

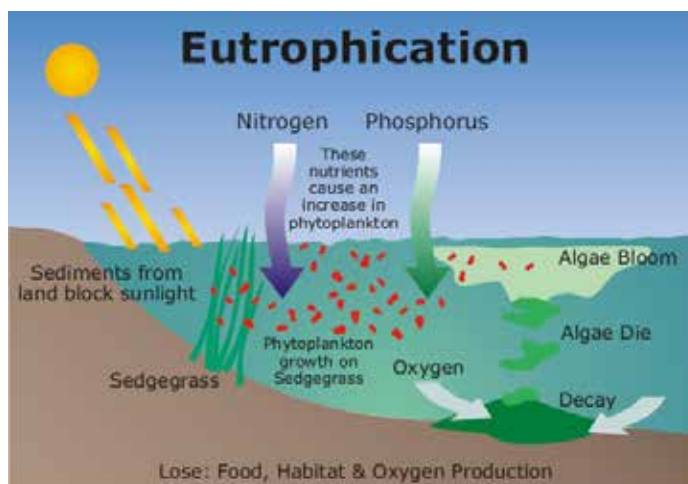
ENV101 - LABORATORY 9:

THE EFFECTS OF EUTROPHICATION: ALGAE BLOOMS

Human-induced nutrient loading of the world's water bodies has been linked to increased and prolonged algae blooms, sometimes with potentially deadly consequences.

BACKGROUND

"Eutrophication" is derived from two Latin words meaning "good" and "food". In studies of freshwater ecosystems, the term is used to refer to the process by which lakes, ponds, and streams become enriched with inorganic plant nutrients, especially phosphorus and nitrogen. This process happens naturally over a long period of time as dead organic matter accumulates, and is one step in the normal succession of the freshwater ecosystem. However, when the nutrient enrichment is due to the activities of humans – fertilizer runoff from agriculture or private homes, for example – the rate of this natural process is greatly intensified. Human induced eutrophication is sometimes referred to as "***cultural eutrophication***."



In freshwater ecosystems, phosphorus and nitrogen are the primary limiting nutrients for plant and algae growth, the levels of these two nutrients will determine the primary biological productivity of the lake, pond, or stream. A sharp increase in one or both of these elements can result in an "algal bloom", a sudden population explosion of photosynthetic algae. There are



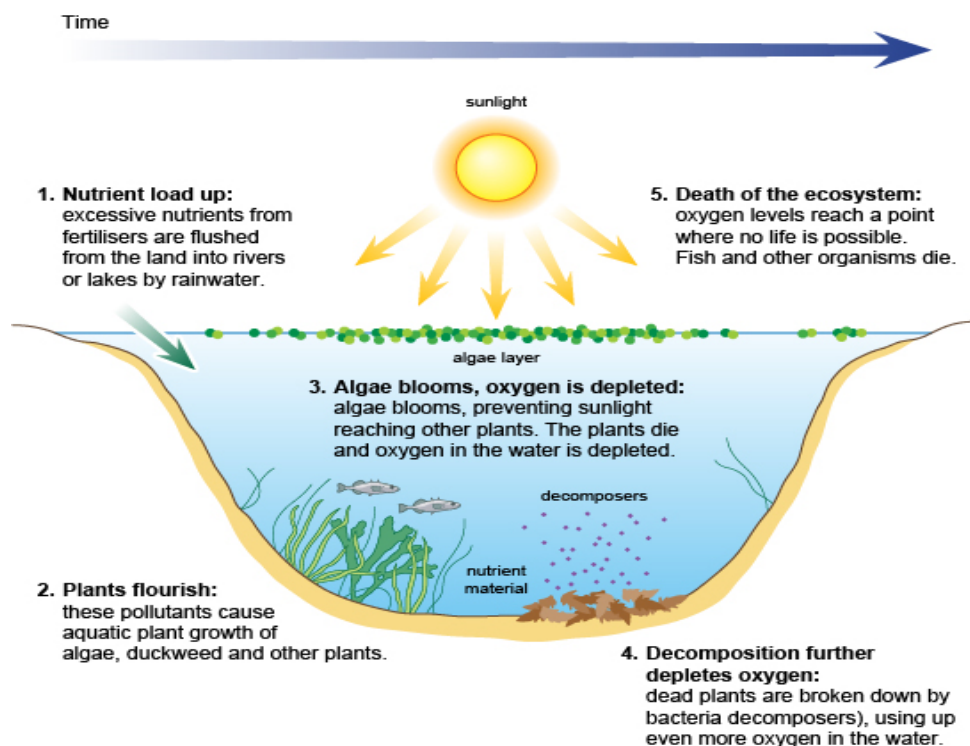
several direct and indirect costs associated with algal blooms. As the algae population proliferates, waters become increasingly more turbid. This turbidity is due in part to the single-celled algal organisms present in the water column near the surface and in part to dead and decaying organic material drifting to the bottom of the water body. The turbidity coupled with the appearance

