

Eutrophication Lab

Introduction

Eutrophication is the natural aging process of lakes. This begins with the addition of nutrients into the system. These nutrients in turn stimulate the growth of microscopic free-floating aquatic plants known as **phytoplankton**, such as algae. **Cultural eutrophication** is the accelerated enrichment of surface waters due human activities such as agriculture, use of fertilizers, and changes in land surrounding aquatic environments accelerates the growth of phytoplankton.

Rivers and streams are mainly responsible for the **loading**, or amount of nutrients to aquatic environments. Nutrients enter streams from both **point** and **nonpoint** sources. Two of the most important nutrients responsible for eutrophication are **nitrogen** and **phosphorus**. In freshwater environments such as lakes, phosphorus is usually the nutrient in the lowest concentration and therefore generally limits the growth of phytoplankton. Phosphorus is often introduced as phosphates (PO_4^{3-}) in wastewater and septic system output, detergents, fertilizer runoff, animal waste, paved surfaces, industrial discharge, drinking water treatment, forest fires, and synthetic material.

Harmful algal blooms (HABs) are usually produced under **eutrophic** conditions. Cyanobacteria and dinoflagellates are examples of phytoplankton responsible for green surface scum, oxygen depletion, and subsequent fish kills. Low **dissolved oxygen** (DO) concentrations can result from the decomposition of phytoplankton. As bacteria decompose phytoplankton, they take up oxygen, and since DO is essential to many aquatic organisms, a decrease can lead to the death of a wide range of wildlife.

In this activity, we will simulate the process of eutrophication by setting up **microcosms**. Microcosms are scaled down and simplified versions of a natural environment, such as a lake or stream. Each group will prepare a jar containing a different concentration of liquid fertilizer in the water sample. Then, over several days, we will record the levels of dissolved oxygen, nitrates and phosphates, as well as any changes in the pH of the water sample. Finally, we will compare our results to those of other groups.

Problem

What is the effect of _____ on _____?

Hypothesis (Prediction)

Which sample container will experience the greatest change in the level of dissolved oxygen (DO)? Why do you think so?

If _____ [condition exists] _____ then _____ [this should happen] _____, because _____ [reason] _____.

Materials

- bucket or jug (for collecting water samples)
- pond or stream water
- clear plastic bottle or glass jar with lid
- liquid fertilizer / plant food
- plastic pipettes
- small test tubes
- graduated cylinders
- API Pond Master Test Kit
- Universal indicator or pH sensor with Vernier LabQuest software
- Dissolved Oxygen (DO) Test Kit or
Vernier dissolved oxygen (DO) probe connected to Vernier LabQuest software
- Vernier Nitrate Ion-Selective Electrode (ISE)

Variables

Identify which parts of the experiment are acting as the different variables:

- Independent variable – the thing you are changing up between groups
- Dependent variable – the responding variable... you measure this or notice changes in this
- Controlled Variables – all the things you keep the same among the groups

Procedure

1. Before starting, collect water samples from a nearby stream or pond in a bucket or jug.
2. Label your clear plastic bottle or glass mason jars with your group letter and trial number. You will be doing three trials for each letter. Divide letters amongst class groups.
 - a. 2 mL
 - b. 4 mL
 - c. 6 mL
 - d. 8 mL
 - e. 10 mL
 - f. 12 mL
3. Your teacher will prepare a control group that contains no fertilizer (0 mL) and will measure the parameters for dissolved oxygen, nitrates, nitrites, ammonia, pH, and phosphates.
4. In your three jars, add the amount of liquid fertilizer (specified by your group letter) to the sample container between 2–12 mL.
5. Carefully fill your jar with 500 mL of pond water.
6. Make qualitative observations about the water sample (e.g., colour, clarity, note any debris, smell, etc.).
7. Following the instructions of each test kit and pH/dissolved oxygen probe, and measure and record the values in your data tables of:
 - a. temperature
 - b. pH
 - c. dissolved oxygen (DO) in mg/L
 - d. the concentration of nitrate ions (NO_3^-) in mg/L
 - e. the concentration of phosphate ions (PO_4^{3-}) in ppm (parts per million)
8. Cap your group's bottle and place it next to a window so that it receives plenty of sunlight. (Your teacher will show you where your bottle should go.) This will allow any phytoplankton in the water to grow over the next several days.
9. Each class for three weeks, repeat the data collection, and record your qualitative and quantitative data in a shared Google Sheets.
10. At the end of the last day, after recording your measurements, dump your water down the sink and rinse the clear plastic bottle.

Processing & Analyzing the Data

Record your results in a data table in a shared Google Sheets for each of your trials. Use the table below as an example:

Data Table 1: Trial 1 for Amount of fertilizer added: _____ mL

Measurement	Day 1	Day 2	Day 3	Total Change
temperature				
pH				
dissolved oxygen (DO) (mg/L)				
nitrates (NO ₃) (mg/L)				
phosphates (PO ₄) (ppm)				

- Number data (quantitative) should be in labelled data tables.
- Averages, totals, or other statistics that are appropriate and realistic for the type of experiment should be included.
- Qualitative observations (non-numerical) can be in a table or written paragraph style.
- Graphs are encouraged. Choose the style of graph that makes the most sense for the type of data recorded.

Discussion

Consider the following questions when you write up your lab report discussion (in 2–4 paragraphs):

- Was your prediction correct? Explain why or why not.
- Were there any errors that you made? Could these errors have influenced the data?
- How confident are you in the validity and reliability of your data? If you could do it again, were there changes that should be made to improve the validity and reliability?
- How did your results compare to those of the rest of the class? Why do you think this happened? (2–3 sentence summary)

Conclusion

Evaluate your hypothesis based on the data you found:

- What was your hypothesis and was it right or wrong (in the end)?
- Based on what you learned/proved, what can you now say about the original problem statement?
- Is there a specific need for further experimentation? How so?

Extend Your Thinking

If we are aware of the environmental factors that are causing eutrophication, then what are some solutions to preventing nutrient concentrations from causing harmful levels of algal growth?

For example, it's widely understood that fertilizer runoff from farm fields is the main cause of harmful algal blooms in Lake Erie. In 2019, Governor DeWine announced a \$172 million plan to create a network of wetlands to capture and filter runoff from farm fields and to pay Ohio farmers to voluntarily adopt new agricultural practices. How likely do you think this plan or other plans would work? Please explain.



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