Algae Experiments

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California Department of Education Science Standards

6th Grade

- Ecology (Life Science)

  5. Organisms in ecosystems exchange energy and nutrients among themselves and with the environment.

  a. Students know energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis and then from organism to organism through food webs.

  b. Students know matter is transferred over time from one organism to others in the food web and between organisms and the physical environment.

  e. Students know the number and types of organisms an ecosystem can support depends on the resources available and on abiotic factors, such as quantities of light and water, a range of temperatures, and soil composition.

- Investigation and Experimentation

  7. Scientific progress is made by asking meaningful questions and conducting careful investigations.

  a. Develop a hypothesis.

  b. Select and use appropriate tools and technology (including calculators, computers, balances, spring scales, microscopes, and binoculars) to perform tests, collect data, and display data.

  c. Construct appropriate graphs from data and develop qualitative statements about the relationships between variables.

  d. Communicate the steps and results from an investigation in written reports and oral presentations.

  e. Recognize whether evidence is consistent with a proposed explanation.

7th Grade

- Investigation and Experimentation

  7. Scientific progress is made by asking meaningful questions and conducting careful investigations.

  a. Select and use appropriate tools and technology (including calculators, computers, balances, spring scales, microscopes, and binoculars) to perform tests, collect data, and display data.

  b. Use a variety of print and electronic resources (including the World Wide Web) to collect information and evidence as part of a research project.

  c. Communicate the logical connection among hypotheses, science concepts, tests conducted, data collected, and conclusions drawn from the scientific evidence.

  d. Construct scale models, maps, and appropriately labeled diagrams to communicate scientific knowledge.

  e. Communicate the steps and results from an investigation in written reports and oral presentations.

8th Grade

- Chemistry of Living Systems (Life Science)

  6. Principles of chemistry underlie the functioning of biological systems.

  a. Students know that carbon, because of its ability to combine in many ways with itself and other elements, has a central role in the chemistry of living organisms.

  b. Students know that living organisms are made of molecules consisting largely of carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulfur.

- Investigation and Experimentation

  9. Scientific progress is made by asking meaningful questions and conducting careful investigations.

  a. Plan and conduct a scientific investigation to test a hypothesis.

  b. Evaluate the accuracy and reproducibility of data.

  c. Distinguish between variable and controlled parameters in a test.

  e. Construct appropriate graphs from data and develop quantitative statements about the relationships between variables.

g. Distinguish between linear and nonlinear relationships on a graph of data.

Algae Experiments

In this final lesson, the students will be able to apply the knowledge and skills that they have gained throughout the previous six lessons. The students are provided with some basic information about the importance of algae in the food web (as well as in our daily lives) and the basic needs of algae including light, nutrients, habitat and other factors that affect algal growth. The students are presented with a challenge:

There are a group of scientists at UCSB that are part of a research project called the Long Term Ecological Research (LTER) project. They are currently looking at how the land and the ocean interact and how people are involved. They are extremely interested in algae since it is such an important member of aquatic ecosystems (since it is the base of the food chain). These scientists need your help! They need to learn more about algae, how it grows, factors that affect its growth, and how humans might be involved in causing algae blooms. It is your job to design an experiment to test a factor (or multiple factors) that affect algae growth. After you design and run your experiment, you need to write up your results so that we can give the LTER scientists a report of your findings.

This activity gives the students the opportunity to practice the scientific method, but it also provides them with the chance to be creative and design an experiment that they are truly interested in because it is their own.

Objectives:

*****The students will learn the basic needs of algae including light, nutrient, habitat and food web information.

* The students will learn or review the scientific process and will practice it by designing and running algae experiments.

Specifications:

a. The students will be able to explain what the basic requirements are for algae to survive.
b. The students will be able to explain possible habitats that algae live in.
c. The students will be able to explain the role of algae in a food web.
d. The students will be able to develop a hypothesis.
e. The students will be able to set up an experiment using a control.
f. The students will be able to run their experiment and analyze the results.

Introduction:

Why do we care about algae?

To some people algae is affectionately known as pond scum; it is also known by a variety of names ranging from plankton to kelp. Regardless of what you call it, humans use algae almost every single day. Brown algae produce a substance called alginate and red algae produce a substance called agar (also known as agaropectin or agarose) as well as a substance called carageenan. Alginate, agar and carageenan are found in many household items that you use (or eat) everyday. They are found in shampoo, conditioner, cosmetic products, dietary supplements, toothpaste, and many food products- even in ice-

cream (they help give it its texture). Take a look at the ingredients of some of the products you use and eat every day and see which ones have algae in them, you'll probably be surprised!

