Life Science

6-8

Photosynthesis and Respiration of Microscopic Life - Student Lab

MATERIALS:

Computer
250 mL respiration chamber
Vernier computer interface
Lamp
Logger Pro
Photosynthetic microbe
Venier O_2 Gas Sensor
Aluminum foil

BACKGROUND CONTENT:

Microscopic organisms are too small to seen with the human eye. These organisms were thought to be primarily agents of disease. However, we now know that disease causing microbes are the minority and that many microorganisms are responsible for many positive impacts, they help clean up the environment and keep our soil fertile. Recent estimates suggest that at least 40% of the planets atmospheric oxygen comes from photosynthetic microbes! Microbes are the most abundant biomass (living matter) on the planet; more biomass than plants and animals combined! Many microbes are autotrophs or primary producers. This means they obtain their energy from the sun or chemicals within their environment. Primary producers do not obtain energy by consuming other organisms. Humans and grazing animals are examples of heterotrophs or organisms that gain their energy by eating other organisms (plants or animals).

Photosynthetic organisms make chemical energy by storing energy from the sun into sugars. The process of photosynthesis involves the use of light energy to convert carbon dioxide and water into sugar, oxygen, and other organic compounds. This process is often summarized by the following reaction:

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

When the organism requires energy, they can tap into the stored sugar energy using a process called cellular respiration. Cellular respiration refers to the process of converting the chemical energy of organic molecules into a form immediately usable by organisms. Glucose may be oxidized completely if sufficient oxygen is available by the following equation:

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

PROCEDURE:

(This procedure can use any Photosynthetic organism. For *Cyanidium* cultures, swirl *Cyanidium* into solution, obtain 20 ml of aqueous solution.)

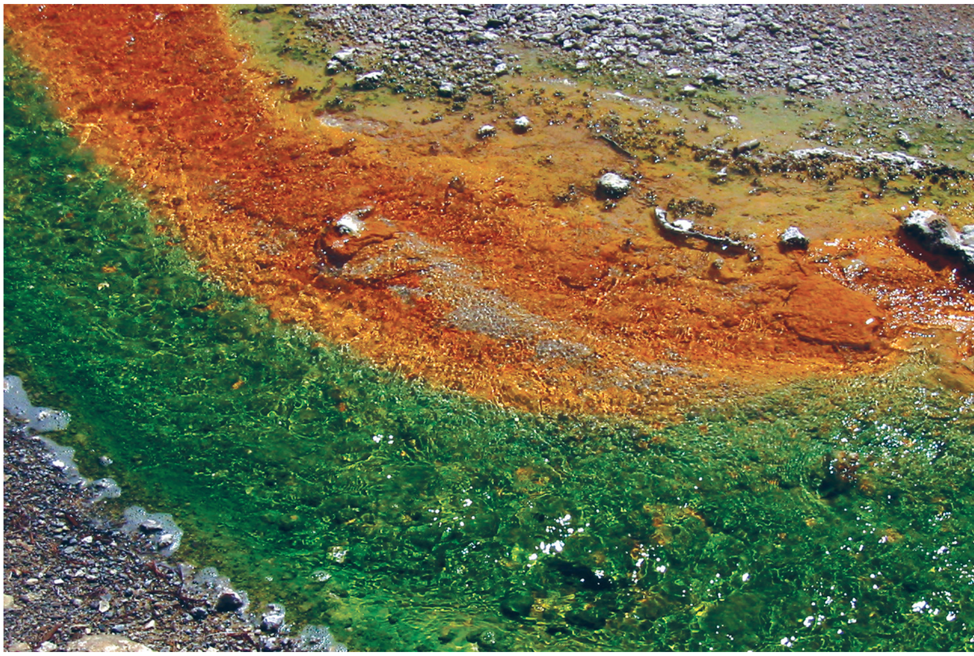
1. Connect the O_2 Gas Sensor to the Vernier interface.
2. Prepare the computer for data collection by opening the file "31A Photosyn-Resp (O_2)" from the Biology with Computers folder of the LoggerPro.
3. Obtain 20 ml of aqueous solution of microbes from the resource table.
4. Place the solution into the respiration chamber. Wrap the respiration chamber in aluminum foil so that no light reaches the solution.
5. Place the O_2 Gas Sensor into the bottle, GENTLY push the sensor down into the bottle until it stops. The sensor is designed to seal the bottle without the need for unnecessary force. Wait 3 minutes before proceeding to Step 6.
6. Click [collect] to begin data collection. Data will be collected for 10 minutes.
7. When data collection has finished, determine the rate of respiration:
    a. Move the mouse pointer to the point where the data values begin to decrease. Hold down the left mouse button. Drag the pointer to the point where the data ceases to decline and release the mouse button.
    b. Click on the Linear Fit button, to perform a linear regression. A floating box will appear with the formula for a best fit line.
    c. Record the slope of the line, m, as the rate of respiration in Table 1.
    d. Close the linear regression floating box.
8. Move your data to a stored run. To do this, choose Store Latest Run from the Experiment menu.
9. Remove the aluminum foil from around the respiration chamber.
10. Turn the lamp on. Place the lamp as close to the respiration chamber as reasonable. Note the time. The lamp should be on for 3 minutes prior to beginning data collection.
11. After the three-minute time period is up, click [collect] to begin data collection. Data will be collected for 10 minutes.
12. When data collection has finished, determine the rate of photosynthesis:
    a. Move the mouse pointer to the point where the data values begin to decrease. Hold down the left mouse button. Drag the pointer to the point where the data ceases to decline and release the mouse button.
    b. Click on the Linear Fit button, to perform a linear regression. Choose "Latest: Oxygen Gas" and a floating box will appear with the formula for a best fit line.
    c. Record the slope of the line, m, as the rate of photosynthesis in Table 1.
    d. Close the linear regression floating box.
13. Save a graph showing your photosynthesis and respiration data:
    a. Label each curve by choosing Text Annotation from the Insert menu. Enter "Photosynthesis of microbe" in the edit box. Repeat to create and annotation for the "Respiration" data. Drag each box to a position near its respective curve. Adjust the position of the arrow heads.
    b. Save a copy of the graph, with both data sets displayed. Select the Print button from the File menu tab. Enter your names(s) and press [OK]. In the Name space choose Microsoft Office Document Image Writer and press [OK]. Save file in My Documents/ Students and name file with first name(s)and last initial(s) and then press [Save].
14. Remove the microbe solution from the respiration chamber. Clean and dry the respiration chamber.

DATA

SAMPLE	RATE OF PHOTOSYNTHESIS/ RESPIRATION (PPT/MIN)

QUESTIONS:

1. Were any of the rate values a positive number? If so, what is the biological significance of this?
2. Were any of the rate values a negative number? If so, what is the biological significance of this?
3. Do you have evidence that cellular respiration occurred in your sample?
4. Do you have evidence that photosynthesis occurred in your sample?
5. List five factors that might influence the rate of oxygen production or consumption in your sample. Explain how you think each factor will affect the rate.



EXTENSIONS

1. Design and perform an experiment to test one of the factors that might influence the rate of oxygen production or consumption in Question 5.
2. Compare the rates of photosynthesis and respiration among different organisms and plants.