%	10 °C				
60	45%	20 °C				
90	80%	30 °C				

- Analyze: Use the data you collected to answer the questions below.

A. Which scenario had the highest germination rate? _____

B. A **variable** is something that can be changed in an experiment. In the experiments you just performed, you changed the water, light, and temperature. Can you tell which of these variables affected the germination rate? Explain your answer.

C. A **controlled experiment** is an experiment in which only one variable is changed at a time. Why is it important to do a controlled experiment in order to determine how a variable, such as water, light, or temperature, affects seed germination rates?

- Form a hypothesis: A **hypothesis** is a proposed explanation for an observation. Write a hypothesis about what conditions would be best for germinating seed A.

(Activity B continued on next page)

Activity B (continued from previous page)

4. Experiment: You will now run a set of controlled experiments to test each variable separately. Complete three trials for each scenario in the tables below. Record your results.

Water (drops/hr)	Light	Temp.	Number of sprouts			Mean number of sprouts
			Trial 1	Trial 2	Trial 3	
50	50%	5 °C				
50	50%	15 °C				
50	50%	25 °C				
50	50%	35 °C				

Water (drops/hr)	Light	Temp.	Number of sprouts			Mean number of sprouts
			Trial 1	Trial 2	Trial 3	
50	0%	18 °C				
50	50%	18 °C				
50	100%	18 °C				

Water (drops/hr)	Light	Temp.	Number of sprouts			Mean number of sprouts
			Trial 1	Trial 2	Trial 3	
0	50%	18 °C				
50	50%	18 °C				
100	50%	18 °C				


5. Analyze: Describe the effect of each variable on seed A's germination rate. _____

6. Challenge yourself: Experiment to find the best combination of water amount, light level, and temperature at which to germinate the most seeds of seed type A.

A. Which conditions yielded the highest germination rate? _____

B. What type of habitat do you think seed A would grow best in? Explain your answer.



Activity C: Experimental design	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none">• Click Reset.• Select Seed type: B.	
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Question: In what conditions will seed B and seed C have the highest germination rate?

1. Observe: Run two experiments with seed B. What did you observe? _____

2. Form a hypothesis: What conditions do you think will be ideal for germinating seed B?

3. Design an experiment: Describe the controlled experiment you will run to test your hypothesis. _____

4. Gather data: Run your experiment. Record all your results in your notes. You will turn in your notes with this worksheet.

5. Draw conclusions: What conditions gave the best germination rate for seed B? _____

(Activity C continued on next page)



Activity C (continued from previous page)

6. Compare: Study the results of your experiments with seed A and seed B.

A. Which variable(s) affected seed B that did not affect seed A? _____

B. Based on this fact, do you think seed B is normally planted deep below the soil or near the surface? _____

7. Observe: Run two experiments with seed C. What did you observe? _____

8. Form a hypothesis: What conditions do you think will be ideal for germinating seed C?

9. Gather data: Run a controlled experiment to test your hypothesis. Record all your results in your notes. You will turn in your notes with this worksheet.

10. Draw conclusions: What conditions gave the best germination rate for seed C? _____

11. Compare: How do the ideal conditions for germinating seed C compare with those for seed A and seed B? _____

12. Interpret: What type of habitats do you think seed B and seed C would grow best in?

Seed B: _____

Seed C: _____