In addition to being very useful to humans, algae are also vitally important in aquatic ecosystems since they are the base of the food chain and support all other aquatic life. They fill the same role in water that plants on land fill- they use the energy from the sun to photosynthesize, which makes them primary producers. They can also provide habitat for many other organisms. For example, kelp forests which are made up of giant kelp (a type of brown algae) are one of the most diverse habitats on earth because of all of the other organisms that depend on the kelp for food and shelter.

The Basic Needs of Algae

You now know some of the reasons why algae are so important, but how do they live? What are the basic needs of algae? A basic need is something that you will die without. What are your basic needs? You need food, water and shelter. The basic needs of algae are very similar to ours. Algae need light (as an energy source- we get our energy from food), nutrients (which we also get from our food), and some sort of habitat (our homes, towns, and environment).

Light: algae need light to survive because it is their energy source. What happens to the light as you swim towards the bottom of an ocean or a lake? It gets dim. The general rule (and of course there are always exceptions to rules) is that algae cannot live when the light becomes so dim that it is less than 1% of the surface light. In the ocean, the 1% light level usually occurs somewhere around 100 meters (or approximately 300 feet) deep. So, you wouldn't expect to find algae deeper than this in the ocean.

What are some factors that may change the light levels in water? During the year the length of daylight hours changes with the seasons, this may affect algae growth. If it is a really cloudy day, the light may change and affect the algae. Big waves may stir up the ocean and increase the amount of sand floating in the water; this will change the light levels as well. Runoff from land after a big storm may add lots of dirt to the water, making it cloudier and decreasing the light that enters the ocean. Can you think of any living things that might change the light levels in the ocean or in a stream?

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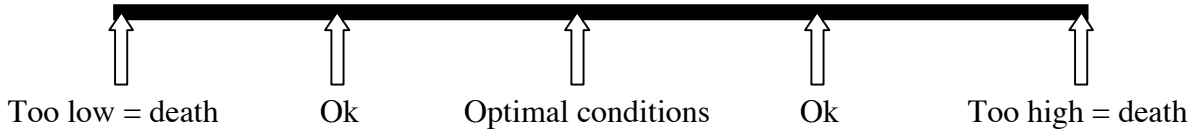
Nutrients: algae need nutrients to survive. They need macronutrients, micronutrients and vitamins. Sometimes algae don't have enough of one nutrient, this would make it a limiting factor. Other times, there is so much of one type of nutrient that it causes rapid algae growth, also known as an algae bloom. Humans often times add nutrients to aquatic environments and may contribute in causing algae blooms. Humans most commonly add nitrogen and phosphorus to the aquatic environment.

Nitrogen is found in fertilizers and even in pet feces. Phosphorus is also found in fertilizers and is a common ingredient in different types of soap. It used to be found in almost all laundry detergents, but now if you read the labels on laundry detergent almost all of them say "contains no phosphates". It was removed from this product because it was such a big environmental problem. You will still find it in some types of soap, especially in dishwasher detergent. One of the ways that we are trying to reduce the amount of nutrients that humans add to the environment is by removing them at wastewater treatment plants (which is where all of the water from your dishwasher, shower, sinks and toilets goes).

Habitat: there is a great diversity among algae; ranging from tiny microscopic cells to giant kelp. It makes sense that all of these different types of algae would live in many different habitats. All algae live in one of two general situations: they float in the water and are not attached to anything, or they are attached to the bottom. Algae that are attached to the bottom (such as kelp which is attached to rocky reefs at the bottom of the ocean) are considered benthic (they live on the bottom). Algae that float through the water are considered planktonic (plankton means drifter).

Another general category of algae habitat is the type of water that they live in: is it freshwater or saltwater? Algae live in streams, creeks, lakes, estuaries, and the ocean; in fact you will find algae in almost every body of water.

Algae are usually specialized to live in a particular type of habitat (floating or anchored, saltwater or freshwater) and to the conditions that exist in that habitat (such as the amount of light and nutrients). For example, the algae living at the surface of the water is going to get more intense light than algae which lives 50 feet below the ocean's surface. Each type of algae has ideal living conditions and usually can handle a range of conditions on either side of their optimal conditions. If the conditions vary too much from the optimal conditions, then the algae may die.



Other Factors: while light, nutrients and habitat are the most basic needs of algae, there are many other environmental and biological factors that affect where they live, how they live and *if* they live!

The environmental (or physical) factors that affect algae are light, temperature, pH (how acidic or basic the water is) salinity (how much salt is in the water), water motion and nutrients. All of these physical factors together define what a particular

habitat is like. Some algae are adjusted to habitats that have high levels of light, warm temperatures, high salinity, not much water motion and low nutrient concentrations. If these particular algae were put in another habitat where there was low light, cold water, low salinity, lots of water motion and lots of nutrients; they may not do as well or they may even die.

