Algae Experiments

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Santa Barbara Coastal Long Term Ecological Research Project

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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?

_____

_____

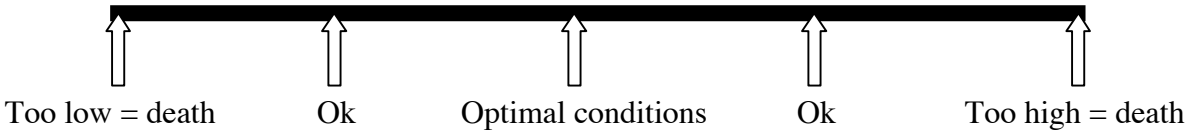
Nutrients: algae need nutrients to survive. They need macronutrients, micronutrients and vitamins. Sometimes algae don't have enough of one nutrient, this would make it a limiting factor. Other times, there is so much of one type of nutrient that it causes rapid algae growth, also known as an algae bloom. 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.

Information:

Chapman, D. Winter 2004. EEMB 134 (Phycology) Laboratory Manual. Department of Ecology, Evolution and Marine Biology, UCSB, Santa Barbara.

Lobban, C.S. and P.J. Harrison. 1997. Seaweed Ecology and Physiology. Cambridge University Press, New York.

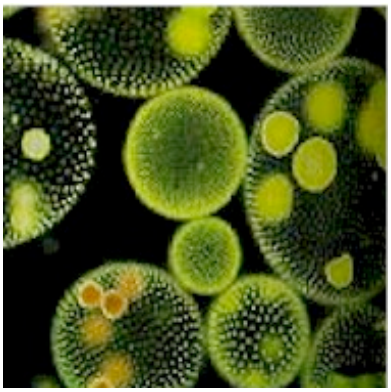
Name_____ Period _____

Chemistry Connection Worksheet

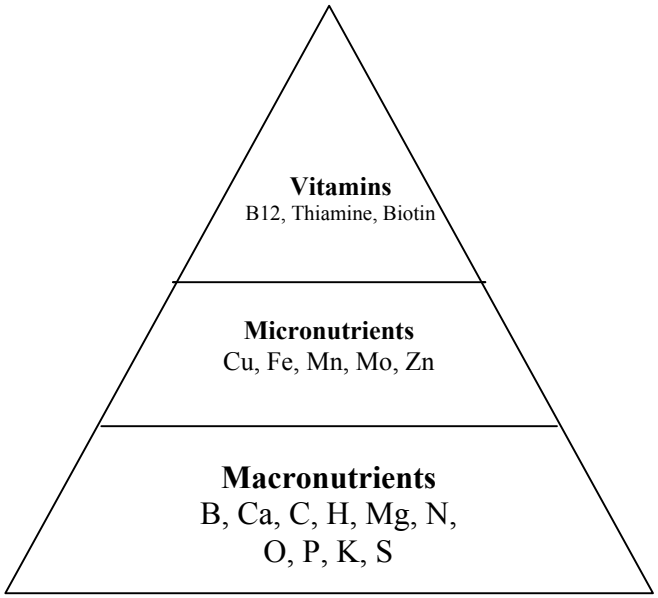
Nutrients

Every living organism needs to eat to stay alive, what they eat and how they eat it is going to vary a lot though! I'm sure that all of your parents have encouraged you to eat more fruits, veggies, and "healthy" food instead of eating junk food like candy and desserts. You are also probably familiar with the food pyramid, describing how many servings of each food group you should eat every day. Algae have their own food pyramid, and while they aren't eating sandwiches and fruit, they do have their own nutrition requirements. Food for algae falls into two major categories: macronutrients and micronutrients. Macronutrients are the "food" that the algae need a lot of while they tend to need less of the micronutrients.

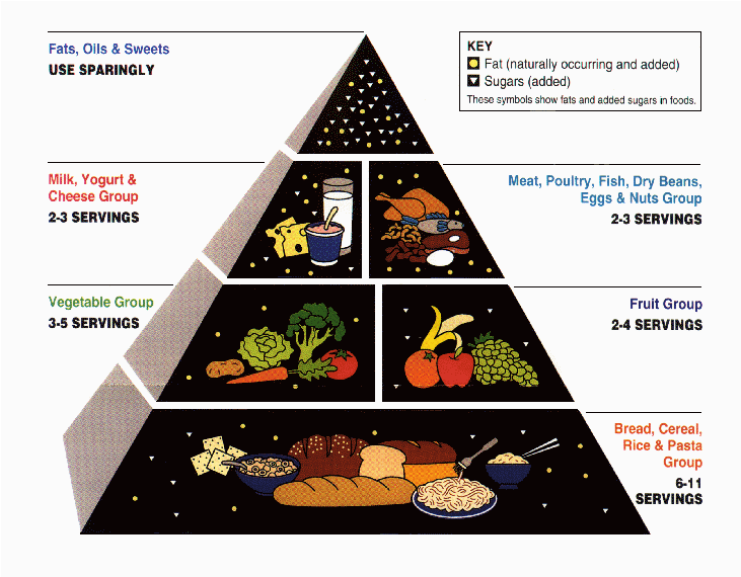
Algae Nutrients



Macronutrients	**Micronutrients**
Boron (B)	Copper (Cu)
Calcium (Ca)	Iron (Fe)
Carbon (C)	Manganese (Mn)
Hydrogen (H)	Molybdenum (Mo)
Nitrogen (N)	
Oxygen (O)	**Vitamins**
Phosphorus (P)	B12
Potassium (K)	Thiamine
Sulfur (S)	Biotin



The Algae Food Pyramid



The Human Food Pyramid

Limiting Nutrients

Do you remember when we talked about limiting factors? We defined limiting factors as any abiotic or biotic factor that restricts the number of individuals in a population. An example is houses. If there are no more houses for sale and no land to build more houses on in a town; the population of that town cannot increase. In this case, housing would be a limiting factor. Nutrients can be a limiting factor as well. If you didn't have food to eat, you wouldn't be able to grow- in fact it could lead to death. In this case, nutrients would be the limiting factor, limiting your growth.