of algal mats, which can sometimes reach from shore to shore, render eutrophic bodies of water unappealing to swimmers and boaters.

An algal bloom can also set off a chain of events whose biological effects are more far-reaching and graver than these aesthetic considerations. As the algae begin to die, they sink to the bottom of the pond and bacterial populations move in to decompose the organic matter. These aerobically respiring microbes can cause significant and sudden drops in the level of dissolved oxygen in the water. During the daylight hours, there is a great deal of photosynthetic (oxygen-generating) activity in a eutrophic body of water, so this affect may not be initially apparent. Extreme cases of algae build up can prevent sunlight from penetrating below the surface and this will further reduce oxygen production. At night, however, when photosynthesis ceases (but plant and animal respiration continues to use up the oxygen present), the resulting net drop in dissolved oxygen can be devastating, sometimes leading to massive animal (fish and invertebrates) die-offs. Watch these Youtube videos.

<https://youtu.be/mLbDbmmV6Qc> (Eutrophication simply put)

<https://youtu.be/AxaWXWd2pw4> (Khan Academy)



PART ONE: MEASURING THE IMPACTS OF INCREASED NUTRIENTS

We will be using a freshwater, photosynthetic protista species (*Euglena spp*) to mimic the effects fertilizers can have on plants and algae growth in lake or pond ecosystems. The *Euglena* are a genus of single celled flagellated eukaryotes that are capable of photosynthesis and are found in freshwater ponds and lakes around the world. They are one of the many species we commonly call ‘algae’.



We will look at the effects different fertilizer concentrations have on the growth rate of *Euglena* compared to a control over a period of one week. Your instructor has set up 6 test tubes containing approximately equal concentrations of *Euglena*. Each test tube was given a different concentration of fertilizer and allowed to grow under lights for one week. You (and your group) will assess the effects of these different concentrations of fertilizer.

First, identify the primary question we are addressing.

PRIMARY QUESTION: _____

Write out a clear hypothesis on the *Euglena*’s probable response to the different fertilizer concentrations based on the reading above and your knowledge.

TESTABLE HYPOTHESIS: _____

Read over the procedures below so you are familiar with the overall experimental conditions and make predictions as to your primary results.

PREDICTED RESULTS: _____

MATERIALS

- Cultured *Euglena*
- Large test tubes (20+ ml) (5 conditions and 1 control)
- Test tube Rack
- Spring Water
- Miracle-Gro Liquid Houseplant Food (N:P:K = 8:7:6) at 5 different concentrations
- Plastic pipets
- Para-film

- Lab tape and Permanent marker for labeling beakers
- Microscope slides with marked grids

PROCEDURE

1. You and your group go over to the samples (test tubes) and make a set of general observations about the appearance of the different samples.
2. Obtain a grid slide from the front bench.
3. For each test tube/condition:
 - a. Gently swirl the test tube to evenly mix the euglena and water.
 - b. Then prepare a wet slide of the *Euglena* by placing one (**ONE (1)**) drop in the center of the grid on the slide.
 - c. Gently place a cover slip over the drop as demonstrated by your instructor.
 - d. Place slide and microscope and using the scanning (Red - lowest power) objective to observe plankton activity. Find an active zone on the slide on the grid, where you can see organisms passing across a single grid/quadrat of your choice.
 - e. (If your field of view is too chaotic, select to low power objective – the next size/yellow one, this will create a view of essentially 1 square on the grid slide, which may be easier to count.)
 - f. Set your stopwatch to 15 seconds.
 - g. Start the stopwatch and count how many organisms move within or pass through your grid/quadrat of choice during the 15 seconds. At the end of trial write down the number in the data table below in the area marked “Grid 1” for that test tube’s condition (Control, 1x solution, 2x solution, etc.).
 - h. Move the slide to another ‘Grid’ on the same slide, and repeat the process of counting euglena moving in the new grid. Enter your data in the “Grid 2” in the same condition.
 - i. Repeat this process three (3) more time, until the column is full.
4. Follow the same set of procedures for each of the six conditions.
5. Then repeat two more times with a fresh sample every time until all three data tables are filled.
6. The slides should be carefully rinsed and dried between samples, and the cover slips thrown out after each use.
7. At the end of the data collection, return the grid slides to the front table.
8. Calculate your means for each table, and then place them in the “means” table.
9. Enter your group means into the instructor’s provided excel table on the classroom computer once your tables are filled.