The two important biological factors that affect algae are predators and competition. If an alga has lots of predators around, it will be difficult for it to grow (since the predators will keep eating it). Off the coast of Santa Barbara there are lots of kelp forests. However, urchins love to eat kelp and if there are too many urchins they can eat an entire kelp forest pretty quickly! When this happens, the remains (or lack there of) of the kelp forest are called an urchin barren. Competition can affect algae growth in many different ways. One example is if you have two types of algae that both like to live close to the surface of water where there is a lot of light and one is able to grow faster than the other, it may block out the light and make it more difficult for the second alga to grow. They may also compete for nutrients, rocky reef to attach to (if they are benthic), and in numerous other ways.

Lab Activity

There are a group of scientists at UCSB that are part of a research project called the Long Term Ecological Research (LTER) project. They are currently looking at how the land and the ocean interact and how people are involved. They are extremely interested in algae since it is such an important member of aquatic ecosystems (since it is the base of the food chain). These scientists need your help! They need to learn more about algae, how it grows, factors that affect its growth, and how humans might be involved in causing algae blooms. It is your job to design an experiment to test a factor (or multiple factors) that affect algae growth. After you design and run your experiment, you need to write up your results so that we can give the LTER scientists a report of your findings.

Materials: Sediment jars (4: 1 soil, 1 sand, 1 gravel and 1 diatomaceous earth), algae from aquarium store (ask for some water from a dirty aquarium- algae will be growing in it) or from a local river/creek/lake/ ocean, mason jars (24 included), Schultz plant food, Cascade dishwashing detergent, labels (to stick on the jars), screen, tinfoil, soil, diatomaceous earth, gravel, 1- 5 gallon bucket (for water collection) lab report rubric handout, microscopes (optional- not included), slides (optional- not included), and bleach (not included).

- Begin this activity by having the students read the 3 pages of "Algae Experiments" information which provides them with background information for this activity. This could be done as homework the night before class, read aloud as a group, or individually read in class.
- This activity gives the students a lot of freedom to be creative and design their own experiment. The goal is to get them to think about what factors will affect algae growth and how to test the effect of those factors following the scientific process. If your students aren't familiar with the scientific process, that should be reviewed before they begin designing their experiments.

- Before the students begin designing their experiments, it will probably be helpful to go over an example of a possible experiment with them (provided below is a possible example looking at sedimentation and the effect of light levels).
- Using the sediment jars included in the kit, demonstrate to the class how sedimentation works (fine particles stay suspended in the water much longer than large particles which settle out quickly) and ask them to observe how different sized particles may change the light level in the water.
- After demonstrating how different materials can change the light levels in water, ask the students how they think this could affect algae growth. Would some algae do better with less light? Would some algae do worse with less light? Would some algae die? This could be done as a teacher lead example, a group discussion or as a journal writing activity.
- From this idea, help the students form a hypothesis. One possibility would be to say: If algae need a certain amount of light to survive, than they will not grow as well when the light becomes dimmer and they will die if they have no light at all.
- A sample experiment to test this would be to put water that has algae in it in 4 mason jars. One jar would be a control and you would not do anything to it (you would put it in the same location as the other 3 and keep every factor as constant as possible. The second jar would have less light than the first (wrap with one layer of screen). The third jar would have even less light (wrap with 2-3 layers of screen). The fourth jar should have no light (wrap with tinfoil to block out all light). The students would need to decide how to make all other conditions constant. For example, if they need complete dark for the fourth jar, they will need to have a lid on it, to make sure that gas exchange isn't affecting algae growth; they would want to have lids with holes poked in them on all 4 jars. The next step would be to decide how full the jars will be, how long you are going to run the experiment for, how often you are going to check on the experiment, and what data you are going to collect (are you going to count cells under a microscope, draw a color chart of various shades of darkness matching dense algae growth or light algae growth, or other factors).
- After the students have created a hypothesis and designed an experiment to test their hypothesis; they should submit it to you for approval. After you approve the experiment, have the students submit a supplies list (many supplies are provided, but depending on student creativity and the experiments they design you may need to get a few cheap supplies- you could also limit them to using the supplies provided). The students should then design data tables appropriate for their experiment before setting up the actual experiment.
- **It will be necessary for you to collect water from a local body of water using the 5-gallon bucket provided, try to choose water which visibly has lots of particles in it as it will increase the chances that the students will get abundant algae growth. You may also want to "grow" the algae for a week or two after collection in a high light area with some added plant food to stimulate growth if algae doesn't appear to be very abundant in your water sample**
- You may decide how long you want the experiments to run (at least 1 week, probably a few would be best) or you could let the students decide.
- **IMPORTANT:** Many water bodies (marine and freshwater) of the world are being invaded by plant and animal species that don't belong there (introduced or exotic

species). These species are usually introduced because of people's careless activities and have the potential to change the natural ecosystem and its indigenous food web. So, please tell your students not to dispose of any live algae or animal from the experiment down the drain. Before anything is "dumped" it has to be killed first. A good way to sterilize the water before disposing of it is to add bleach (a 10% solution is plenty) and let it sit overnight before dumping it down the drain. Of course students should not handle bleach, as it is very harmful to skin and eyes, unless supervised very closely. **THANK YOU for protecting our local species!**

- After the students have finished running their experiments they should complete a student lab write up (following the "Algae Experiments Lab Rubric"), their lab write up can be modified to fit whatever format you use in your classroom or can be downsized/expanded to fit your needs. A possible extension of this project would be to have the students do a short oral report to the rest of the class at the completion of their experiment to share their results.

