

Experiment GB-4: Ecological Balance

Exercise 1: Dissolved Oxygen Concentration and pH in an Aquatic Environment with an Animal

Aim: To measure changes in dissolved oxygen concentration and pH of water inhabited by fish.

Procedure

1. Place a magnetic stirrer on or next to the base of a ringstand. Place 200 mL of fresh pond water, at room temperature, in a 400 ml beaker. Add a stir bar to the beaker and place the beaker on a magnetic stirrer. Turn on the stirrer and position the stir bar to one side of the beaker bottom.
2. Adjust the position of the clamps that will hold the dissolved oxygen and the pH electrodes in the beaker of pond water.
3. Remove the dissolved oxygen and the pH electrodes from the beakers of deionized water. Blot the drops of deionized water from each device. Mount the electrodes on the ringstand using the clamps, and position the tips of the devices in the pond water. Cover the top of the beaker with plastic wrap to prevent the exchange of gases over the pond water with those in the environment.
4. Turn on the stirrer so that the stir bar rotates slowly and evenly. Wait two minutes before recording the dissolved oxygen concentration and pH level of the pond water.
5. Click Record on the LabScribe Main window to begin recording. When the recordings on both channels reach a stable baseline, type the words Pond Water Alone in the Mark box to the right of the Mark button. Press the Enter key on the keyboard to mark the stable baseline of the recording.
6. After recording at least fifteen seconds of stable baseline on each channel, type the words Goldfish in Pond Water in the Mark box to the right of the Mark button. Peel back the plastic wrap that covers the top of the beaker and place a goldfish in the pond water. Cover the top of the beaker with the plastic wrap, and press the Enter key on the keyboard to mark the recording. Lower the speed of the stirrer, if the goldfish seems stressed.
7. Record the dissolved oxygen concentration and pH of the pond water for thirty minutes. At the end of thirty minutes, click Stop to halt the recording.
8. Select Save in the File menu. Before analyzing the data from this exercise, complete Step 9 and then proceed directly to Exercise 2.
9. Remove the dissolved oxygen and the pH electrodes from the beaker of pond water. Remove the goldfish from the beaker and place it in the fish tank. Discard the pond water and refill the beaker with 200 ml of fresh pond water. Reposition the electrodes and the stir bar in the beaker of fresh pond water. Cover the beaker with plastic wrap.
10. Continue directly to Exercise 2.

Exercise 2: Dissolved Oxygen Concentration and pH in an Aquatic Environment with a Plant

Aim: To measure changes in dissolved oxygen concentration and pH of water in the presence of an aquatic plant.

Procedure

1. Using the setup completed at the end of Exercise 1, make sure the stir bar rotates slowly and evenly. Wait two minutes before recording the dissolved oxygen concentration and pH level of the pond water.
2. Click Record on the LabScribe Main window to begin recording. When the recordings on both channels reach a stable baseline, type the words Pond Water Alone in the Mark box to the right of the Mark button. Press the Enter key on the keyboard to mark the stable baseline of the recording.
3. Record at least fifteen seconds of stable baseline on each channel, type the words Plant in Pond Water in the Mark box to the right of the Mark button. Peel back the plastic wrap that covers the top of the beaker and place a piece of aquatic plant, like Elodea, in the beaker. Aim a lamp toward the beaker of pond water containing the plant. Turn on the light to illuminate the plant material in the beaker.

Warning: *It is important to prevent the temperature of the pond water from rising while the light is on. You may need to place a large beaker with water, that will act as a heat reservoir, between the light and the beaker of pond water.*

4. Cover the top of the beaker with the plastic wrap, and press the Enter key on the keyboard to mark the recording.
5. Record the dissolved oxygen concentration and pH of the pond water containing the aquatic plant for ten minutes.
6. At the end of ten minutes, click Stop to halt the recording. Select Save in the File menu; then immediately, click Start to begin recording again. Do not turn off the light at any time.
7. Proceed directly to Exercise 3.

Exercise 3: Dissolved Oxygen Concentration and pH in an Aquatic Environment with a Plant and an Animal

Aim: To measure changes in dissolved oxygen concentration and pH of water inhabited by a fish in the presence of an aquatic plant.

Procedure

1. Type the words Goldfish & Plant in Pond Water in the Mark box to the right of the Mark button. Peel back the plastic wrap that covers the top of the beaker with the plant. Place a goldfish in the same beaker. Cover the top of the beaker with the plastic wrap, and press the Enter key on the keyboard to mark the recording. Lower the speed of the stirrer, if the goldfish seems stressed.

2. Record the dissolved oxygen concentration and pH of the pond water containing the plant and the goldfish for thirty minutes. At the end of thirty minutes, click Stop to halt the recording.
3. Select Save in the File menu.
4. Turn off the light and carefully move it away from the beaker. Remove the dissolved oxygen and the pH electrodes from the beaker of pond water. Remove the goldfish and the plant material from the beaker and place them in the fish tank. Discard the pond water. Place the electrodes in beakers of deionized water.