List of Group Members:

EUGLENA DATA COLLECTION TABLES**GENERAL OBSERVATIONS TABLE**

<u>TEST TUBE</u>	<u>GENERAL OBSERVATIONS</u>
Control	Looks mostly clear, hint of green in spots. Bits of grey yellow on tube bottom
1x Solution	Similar to the control
2x Solution	Bit greener, little bit of green sediment on bottom
3x Solution	Getting greener, especially when stirred, thicker sediment at bottom
4x Solution	Noticeably greener, lots of sediments and stringy algae in solution in tube
5x Solution	Just gross. Lots of sediment, a skin on surface of water, hard to see through

DATA COLLECTION SAMPLE - 1

Observations	Control	1x Solution	2x Solution	3x Solution	4x Solution	5x Solution
Grid 1-	8	4	9	15	21	26
Grid 2-	2	5	16	11	18	37
Grid 3-	3	3	11	9	22	24
Grid 4-	2	4	8	16	23	34
Grid 5-	5	3	12	14	17	29
Mean						

DATA COLLECTION SAMPLE - 2

Observations	Control	1x Solution	2x Solution	3x Solution	4x Solution	5x Solution
Grid 1-	4	3	8	14	26	28
Grid 2-	3	4	7	13	17	35
Grid 3-	5	6	14	17	18	23
Grid 4-	6	5	11	9	21	20
Grid 5-	3	6	9	11	19	31
Mean						

DATA COLLECTION SAMPLE - 3

Observations	Control	1x Solution	2x Solution	3x Solution	4x Solution	5x Solution
Grid 1-	6	7	11	18	22	16
Grid 2-	5	4	9	14	21	29
Grid 3-	2	6	9	11	19	23
Grid 4-	3	3	14	8	17	33
Grid 5-	4	4	8	16	18	28
Mean						

GROUP SUMMARY DATA TABLE (WEEKLY MEANS)

Observations	Control	1x Solution	2x Solution	3x Solution	4x Solution	5x Solution
Mean 1						
Mean 2						
Mean 3						
Mean of Means						

CLASS SUMMARY TABLE IN EXCEL ON CLASSROOM COMPUTER
(TO BE POSTED ON BLACKBOARD)

LAB ANALYSISGraphing the Data:

From the data above, calculate the means for each sampling session, and then the “Means of the Means” for each treatment. Based on this data, create a graph using excel and then answer the following questions (you may use your text/lecture notes to help). Also, type up your Question, Hypothesis, & Predictions. Email me a single document (Microsoft Word) with your answers and your graph. (Remember to properly name the file (Env101. Lab9.Your.name).)

1. Did the algae colonies grow as well in the control beakers as the ones with fertilizer?
2. Does your control test tube appear healthy? If not, why do you think this is so?
3. Did the algae growth respond in a predictable way to fertilizer concentrations? Describe the trends you observed in the means data.

4. At which concentration(s) did the algae show the most growth?
5. Describe what you predict would happen in each of the treatments if we extended the experiment another few weeks?
6. Given our experiment, where do you think similar eutrophication effects may take place here on Long Island? Give examples of where (there are lots and we have mentioned many in lecture).
7. List the primary nutrients that cause eutrophication problems (use the textbook).
8. What are several of the main sources of these excess nutrients, in general?
9. For your examples from question # 6, what do you think were the specific *sources* of excess nutrients affecting those water bodies?
10. What things can you personally do to decrease Long Island eutrophication problems? Which of these things WILL you do?

Sources of Eutrophication

