CB 8 Metabolism of Germinating Pea Seeds

You know that organisms that cannot photosynthesize must find their own food source for energy. This includes all consumers such as animals, fungi and bacteria. You also know that consumers must carry out cellular respiration to extract usable energy from their food sources. But, although plants photosynthesize, do they ever carry out cellular respiration? Do plants ever release rather than take in carbon dioxide? What about the parts of plants which do not photosynthesize, such as roots and seeds? What is their energy source?

Materials (*per student team*)
• 10 germinating pea or bean seeds (moistened for 24 hours)
• 10 non-germinating pea or bean seeds (dry)
• 3 test tubes with one-hole rubber stoppers to fit the tubes
• 0.04% phenol red indicator solution
• non-absorbent cotton; soda straw
• Casio fx2 Graphing Calculator
• Casio Data Collector EA-100
• 2, Dissolved CO_2 Sensors
• Casio QV2800 Digital Camera

Special Technique
In this activity, you will test for the production of carbon dioxide by germinating and non-germinating pea seeds and compare the results to your own exhaled breath. CO_2 dissolves in and reacts with water, producing carbonic acid. The presence of an acid can be detected by a number of indicator solutions that change color in the presence of an acid. Phenol red is such an indicator. It is red if the solution is basic and light yellow if the solution is acidic.

Day 1 Procedure (see Figure 8.1)
1. Label two test tubes A and B and fill them approximately one-fourth full of tap water. Into each tube, place 8 drops of phenol red indicator solution.
2. Place a wad of non-absorbent cotton about half or two-thirds of the way into tubes A and B so that it does not touch the water and indicator in the bottom of the tubes. Use just enough cotton to provide support for the seeds you will put into the tubes.
3. Place 10 germinating seeds into Tube A and 10 non-germinating seeds into Tube B. Place one-hole stoppers snugly into both tubes.
4. Place one of the probe ends from the CO_2 sensor snugly into each hole of the stopper.
5. Complete the necessary connections of the sensor to the EA-100 and the EA-100 to the graphing calculator. Program the graphing calculator to take data of CO_2 levels every hour for the next 24 hours.
6. Take a digital image of your setup.
7. Construct a hypothesis about which of the three conditions will exhibit respiration and why this will happen.
8. Set the tubes aside in a vertical position until the next day.

Day 2 Procedures

1. Observe tubes A and B for color changes. Take a second digital image and record any qualitative observations in your *Log.*
2. Read the output on the graphing calculator of the graphs for Tubes A and B. Print out these graphs for your lab report.

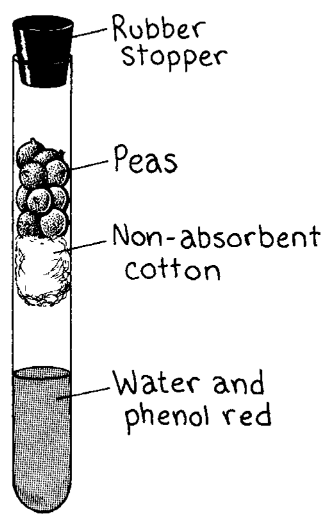
Interpretations

1. What is the purpose of the tube with dry seeds?
2. Compare and contrast the color changes recorded in each of the tubes. Explain what these color changes indicate.
3. What do these data suggest about your hypothesis?
4. What evidence is there of CO_2 production by the dry seeds? What evidence do you have that the dry seeds are indeed alive?
5. How might you be able to detect CO_2 production in dry seeds?

Applications

1. How do greenhouses help plants grow?
2. Suppose you want to grow a garden in the spring. Explain how and where you could get a "jump start" before it normally becomes warm enough to allow seedlings to grow outside. Keep in mind the necessary conditions for seed germination. Also tell when you would plant your seedlings outside. Consult an experienced gardener if you wish.
3. Comment on this statement: Plants both respire and photosynthesize, often at different times.

Figure 8.1 Set-up for CB 8 (without the data probes connected)



Casio FX2.0 Calculator Procedures For CB 8

Setting up the EA100 to Receive Data from the CO_2

In this experiment, you will use one EA100 and two Venier Dissolved-CO_2 sensor probes. Always be sure that the EA100 is turned OFF before inserting the probes. The EA100 requires a specific order of set up if it is to receive data properly. First it is looking for sample rate, then for number of samples, and finally for time definition. (Time definition is almost always set to 1, which is the indicator for real time collection.) For this example we will use the following set up:

Sample Rate: 1 hour (collects a data sample every hour)
Number of Samples: 24
Time Definition: 1

Since the EA100 is designed for collecting data at rates that involve seconds and milliseconds, we must use a program from the FX2.0 to tell the EA100 to collect our data at an hourly rate. Also the EA100 is designed to collect samples in multiples of 10, and since we want 24, which is not a multiple of 10, we must also use the FX2.0 to make this adjustment. Alternatively, you could simply collect 20 or 30 samples, instead of 24, since 20 and 30 are multiples of 10 and are built in choices already featured in the FX2.0. It is also possible to HALT the EA100 at any time, so you could simple halt taking samples after 24 hours. If you are on a modified schedule that meets every other day, you could collect 50 samples every hour and halt at 48 hours.