MINNESOTA ACADEMY OF SCIENCE

Lesson Title / Topic

Estimating algae cell density from cell counting under microscopes and examining the effects of chemicals on algae growth

Content Area(s)

Biology

Grade Level(s)

9-10

MN Science Standards

- LS: Ecosystems: Interactions, Energy, and Dynamics

1 Use a computational model to support or revise an evidence-based explanation for factors that have ecological and economic impacts on different-sized ecosystems, including factors caused by the practices of various human groups. Examples of ecological impacts might include changes in the carrying capacity, species numbers and/or types of organisms present in an environment. Examples of human practices that can have positive or negative impacts, such as stream restoration versus deforestation as an ecological example. Examples of computational models may include online simulations of population dynamics, population ecology, or population growth.

Student Objectives

Upon completion of this lesson, students will be able to:

- Use a smaller scale measurement to estimate the density of a larger container.
- Analyze the effects of human chemical use on algae growth.
- Calculate standard error using google sheets and use it to help determine statistical significance

Materials

- algae culture (individual cells, not the algae beads)
- light microscopes and palmer cell slides
- large containers and available light source
- algae fertilizer/agricultural fertilizer that could end up in runoff, algicide (chlorine, ethanol, etc.)
- pipettes

Time Required

3 - 5 class periods

Procedure

1. View the live algae culture under a microscope so students understand what it looks like.
2. Divide students into lab groups, giving each group their own sample to work with.
3. Set up three containers to grow by a window or under light and label 1,2 and 3.
    a. To container 1, add just algae and water.

    b. To container 2, add algae, water, and fertilizer.
    c. To container 3, add algae, water, and algicide (can use chlorine, ethanol, etc.).

    Let students decide how much algae/water/fertilizer to add, but make sure it is consistent across the class.
4. Perform an initial count under a microscope after setting up the containers.Have students record initial numbers and observations.
    a. Swirl the algae containers and pipette 1 mL into the depression of a Palmer cell
    b. Place a cover slip over the sample.
    c. View the sample under a microscope at a magnification where it is possible to count all of the algae cells visible.
    d. Begin as close to the same place on the edge of the circular depression as possible and count all of the cells within the viewing window, moving horizontally until reaching the other side. Use a counter for an easier time remembering.
    e. Multiply the “vertical” dimension of the viewing window by the length traveled across the palmer cell and the depth of the palmer cell. Use cells per that calculated volume to determine cells/mL proportionally.
5. Perform another count during the next class period. Repeat the same procedure as above. Have students record numbers and observations.
6. Perform a third count either the next day, or over the next few days as time allows. Repeat the same procedure as above. Have students record numbers and observations.
7. Calculate the growth rate of each culture by looking at the change in cell density over time.
8. Share results with the class to obtain class averages for each container. Give each student a copy of the class data in a google sheet.
9. Make a plot of time vs. average cell density to visually represent the recorded growth rates. Include the values from all 3 groups for comparison.
10. Discuss observations and conclusions. Analysis questions:
    a. Using the class data, which group showed the fastest growth rate? Which showed the slowest?
    b. Determine the standard error for each average growth rate. First, use the google sheet with the class data to calculate standard deviation (STDEV[cells containing results from each group for one container]). Next, divide the standard deviation by the square root of the number of class groups ([STDEV cell]/SQRT[# of groups]). The resulting value is the standard error for each average growth rate.
    c. Determine whether the differences in growth rates were statistically significant, using the method most familiar to students. For example, multiply the standard error by two, then add or subtract it from each average. If the averages +/- standard error overlap, then they are not statistically significant. (In other words, the differences in the growth rates could have happened by chance and not because of the chemical additions.)
    d. If the chemicals had a significant effect on the growth rates, why do you think they affected the algae growth in the way they did? If the chemicals did not have a significant effect, why do you think this is?
    e. Why might we want to avoid introducing chemicals that decrease algae growth into our waterways? Why might we want to avoid those that increase algae growth?
    f. List any potential sources of error in this experiment and how they could have affected your results.
    g. Propose some additional chemicals to examine in a similar experiment or some additional measurements of algae health other than cell density/growth rate. What might yield interesting or relevant results?

Additional Suggestions

- Experiment with different chemical additions.
- Figure out how fast the algae grows in general, so the growth is noticeable, at least in the control.
- Grow algae for a while before starting the experiment so it can establish in the containers and start with a significant density.

Credit

Linnea Cooley, St. Paul Academy and Summit School (St. Paul, MN), Class of 2023, developed this lesson. Linnea’s science fair project, "*Effect of Ethanol and Octocrylene on the Cell Growth and Chlorophyll-a Levels of Cyclotella meneghiniana*" went to the National Junior Science & Humanities Symposium in 2022. Linnea is a 2022-23 Minnesota Junior Academy of Science officer.