Data Analysis

Exercise 1: Environment with Animal

1. Scroll to the section of data recorded during Exercise 1 where the goldfish was introduced to the ecosystem.
2. Use the Display Time icons on the LabScribe toolbar to position the complete recording on the Main window. The required data can also be selected by:
 - Placing the cursors on either side of the section of data needed. Place one cursor on the stable dissolved O₂ and pH levels recorded from pond water alone. Place the second cursor on the stable dissolved O₂ and pH levels recorded after a total of 30 minutes with the presence of the goldfish in the water
 - Clicking the Zoom between Cursors button on the LabScribe toolbar to expand the segment of data to the width of the Main window
3. Click on the Analysis window icon in the toolbar or select Analysis from the Windows menu to transfer the data displayed in the Main window to the Analysis window.
4. Look at the Function Table that is above the uppermost channel displayed in the Analysis window. The mathematical functions that are listed should include Title, Value1, Value2, V2-V1 and T2-T1. The values for these parameters from each channel are seen in the table across the top margin of each channel.
5. Place a cursor at the point in the recording when the goldfish was placed in the beaker of pond water (Time = 0). Place the second cursor at the point in the recording that is thirty minutes after the goldfish was placed in the beaker (Time = 30).
6. Once the cursors are placed in the correct positions for determining the dissolved oxygen concentration and pH levels, the values for both can be recorded in the on-line notebook of LabScribe by typing the names and values directly into the Journal.
7. The functions in the channel pull-down menus of the Analysis window can also be used to enter the names and values of the parameters from the recording to the Journal. To use these functions:
 - Place the cursors at the locations used to measure the dissolved oxygen from the O₂ Concentration channel.
 - Transfer the name of the mathematical function used to determine the dissolved O₂ to the Journal using the Add Title to Journal function in the O₂ Concentration channel pull-down menu.

- Transfer the value for the dissolved oxygen to the Journal using the Add Ch. Data to Journal function in the O2 Concentration channel pull-down menu.
8. Place a cursor on the stable baseline recorded just before the goldfish was placed into the beaker of pond water. Place the second cursor at the point in the recording that is 30 minutes after the goldfish was placed in the water.
 9. Measure the values for the following parameters from the O2 Concentration channel for the region of data selected:
 - O2 Conc - Time 0, which is Value1 on the O2 Concentration channel.
 - O2 Conc - Time 30, which is Value2 on the O2 Concentration channel.
 10. Record the values for these parameters in the Journal using one of the procedures described in Step 6, and in [Table GB-4-L1](#).
 11. Measure the Overall Change in O2 Concentration using the parameter, V2-V1, from the Function Table in the Analysis window.
 12. Divide the Overall Change in O2 Concentration by the initial O2 Concentration of the pond water to determine the percent change in dissolved oxygen.
 13. Repeat Steps 7 through 12 for pH, using the pH channel.
 14. Click Save in the File menu
 15. Click on the Main icon in the LabScribe toolbar to return to the Main window.

Exercise 2: Environment with Plant

1. Scroll to the section of data recorded during Exercise 2. Display the complete recording from Exercise 2 on the Main window.
2. Use the same techniques used in Exercise 1 to measure the dissolved oxygen concentration and pH levels of the pond water after the plant was immersed in the pond water.
3. Use the same techniques explained in Exercise 1 to record the values of both the O2 concentration and pH levels in the Journal, and in [Table GB-4-L1](#).
4. Click Save in the File menu.
5. Click on the Main icon in the LabScribe toolbar to return to the Main window.

Exercise 3: Environment with Plant and Animal

1. Scroll to the section of data recorded during Exercise 3. Display the complete recording from exercise 3 on the Main window.
2. Use the same techniques used in Exercise 1 to measure the dissolved oxygen concentration and pH levels of the pond water after both the plant and the goldfish were immersed in the pond water.
3. Use the same techniques explained in Exercise 1 to record the values of both the O2 concentration and pH levels in the Journal, and in the data table.
4. Click Save in the File menu.

- Click on the Main icon in the LabScribe toolbar to return to the Main window.

Table GB-4-L1: Changes in Dissolved Oxygen Concentrations and pH While Organisms Are in a Closed Ecosystem.

| Organisms in Pond Water | pH Level | | | Dissolved Oxygen Concentration ($\mu\text{Molar O}_2$) | | | |
|-------------------------|----------|--------|---------------------|--|--------|---------------------|--------------------------------------|
| | Initial | Ending | Change (Δ) | Initial | Ending | Change (Δ) | Rate ($\mu\text{MO}_2/\text{min}$) |
| Animal, 30 Mins | | | | | | | |
| Plant, 10 Mins | | | | | | | |
| Plant & Animal, 30 Mins | | | | | | | |

Questions

Exercise 1: Environment with Animal

- Do any changes in the dissolved oxygen concentration and pH of the pond water take place while the fish is in the beaker?
- What could be the causes of the changes or the lack of changes?

Exercise 2: Environment with Plant

- Do any changes in the dissolved oxygen concentration and pH of the pond water take place while the plant is in the beaker?
- What could be the causes of the changes or the lack of changes?

Exercise 3: Environment with Plant and Animal

- Do any changes in the dissolved oxygen concentration and pH of the pond water take place while the fish and the plant are in the beaker together?
- What could be the causes of the changes or the lack of changes?
- If increases or decreases in the oxygen concentration and/or pH of large bodies of water (lakes, seas, oceans) took place, what would be some of the causes of these changes? Make sure you indicate whether the cause would create an increase or decrease in pH or dissolved oxygen concentration.