RESPIRATION OF GERMINATING SEEDS

Driving Question

Why do seeds have optimal temperature ranges in order to germinate?

Materials and Equipment

- CO_2 sensor
- Beaker, 1000-mL
- Sampling bottle (included with sensor)
- Spring water, 500mL
- 30 dry pea or bean seeds
- 30 germinating pea or bean seeds
- Ice, cubed or crushed, 500mL

Background

In the state of California, USA, seed sales and exports generate $2.9 billon USD, nearly 3% of the states total agricultural economy. In order to produce high quality seed crops we must provide them with ample sun, water and nutrients so that the seeds themselves have enough stored resources to germinate and thrive until they can germinate. Seeds, although dormant, still maintain some cellular functions which require enzymes. Enzymes are complex proteins which catalyze chemical reactions and are often sensitive to changes in the environment, specifically temperature and pH. All enzymes have an optimal temperature where they most efficiently catalyze chemical reactions. In this activity, you will investigate whether dry seeds or germinating seeds have the higher rate of cellular respiration as indicated by CO_2 production, and you will then determine whether temperature affects the rate of respiration for the germinating seeds.

Procedure

1. Connect to the CO_2 sensor.
2. Open AGR 05 Respiration of Seeds.spklab file.
   - If the file is not available create a graph display of CO_2 (ppm) versus time.
3. Calibrate the CO_2 sensor as directed in the product manual.
4. Place 30 dry dormant seeds into the sample bottle and insert the CO_2 sensor into the bottle.
5. Start data recording. Adjust the scale of the graph to show all data. After 10 minutes, stop data recording.
6. When data collection has finished, record the initial and final values for the dry/dormant seeds in Table 1. Empty and rinse the sample bottle.
7. Place 30 germinating seeds into the sample bottle and insert the CO_2 sensor into the bottle.
8. Start data recording. Adjust the scale of the graph to show all data. After 10 minutes, stop data recording.
9. When data collection has finished, record the initial and final values for the germinating seeds in Table 1. Empty and rinse the sample bottle.
10. Place approximately 400 mL of cubed or crushed ice into the 1000-mL beaker. Add 400 mL of water into the 1000-mL beaker.
11. Place 30 germinating seeds into the sampling bottle and insert the CO_2 sensor.

12. Put the sampling bottle into the 1000-mL beaker and make sure it is nested into the ice bath. Do not let the sensor get wet.
13. Start data recording. Adjust the scale of the graph to show all data. After 10 minutes, stop data recording.
14. When data collection has finished, record the initial and final values for the germinating seeds in Table 1. Empty and rinse the sample bottle.
15. Calculate the change (Δ) in CO_2 concentration for each run and the rate of CO_2 production per minute.

Table 1: Data table

Run	Initial CO_2 Concentration (ppm)	Final CO_2 Concentration (ppm)	ΔCO_2 Concentration (ppm)	Time (min)	Rate of CO_2 Production (ppm/min)
Dry dormant seeds					
Room-temperature germinating seeds					
Cold germinating seeds					

Analysis

1. How does the rate of CO_2 production for germinating seeds compare with the rate of CO_2 production for the dry, dormant seeds?
2. How does the rate of CO_2 production for cold, germinating seeds compare with the rate of CO_2 production for the room-temperature, germinating seeds?
3. What other factors might affect the rate of rate of cellular respiration by the germinating seeds?
4. What is the chemical equation for cellular respiration? Where does cellular respiration occur in the cell?
5. Judging from this expression, what gaseous molecule would you expect to be produced during cellular respiration?
6. Explain why plants and seeds need to perform cellular respiration, even though they are photosynthetic organisms.