Name_____

CASE

# Activity 5.2.5 Refueling Plants

## Purpose

As you discovered in *Activity 5.2.4 Sugar from the Sun*, plants make glucose by using the energy of the sun to convert raw materials through the process of photosynthesis. When plants require energy, they can tap into the stored energy of glucose by a process called cellular respiration.

The process of photosynthesis involves the use of light energy to convert carbon dioxide and water into glucose and oxygen. This process can be summarized by the following reaction.

$$6H_2O + 6CO_2 + light\ energy \rightarrow C_6H_{12}O_6 + 6O_2$$

Cellular respiration refers to the process of converting the chemical energy of organic molecules into a form usable by organisms. Glucose may be oxidized completely if sufficient oxygen is available in the following reaction.

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6H_2O + 6CO_2 + energy$$

Notice that the chemical equation for photosynthesis is nearly the exact opposite of respiration. Plants produce and consume sugars in a self-fueling cycle. Can you find evidence of plants fueling themselves in this activity?

## Materials

**Per pair of students:**

- LabQuest2
- $CO_2$ gas sensor
- 250ml respiration chamber
- Aluminum foil
- Plant leaves
- Forceps

**Per student:**

- Safety glasses
- Pencil
- *Agriscience Notebook*

## Procedure

Photosynthesis and respiration rates can be determined by measuring the level of $CO_2$ in a controlled environment. To observe the rates of respiration and photosynthesis, measure the level of $CO_2$ in the respiration chamber using a LabQuest2 and $CO_2$ gas sensor.

### Part One – Setting Up the Experiment

1. If your $CO_2$ gas sensor has a switch, set it to the *Low (0–10,000 ppm)* setting. Connect the $CO_2$ gas sensor to a LabQuest2 and choose **New** from the *File* menu.
2. On the *Meter* screen, tap **Rate**. Change the data-collection rate to 0.1 samples/second and the data-collection length to 600 seconds. Select **OK**.
3. Select the *Sensors* menu, then select **Units**. Select **$CO_2$ gas sensor**, then **ppt** in order to change the unit to parts per trillion (ppt).
4. Change the scale options for the graph.
    - Tap **Graph**.

- Choose **Graph Options** from the *Graph* menu and select **Manual** to change the scaling to manual.

- Enter 2 as the *Top value* (the maximum y-axis value).
- Enter 0 as the *Bottom value* (the minimum y-axis value).
- Select **OK**.

5. Obtain several leaves and blot them dry between two pieces of paper towel if damp.
6. Place the leaves into the respiration chamber, using forceps if necessary.
7. Wrap the respiration chamber in aluminum foil so that no light reaches the leaves.
8. Place the $CO_2$ gas sensor into the bottle. Wait 10 minutes before proceeding to Part Three. While you wait, complete Part Two.

**Part Two – Predictions**

You will conduct two trials for this experiment. In the first trial, the plant materials will be placed in the dark. In the second trial, the plant material will be exposed to light.

1. Study the chemical equations for photosynthesis and cellular respiration outlined in the Purpose section. Predict what will happen to the $CO_2$ level during each trial in Table 1.
2. In Table 1 on the student worksheet, list which processes will occur and describe why you think the levels of $CO_2$ will be as predicted.

**Part Three – Experiment**

1. Once the ten-minute wait period is finished, you will begin data collection. Press the **Start** button on the LabQuest2. Data will be collected for 10 minutes.
2. When data collection is complete, a graph of carbon dioxide gas vs. time will be displayed.
3. Perform a linear regression to calculate the rate of respiration versus photosynthesis.
    - Choose **Curve Fit** from the *Analyze* menu.
    - Select **Linear** as the *Fit Equation*. The linear-regression statistics are displayed to the right of the graph for the equation in the form where *x* is time, *y* is carbon dioxide concentration, *m* is the slope, and *b* is the y-intercept.

      $$y = mx + b$$

    - Enter the absolute value of the slope, *m*, as the rate of respiration in Table 2.
    - Select **OK**.
4. Remove the aluminum foil from around the respiration chamber.
5. Place the respiration chamber in a bright or sunny location. Use caution as you do not want the leaves to heat up and dry out. Note the time. The chamber should be in the light for 5 minutes prior to beginning data collection.
6. Store the data from the first run by tapping the file cabinet icon.
7. After the five-minute time period is up, repeat steps 1–3.
8. Graph both runs of data on a single graph.
    - Tap **Run 2** and select **All Runs**. Both runs will now be displayed on the same graph axes.
    - Examine the data on the displayed graph. To examine the data pairs on the displayed graph, tap any data point. As you tap each data point, the two carbon dioxide values and the corresponding time value will be displayed to the right of the graph.
    - Use the displayed graph and Table 2 to answer the questions below.

9. Remove the plant leaves from the respiration chamber, using forceps if necessary. Clean and dry the respiration chamber.

10. Use the data you collected in Table 2 to answer the analysis questions on the student worksheet.

## Conclusion

1. Why are plants considered self-sufficient?

they are able to make their own food

2. Describe how the processes of photosynthesis and cellular respiration are related.

photosynthesis is making their own food and respiration is when they form water

3. List three factors that might influence the rate of carbon dioxide production or consumption in leaves. Explain how you think each will affect the rate of production or consumption.

-amount of things the plant takes in and they might not produce as much.

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

Name_____

# Activity 5.2.5 Student Worksheet

**Table 1. *Predictions***

| | Trial 1 – In the dark | Trial 2 – In the light |
|---|---|---|
| **$O_2$ level** | lower amounts | higher amounts |
| **Process occurring** | cellular respiration | photosynthesis |
| **Why?** | plants are you the sugars | the plants are using the sun |

**Table 2. *Respiration Rate***

| Leaves | Rate of respiration ($O_2$ ppt/s) |
|---|---|
| **Dark** | **0.0009602** |
| **Light** | **0.0011182** |

***Analysis Questions***

- How do your results compare to your predictions?

correct

- Do you have evidence that cellular respiration occurred in leaves? Explain your answer.

no

- Do you have evidence that photosynthesis occurred in leaves? Explain your answer.

no

- What are two sources of error that may have occurred in this experiment?

not covering the bottle well enough and getting the wrong readings