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CASE

Activity 7.3.4 Seed Viability

Purpose

Are seeds really alive? Seeds are in a dormant state of life. As you learned in the PowerPoint® *The Seed*, some seeds can be dormant for several years until the environmental conditions are optimal for germination. Therefore, technically, seeds are living organisms.

This activity will provide scientific evidence that seeds are alive. Like all living organisms, as seeds grow they consume food. You learned in *Activity 7.3.2 Seed Structure and Enzymes* that germinating seed embryos consume food reserves stored as starch. Respiration converts these food resources in to energy as shown in the following chemical equation:

$$C_6H_{12}O_6 + 6\ O_2(g) \leftrightarrow 6\ H_2O + 6\ CO_2(g) + \text{energy}$$

Activity 4.1.4 Cellular Respiration detected the rate of respiration of an organism by measuring the carbon dioxide concentration. Apply the same techniques again to this experiment in order to collect evidence that a seed is a living organism.

Materials

Per pair of students:

- LabQuest® interface
- Vernier CO_2 gas sensor
- Vernier temperature sensor
- (50) pea seeds
- 250ml respiration chamber
- Dry erase marker
- Paper towel
- Ice cubes
- (2) 100ml beakers

Per student:

- Pencil
- *Agriscience Notebook*

Procedure

You and your partner will conduct experiments to collect scientific evidence and support the claim that seeds are alive. Follow instructions provided and record your data in Table 1.

Part One – Setting up the Experiment

1. Write your name on two 100ml beakers using a dry erase marker pen.
2. Count out 50 pea seeds from the container your teacher provides.
3. Place 25 seeds in each 100ml beaker.
4. Place one of the beakers in the area designated by your teacher.
5. Fill the second beaker containing seeds half-full of tap water and set this beaker aside next to the dry beaker.
6. The following day, remove the seeds from the water and roll them in a wet paper towel to continue germination.
7. Pour out all but quarter inch of water in the bottom of the beaker. Gently curl the paper towel into the beaker ensuring that some of the paper towel is touching the water (like a wick).
8. Leave the seeds for one or two days, as directed by your teacher, before moving on to Part Two.

Part Two – Carbon Dioxide Evidence

According to the chemical equation for respiration, as the seed germinates it will produce carbon dioxide. Use the LabQuest® and CO_2 gas sensor to collect evidence of this reaction.

1. If the CO_2 gas sensor you are using has a switch, set it to the “Low” setting (0-10,000 ppm).

9. Turn on your LabQuest® and connect the temperature sensor to CH1.

10. Connect the CO_2 gas sensor to CH2. Set up data collection as follows:
    - Choose “New” from the LabQuest® “File” menu.
    - On the Meter screen, tap Rate.
    - Change the data-collection rate to 0.1 samples/second and the data-collection length to 600 seconds.
    - Tap “OK.”

11. Obtain 25 germinated peas and blot them dry between two pieces of paper towel.

12. Place the germinated peas into the respiration chamber.

13. Gently push the sensor into the bottle until it fits snugly. Remember that carbon dioxide is heavier than oxygen; therefore place the chamber horizontally when measuring gas concentration.

14. Wait two minutes, and then start data collection.

15. While waiting, measure the room temperature using the temperature sensor and record the temperature in Table 1.

16. A graph of *CO_2 gas vs. time* will display when data collection has finished.

17. Remove the CO_2 gas sensor from the respiration chamber. Place the peas in a 100ml beaker, fill half full with water, and add ice cubes.

18. Fill the respiration chamber with water and then empty it. Thoroughly dry the inside of the respiration chamber with a paper towel.

19. Once data is collected, you will perform a linear regression to calculate the rate of respiration.
    - From the “Analyze” menu across the top of the LabQuest® screen, select “Curve Fit” and “CO_2”.
    - Select “Linear” for the “Fit Equation”. The linear-regression statistics for these two data columns are displayed for the equation in the form $y = mx + b$, where x is time, y is CO_2 gas concentration, m is the slope, and b is the y-intercept.
    - Enter the slope, m, as the rate of respiration for the germination test Table 1. The slope of the line tells you how fast the gas accumulated in the chamber, therefore you can correlate the metabolic activity of seed respiration with the slope of the graph. Rate is calculated in ppm/s, which reflects how many parts of CO_2 particles per million parts of air volume per each second of time tested.
    - Select “OK”.

20. Repeat Steps 4-12 substituting the germinated peas with non-germinated peas.

Part Three – Temperature Effects on Respiration

1. Remove the peas from the cold water and gently blot them dry between two paper towels.

21. Repeat Steps 4-12 of Part Two using the cold peas.

22. For Step 8 of Part Two use the temperature of the water bath rather than the room temperature.

Table 1. ***Data***

Germination Test	**CO_2 (ppm/sec)**	**Temperature (ºC)**
Germinated Peas	0.01393	19.8
Non-germinated Peas	-0.011067	19.8
Cooled Germinated Peas	0.0033709	20

Conclusion

1. Given the chemical equation for respiration, if respiration increases CO_2 concentrations in the chamber, what should happen to O_2 levels in the chamber?

Oxygen levels should decrease as respiration increases.

23. Explain how the evidence of your experiment supports the claim that seeds are alive.

The evidence shoes that there were higher levels of CO_2 happening in the chamber with the germinated peas. This tells us that respiration was happening in higher levels than that of the other two samples. The seeds that had germinated were obviously therefore using energy and alive.

24. How does temperature affect germination rate? What evidence do you have to suggest temperature influences germination rate?

When temperatures go outside of the optimal range a particular plant needs to germinate, germination can slow or become non-existent. The evidence to prove this is the trial with the cooled germinated peas. While there was more CO_2 recorded than that of the non-germinated, the respiration rate showed in the CO_2 chamber was still less than the original trial.

Source: Redding, K., & Masterman, D. (2007). *Biology with Vernier*. Beaverton, OR: Vernier Software & Technology.