Green Machine: Making Algae Grow

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Learning Experience Description:

This is a hands-on lab that examines the top up model for algae growth limiting factors. Algae need light, carbon dioxide, and nutrients. This lab will help students to conclude what is the best growing situation for algae.

Bioscience Connection:

Students have heard of biofuels which have been made from corn, soybeans, and sugar. Have you heard of fuels being made from algae? This is a cutting edge research area to produce fuel from non-food stock. Our planet continues to increase in population yearly and the need for food and water to sustain this population increases also. We cannot sustain our population with food and water and supply our energy needs with food stocks. It is therefore imperative to develop fuels from non-food stocks. One of these areas that is being researched is the production of biofuels from algae.

Background Information:

Students should know the carbon cycle, cellular respiration, photosynthesis, food webs, trophic levels, how to record data, follow multiple step directions, and work in small cooperative groups. They should have some experience in working through scientific problem solving.

Grade Level:

This lesson is designed to fit science high school life science standards, but could be adapted for other grades.

Duration of Learning Experience:

This learning experience is a three to four week laboratory experience. The initial set up can be done in one lab period of 40-60 minutes. Part one sets up the growing conditions for algae while the remaining days will take 10 minutes or less to make observations and record data.

Pre-Visit Classroom Information:

No pre-activities are necessary for this activity.

Post-Visit Classroom Information:

This is a long-term lab activity that will be finished in the classroom after several weeks of making observations and collecting data. It has various extensions that can be used along with this lab or in addition to.

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Concept/Topic:

This lab will address the research that is being done finding the optimum conditions for growing algae. This lab is a modification of evaluating optimum growing conditions for algae that is then taken to the field for field testing. This is work is being done by a team of scientists at the University of Kansas. The program is called Feedstock to Tailpipe. The goal is to optimize lipid growth in algae that is then used for maximum biofuel generation.

Content Standards, Benchmarks, and Indicators Addressed:

Standard 1: SCIENCE AS INQUIRY – The student will develop the abilities necessary to do scientific inquiry and develop an understanding of scientific inquiry**.**

Benchmark 1: The student will demonstrate the abilities necessary to do scientific inquiry.

2. ▲ actively engages in investigations, including developing questions, gathering and analyzing data, and designing and conducting research (1.1.2)

3. ▲ actively engages in using technological tools and mathematics in their own scientific investigations. (1.1.3 Graphs and analysis)

Standard 3: LIFE SCIENCE – The student will develop an understanding of the cell, molecular basis of heredity, biological evolution, interdependence of organisms, matter, energy, and organization in living systems, and the behavior of organisms.

Benchmark 1: The student will demonstrate an understanding of the structure and function of the cell.

1. understands cells are composed of a variety of specialized structures that carry out specific functions. (3.1.1 Cell structure and function)

2. ▲ understands cell functions involve specific chemical reactions.3.1.2 Cell chemical reactions

Benchmark 4: The student will understand the interdependence of organisms and their interaction with the physical environment.

1. ▲ understands atoms and molecules on the earth cycle among the living and nonliving components of the biosphere. (3.4.1)

Benchmark 5: The student will develop an understanding of matter, energy, and organization in living systems.

2. ▲ understands the sun is the primary source of energy for life through the process of photosynthesis.

3. ▲ understands food molecules contain biochemical energy, which is then available for cellular respiration. (3.5.3 Cellular respiration)
3.5.2 Ecosystem Energy

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Learning Experience Objectives:

The student will understand how research is used to solve problems.

Required Materials:

- Algal cultural (can be obtained from a scientific or aquarium supplier or even from aclassroom aquarium)
- Water (fresh or salt depending on the algae used)
- Large (20 – 50 mL capacity) test tubes, baby food jars, or other glass containers andlids, stoppers, or something to seal the containers with. 4 containers will be neededfor each group of students. (need to be clear)
- Aluminum foil
- Available light source (sunny window or biogenerator)
- Droppers or pipettes
- Liquid fish fertilizer (available from gardening suppliers)
- Wax pencils or markers and masking tape for labeling containers

Lab Safety:

- The student should follow all directions carefully.
- Allow adequate space for light source.

Step-By-Step Procedures:

See attached lab hand out.

Assessment:

Students will turn in their data sheets and lab notebooks with full write ups.

Closure:

This activity can be concluded with each group sharing their results either as a presentation orally, powerpoints or posters.

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GREEN MACHINE: Making Algae Grow

Purpose: The purpose of this activity is to demonstrate the conditions needed for optimum growth of algae.

Materials:
algal cultural (can be obtained from a scientific or aquarium supplier or even from a classroom aquarium)
water (fresh or salt depending on the algae used)
large (20 – 50 mL capacity) test tubes, baby food jars, or other glass containers and lids, stoppers, or something to seal the containers with. 4 containers will be needed for each group of students. (need to be clear)
aluminum foil
available light source (sunny window or biogenerator)
droppers or pipettes
liquid fish fertilizer (available from gardening suppliers)
wax pencils or markers and masking tape for labeling containers

Procedure:
1. Provide each group of students with four containers. Have students label the containers as follows:

A + Sun, + Nutrients, Group Name or Number
B + Sun, - Nutrients, Group Name or Number
C - Sun, + Nutrients, Group Name or Number
D - Sun, - Nutrients, Group Name or Number

2. Add 15 mL of water to each test tube or container.

3. Add 5 drops of algal culture to each container.

4. Add 5 drops of liquid fish fertilizer to each container labeled "+ Nutrients".

5. Completely cover each container labeled "- Sun" with aluminum foil, so that no light can penetrate the container.

6. Seal each container securely to avoid evaporation.

7. Place all containers in a sunny window or in a biogenerator where they can receive equal amounts of light and they can be exposed to the same temperature (i.e., don't place some on a heater and others near an open window).

8. Have students write a prediction that ranks the containers in order from most growth expected to least growth expected and justify their predictions.

9. Over a period of the next 3-4 weeks, record the color, smell, degree of clarity, and any other observations of the sample in each container in the accompanying data tables.

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10. Look over the data gathered at the end of the 3-4 week period and have students answer the following questions:
a. Under what conditions did algae grow?
b. Under what conditions did the algae grow best?
c. Under what conditions was there no growth?

EXTENSIONS:

Keep track of algal density with cell counts in addition to color detection. Use microscopes, slides and cover slips to do cell counts of the cultures over time. Create graphs of cell density (determined from your counts) over time.

Add treatments to test different concentrations of fertilizer. Create graphs of cell density versus fertilizer concentration for each sample time.

Use nutrient mixes rather than a commercial fertilizer. This will allow students to test the effects of specific nutrients on the growth of their alga. Create graphs of final cell density versus nutrient concentration for each nutrient treatment.

Add treatments to test the effect of sunlight/darkness on algal growth. Create graphs of cell density over time for the different light treatments.

Use more than one species of algae (grown separately) to compare the growth of different species under similar conditions.

Add treatments to test the effect of temperature or salinity on algal growth. Create graphs of final cell density versus temperature or salinity.

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