PRELIMINARY ACTIVITY FOR Primary Productivity

Oxygen is vital to life. In the atmosphere, oxygen comprises over 20% of the available gases. In aquatic ecosystems, however, oxygen is scarce. To be useful to aquatic organisms, oxygen must be in the form of molecular oxygen, O_2. The concentration of oxygen in water can be affected by many physical and biological factors. Respiration by plants and animals reduces oxygen concentrations, while the photosynthetic activity of plants increases it. In photosynthesis, carbon is assimilated into the biosphere and oxygen is made available, as follows:

$$6\ H_2O + 6\ CO_2(g) + \text{energy} \rightarrow C_6H_{12}O_6 + 6O_2(g)$$

The rate of assimilation of carbon in water depends on the type and quantity of plants within the water. *Primary productivity* is the measure of this rate of carbon assimilation. As the above equation indicates, the production of oxygen can be used to monitor the primary productivity of an aquatic ecosystem. A measure of oxygen production over time provides a means of calculating the amount of carbon that has been bound in organic compounds during that period of time. Primary productivity can also be measured by determining the rate of carbon dioxide utilization or the rate of formation of organic compounds.

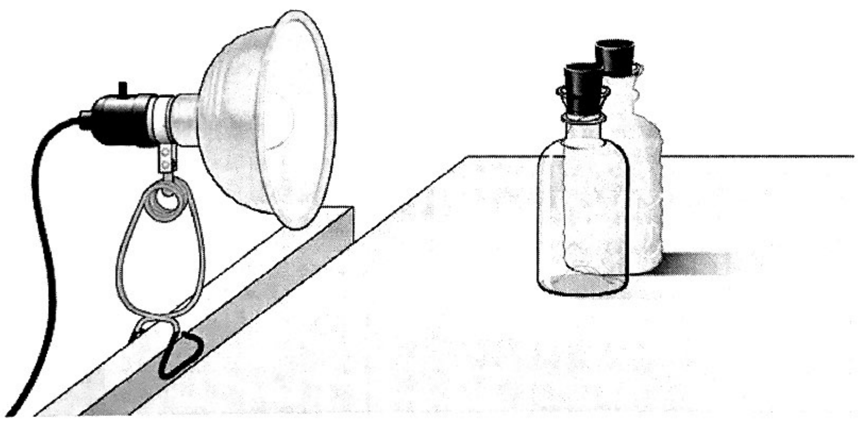

Figure 1 *The light and dark bottle method of measuring oxygen production*

One method of measuring the production of oxygen is the *light and dark bottle* method, as shown in Figure 1. In this method, sample water is placed into two BOD (biochemical oxygen demand) bottles. One bottle is stored in the dark and the other in a lighted area. Only respiration can occur in the bottle stored in the dark. Respiration rate is the decrease in dissolved oxygen (DO) in the dark bottle over time. Both photosynthesis and respiration can occur in the bottle exposed to light. The difference between the amount of oxygen produced through photosynthesis and that consumed through aerobic respiration is the *net productivity*. The difference in dissolved oxygen over time between the bottles stored in the light and in the dark is a measure of the total amount of oxygen produced by photosynthesis. The total amount of oxygen produced is called the *gross productivity*.

The measurement of the DO concentration of a body of water is often used to determine whether the biological activities requiring oxygen are occurring and is an important indicator of pollution.

2. Connect the Dissolved Oxygen Probe to the interface and open the data-collection program.

3. Allow the probe to warm up for 10 minutes. The probe must stay connected to the interface at all times to keep it warmed up. If disconnected for more than a few minutes, it will be necessary to warm up the probe again. When the probe is warmed up, continue to the Procedure.

PROCEDURE

Day 1

1. Obtain three BOD bottles.

2. Fill each bottle with sample water using the following technique:
   a. Obtain a siphon tube.
   b. Insert the tube into the water sample and fill the tube completely with water.
   c. Pinch the tube (or use a tube clamp) to close off the siphon tube.
   d. Place one end of the tube in the bottom of the water quality bottle. Keep the other end in the water sample, well below the surface. Position the bottle lower than the water sample Place a shallow pan under the test tube to collect any water that spills over.
   e. Siphon the water into the bottle. Fill the bottle until it overflows.
   f. Tighten the stopper for the bottle securely by twisting it once in place. Verify that no air is trapped in the bottle.

3. The percentage of available natural light for each water sample is listed in Table 1 below:

Table 1: DO Levels using *Dark and Light Bottle* Method

Water sample	Light exposure (%)	DO (mg/L)
Initial	n/a	
Light	100	
Dark	0	

4. Mix the contents of each bottle. Be sure that there are no air bubbles present in any of the bottles. Fill with more water if necessary.

5. Place the dissolved oxygen probe into one of the bottles, so that it is submerged half the depth of the water. Do not agitate the water, or oxygen from the atmosphere will mix into the water and cause erroneous readings. **Note**: Dissolved Oxygen Probe users need to gently stir the sample to allow the water to move past the probe's tip (if using an Optical DO Probe, this is not necessary).

6. After 60 seconds, or when the dissolved oxygen reading stabilizes, record the reading. This is the *initial* DO. Discard the contents of this bottle and rinse it. **Note**: If you are using a Dissolved Oxygen Probe, rinse the probe with distilled water and place it back in the distilled water beaker. The probe should remain in the beaker overnight, so that measurements can be made the following day.

7. Wrap one of the remaining bottles with aluminum foil so that it is lightproof. This water sample is the *dark* sample. It will remain in the dark.
8. Place the dark and light bottle near a light source, as shown in Figure 1. Leave the light on for 24 hours.

Day 2

9. Obtain the same dissolved oxygen probe you used yesterday and repeat the Pre-lab Procedure to set up the probe as necessary.
10. Place the probe into the *light* water bottle. Verify that the probe is submerged half the depth of the water. After 60 seconds, or when the dissolved oxygen reading stabilizes, record this reading. **Note**: Dissolved Oxygen Probe users need to gently stir the sample while the reading is stabilizing to allow the water to move past the probe's tip (if using an Optical DO Probe, this is not necessary).
11. Repeat Step 10 for the *dark* bottle.
12. Clean up your water bottles and probe as directed by your instructor.

QUESTIONS

1. Only respiration can occur in a dark bottle. Respiration rate is the decrease in DO over time. Calculate the respiration rate (in mg/L/hr) using the formula below.

   Respiration rate = (*dark* DO – *initial* DO) / time

2. Calculate gross productivity (in mg/L/hr) using the formula below.

   Gross productivity = (*light* DO – *dark* DO) / time

3. Calculate net productivity (in mg/L/hr) using the formula below.

   Net Productivity = (*light* DO – *initial* DO) / time

4. List some local sources of pond, lake, or seawater that might be useful in this experiment.
5. List some factors that might influence primary productivity in an aquatic environment.
6. List at least one researchable question for this experiment.