  Graphical Analysis 1

Photosynthesis and Cellular Respiration in Aquatic Plants

(Optical Dissolved Oxygen Probe)

Aquatic autotrophs such as plants and algae undergo photosynthesis and cellular respiration much like terrestrial plants. Atmospheric gases used in both processes dissolve in water and can be exchanged with autotrophic tissues.

Photosynthesis involves the use of light energy to convert carbon dioxide (dissolved in water in the form of carbonic acid, H2CO3) and water into sugar, oxygen, and other organic compounds. This process can be summarized by the following reaction:

6 H2O + 6 CO2 + light energy → C6H12O6 + 6 O2

Cellular respiration involves converting the chemical energy of organic molecules such as glucose into a form immediately usable by organisms. Glucose may be oxidized completely if sufficient oxygen is available by the following equation:

C6H12O6 + 6 O2 → 6 H2O + 6 CO2 + energy

Oxygen dissolves at the interface between the water and the air, and when aquatic autotrophs release oxygen as a byproduct of photosynthesis. This dissolved oxygen can be measured to determine whether aquatic plants are undergoing photosynthesis or cellular respiration under different light conditions.

OBJECTIVES

* Measure the concentration of dissolved oxygen in water using an Optical DO Probe.
* Determine the effect of light on the rate of photosynthesis in aquatic plants.

MATERIALS CHECKLIST

Chromebook, computer, or mobile device

Graphical Analysis 4 app

Vernier data-collection interface

Optical DO Probe

250 mL Nalgene bottle

1 L of aged tap water

aluminum foil

Stir Station, with ring stand post attached

Utility clamp

Stir bar

600 mL beaker

Lamp with LED plant bulb or halogen bulb

Java moss (Vesicularia dubyana) or Christmas moss (Vesicularia montagnei)

PROCEDURE

1. Set the switch on the Optical DO Probe to the mg/L setting. The switch is located on the box containing the microSD card.
2. Connect the Optical DO Probe to the data-collection interface, and then connect the interface to your Chromebook, computer, or mobile device. Launch Graphical Analysis.
   1. Set up the data-collection mode.
   2. Click or tap Mode
   3. Change End Collection to 15 min duration.
   4. Click or tap Done.
3. Obtain a golf-ball sized clump of java moss and gently place it in 250 mL Nalgene bottle along with a stir bar.
4. Fill the 250 mL Nalgene bottle with aged tap water, leaving approximately 2 cm of space at the top of the bottle.
5. Carefully wrap the bottle in aluminum foil, ensuring that the bottom surface of the bottle is flat enough to sit on a Stir Station. Leave space at the neck of the bottle for the Optical DO probe.
6. Place the bottle on the Stir Station and set it to stir at a medium speed.
7. Position the utility clamp on the ring stand post of the stir station above the bottle.
8. Insert the Optical DO Probe into the bottle. Stabilize it using the utility clamp, ensuring that it does not interfere with the stir bar. Wait for one minute.
9. Click or tap Collect to start data collection.
10. When data collection is complete, turn off the stir station.
11. Click or tap View, , and choose Apply Curve Fit. Record the slope of the line in Table 1.
12. Remove the Optical DO Probe from the water sample.
13. Remove the foil from the 250 mL Nalgene bottle.
14. Set up the lamp approximately 30 cm from the Nalgene bottle.
15. Place a 600 mL beaker of water between the lamp and the Nalgene bottle to act as a heat sink.
16. Turn on the lamp.
17. Repeat Steps 6–11.

DATA

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| Table 1 | |
| Java moss | Rate of respiration/photosynthesis (DO mg/L/min) |
| In the dark |  |
| In the light |  |

QUESTIONS

1. In the dark, was the rate value for DO a negative number? If so, what is the biological significance of this?
2. In the light, was the rate value for DO a negative number? If so, what is the biological significance of this?
3. Do you have evidence that cellular respiration occurred in aquatic plants? Explain.
4. Do you have evidence that photosynthesis occurred in aquatic plants? Explain.
5. List five factors that might influence the rate of oxygen production or consumption in aquatic plants. Explain how you think each will affect the rate.