Different factors that students can test (this is only a start; the students may come up with their own creative ideas!):

- Light (using the screen and tinfoil which are provided or other materials the students come up with- this would simulate decreased light from sedimentation or competitive shading from another species).
- Nutrients (fertilizer and dishwasher detergent provided, students could test how various amounts of one changes algae growth or do a comparison between 2 types of nutrients- add fertilizer to one jar and detergent to the other and leave a third without anything as a control).
- Competition (students could use 2 different types of algae- these would probably need to be bought at an aquarium store unless there are clearly two types of algae in the water where you collect water for the experiments –ocean, river, creek, etc).
- pH (they could add a simple acid or base; or different amounts of one or the other and leave a control).
- Temperature (they could leave one jar on ice and put the other one in a bath of hot water- this may be hard to maintain for any length of time though).
- Combinations of these variables. For example testing the impact of phosphate against the impact of nitrogen; or testing the affect of decreasing light levels while simultaneously increasing nutrient levels.

** Some students may want to add living animals to test grazing impacts on algae. While this is a great idea, unfortunately small shrimp, fish and other animals they may want to use will die quickly in the mason jars. They need to be in aquariums with filtration systems. Please explain this to students and help them to find another direction for their experiments.

Science 8A
Lab

12/07/04

Algae Lab

Introduction

In this lab, we had to come up with some kind of factor that would change algae growth. For this experiment, we used a snail to eat off the algae. Our question was will the algae be able to grow fast enough to survive the snail's reproduction and eating habits. Our hypothesis was that the algae would not be able to grow fast enough, therefore be eaten by the snails and killed off. Our experiment showed the results

Methods and Materials

The materials we used were essential to our experimentation. The materials we used are:

3 Fresh water snails

2 glass jars

1 kind of algae

20 algae infected pebbles

6 ounces of algae water

18 ounces of tap water

8 drops of plant food

1 pair of scissors

1 lamp

Our method or procedure was a bit complicated. First, we poked holes on top of the 2 jar lids. Second we poured 3ounces of algae water into each jar. We then added 10 pebbles to each jar. Then we add 3 snails to 1 jar. After that, we put 9 ounces of tap water into each jar. Next, we added for drops of plant food to each jar. Finally we record each day, during science class, how much plant food and algae are in each jar.

Results and Data

This data table shows the results of our experiment.

Jar number	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
Jar #1(algae and snails)	Semi clear	High level of plant food	Lots of plant food	Medium level of plant food	Medium level of plant food	Little plant food
Jar #2 (algae)	Semi clear	High Level of plant food	High level of plant food	Lots of plant food	Lots of plant food	Lots of plant food

The results on this graph show a lot of things. First, it shows that the snails were eating faster than the algae could grow or eat the plant food. It also shows that it takes a long time for the algae to eat the plant food.

Conclusion

This lab was quite interesting. Our question was will the algae be able to grow fast enough to survive the snail's reproduction and eating habits. Our hypothesis was that the algae would not be able to grow fast enough and outlive the snails. Our hypothesis was proven correct. Every day the jar with the snails lost a lot of plant food and algae with the snails eating them unlike the jar with no snails that basically stayed on the same level of algae and plant food. Our control was the jar without the snails to compare algae levels. The variables that were controlled were the amount of plant food, the light, the amount of water, and the amount of snails. The variables left uncontrolled were the exact amount of algae in each jar, the eating habits of the snails, and the growth of the algae. Another uncontrolled variable was the snail's reproduction for they reproduced asexually and we did not know how fast they produced offspring. What surprised me the most was when we added the plant food, it was clear but the next day it looked like parmesan cheese. Another experiment I could do is with a different predator and how fast they would eat the algae. If I could make this experiment better I would take out the plant food because it mostly attracted our attention to that and covered up the algae. This was a very fun lab.

Algae Experiment References

Images:
All images without a reference are from Microsoft Clipart.
Garfield Cartoon: Chapman, D. Winter 2004. EEMB 134 (Phycology) Laboratory Manual. Department of Ecology, Evolution and Marine Biology, UCSB, Santa Barbara.

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