
Photosynthesis and Respiration with Algae Beads

How do different light conditions affect the metabolic processes of freshwater algae?

Objectives

- Compare the metabolic processes of aquatic autotrophs under varying light conditions.
- Describe the role of aquatic autotrophs in the carbon cycle and in the cycling of energy.

Materials and Equipment

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| • Computer or mobile device | • Strainer |
| • Wireless Optical Dissolved Oxygen sensor | • Teaspoon |
| • Photosynthesis Chamber with accessories* | • Freshwater algae beads, 1 teaspoon |
| • Graduated Cylinder, 100-mL | • Bottled drinking water, 60 mL |
| • Beaker, 250-mL | • Tap water, 170 mL |
| • Magnetic stirrer | • Rinse bottle with distilled water |

*Parts required: base; detachable lid; transparent tank; LED lighting system; small bar magnet; stoppers; mirror insert

Safety

Follow these important safety precautions in addition to your regular classroom procedures:

- Keep water away from electrical outlets and all non-water-resistant electronic equipment.

Procedure

Part 1 - Setup

1. Slide the transparent tank ① in the base ② as shown in Figure 1. If the tank does not fit, rotate it and try again.
2. Set the system upon the magnetic stirrer as shown. Add the magnetic stir bar to the inner chamber ③.
3. Stopper each hole on the chamber lid except for the optical dissolved oxygen (ODO) probe hole ④.

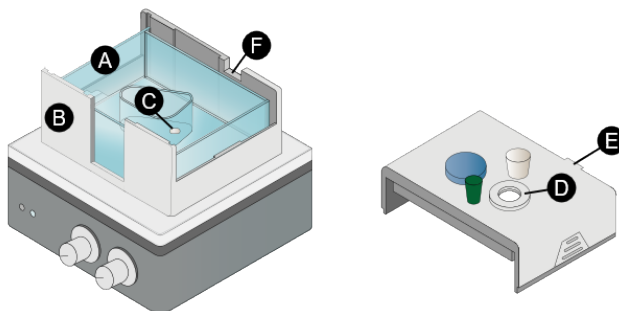


Figure 1. Photosynthesis chamber setup

4. Squeeze both sides of the lid and align the lid tab ⑤ with the base notch ④ to close the chamber.
5. Remove the rubber boot from the end of the ODO probe by turning it clockwise while looking at the probe. Do not let anything contact the end of the probe except the water samples in Part 2.

- Use the O-ring © as shown in Figure 2 to set the probe about 1" deep into the inner chamber. Observe the probe through the side opening ④ to check for the correct depth. There should be enough space for the magnet to avoid striking the probe, and the probe should not be touching the tank floor.

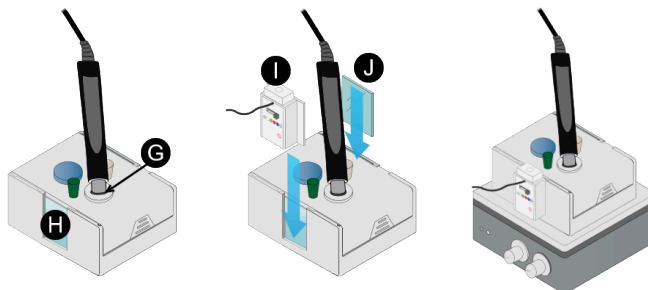
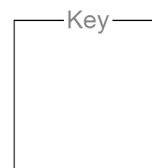


Figure 2. Use O-ring to set probe at 1" depth; add light and mirror last

- Plug in the LED light source ①. Slide the LED light source into the base as shown.
- Slide the mirror ① into place. You will be instructed to position the reflective side either towards the tank or away from it.
- Remove the probe, LED light, and mirror from the base before you attempt to open the chamber.
- Hold the base steady, then gently squeeze the sides of the lid to remove it. Practice opening and closing the chamber on the magnetic stirrer until you are comfortable working with it.

Part 2 - O_2 Measurements in Light versus Darkness

- Go to the Data Collection section and answer Predictions questions 1 and 2 before you begin.
- Connect the optical dissolved oxygen (ODO) sensor to your computer or mobile device and select the Graph template.
- Use the strainer to collect a sample of algae beads, then collect one level teaspoon from the sample. Return unused beads to their container.
- Add the beads to the inner chamber. Adjust the base position to center the bar magnet.
- Measure 60 mL of bottled water and add it to the inner compartment.
- Measure 170 mL of tap water and add it to the outer compartment.
- Turn on the stirrer to a medium-low speed for smooth magnet motion without splashing.
- Close the chamber lid, then insert the ODO probe. Orient the mirror with the reflective side facing away from the tank and slide it into place.
- Slide the light into place. Turn on the white light. Wait exactly 1 minute, then start data collection.
- Stop data collection after 3 minutes.
- Turn the light off. Wait exactly 1 minute, then start data collection to observe dissolved oxygen data when the system is dark. Stop data collection after 3 minutes.
- Turn off the magnetic stirrer. Remove the ODO probe, light, and mirror from the chamber.
- Open the chamber and remove the transparent tank. Slowly pour the tank contents through the strainer into the beaker. Collect the magnet and all algae beads in the strainer.
- Return the algae beads to their original container. Rinse the magnet and tank with distilled water.
- Check ☒ runs in the legend to show light and dark runs on the same graph. Scale the graph; sketch it in Graph 1. Add a title and label the x- and y-axes. Use appropriate values and units. Include a legend.



Questions and Analysis

1. You made predictions of how dissolved oxygen would respond to different light conditions. Were your predictions correct? Why or why not? Support your answer with data.
2. Which condition, light or dark, involved the transfer of energy from one set of molecules to another through chemical change?
3. Based on your observations, what role do algae play in the carbon cycle that land plants usually cannot?
4. If you could repeat this investigation measuring dissolved carbon dioxide instead of dissolved oxygen, what results would you expect to see in the light condition and in the dark condition? Explain your answers.
5. Design an investigation where you compare the photosynthetic rate of algae in white, blue, green, and red light. Include your prediction of the results.