Algae frequently face a problem of having limited nutrients. Nitrogen (N), phosphorus (P), iron (Fe), copper (Cu), zinc (Zn), manganese (Mn), and carbon (C) have all been shown to limit algae growth in different situations. The first two nutrients, nitrogen and phosphorus, limit algae growth most regularly.

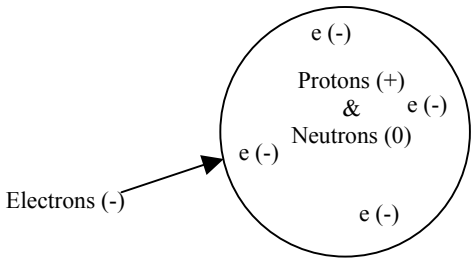
Do you remember any products that might put these nutrients (nitrogen and phosphorus) into the aquatic environment? Write your answer below:

_____

_____

Algae food isn't quite like human food….

You may have noticed that the type of food algae eats is really different than what we eat. Instead of eating a nice slice of pizza, algae enjoy some yummy nitrogen! The favorite foods of algae, such as nitrogen and phosphorus, are all elements that you might be familiar with from the periodic table of elements. Each element on the periodic table is made up of three parts: protons, neutrons and electrons. Protons have a positive charge, neutrons have no charge and electrons have a negative charge. Protons and neutrons make up the core of the element and are surrounded by the electrons. Usually the number of electrons is equal to the number of protons so the element has no charge. Sometimes though, an element may either lose or gain electrons and this will give it a charge. When an element has a charge, it is called an ion. It can gain a positive charge, which makes it a cation, or it can gain a negative charge, making it an anion.



Ions

6 protons (+) & 6 electrons (-) = no charge

6 protons (+) & 5 electrons (-) = +1 charge (cation)

6 protons (+) & 7 electrons (-) = -1 charge (anion)

Practice Questions:

1. Nitrogen (N) normally has 7 protons and 7 electrons. It loses 1 electron, calculate its charge and indicate if it is negative or positive:

_____

2. Phosphorus (P) normally has 15 protons and 15 electrons. It gains 1 electron, calculate its charge and indicate if it is positive or negative:

_____

How do Algae "Eat" their Nutrients?

When you need some nutrients, you might make a sandwich or go to the store and get something that is already made. You take bites of it, digest it, and voila: your body gets nutrients! All of the nutrients that algae need are found in the water around them, but how do they "eat" them? How do they get the nutrients from the water into their cells?

There are 4 ways that algae take nutrients into their cells:

1. Adsorption
2. Passive Transport
3. Facilitated Diffusion
4. Active Transport

Activity: You and your group will visit 4 lab stations, at each one there will be an activity and some questions that you need to answer. You will rotate through each station and learn about the 4 ways that algae take nutrients into their cells.

Station 1: Adsorption

Have you ever heard the phrase "opposites attract"? Well that is basically what is happening in the case of adsorption. There are certain negatively charged molecules (such as proteins with sulfate, carboxyl, and phosphate groups) which are found in the cell wall of algae. When a cation (a positively charged ion) tries to enter the cell, it gets trapped by these negatively charged molecules because the negative charge and the positive charges attract one another. One cation that algae needs is the sodium ion (Na+), it has a charge of +1 and the negatively charged molecules in the cell wall are going to try and grab it and use it to neutralize their charge (+1 and -1= 0 charge). Most things want to be neutral if they can, that is their most comfortable condition.

Question 1: Do you think 2 positive charges would attract or repel? How about 2 negative charges? Answer below

_____

_____

Activity: See for yourself! Magnets have a positively charged end and a negatively charged end. Using the magnets at your station, what happens when you try to put 2 positively charged ends together? (Please be gentle with the magnets, they break easily!)

_____

What happens when you try to put 2 negatively charged ends together?

_____

What happens when you put 1 positively charged end with 1 negatively charged end?

_____

_____

Which of these 3 set-ups (2 positive charges, 2 negative charges or 1 positive and 1 negative charge) is most like adsorption? Circle your answer.

Question 2: If you had a sodium ion (Na+), which of the following would it probably want to combine with?

a) Carbon (C, charge = 0)
b) Chlorine (Cl-, charge = -1)
c) Oxygen (O, charge = 0)

Question 3: Lead (Pb) is often added to aquatic environments as a result of pollution (burning fossil fuels releases lead into the air and it reaches the earth when it rains). Lead is a positively charged metal and is adsorbed by algae cells. Lead can poison humans, what do you think its affect on algae is? Adsorption usually happens quickly, would fast uptake of lead be bad for algae?

_____

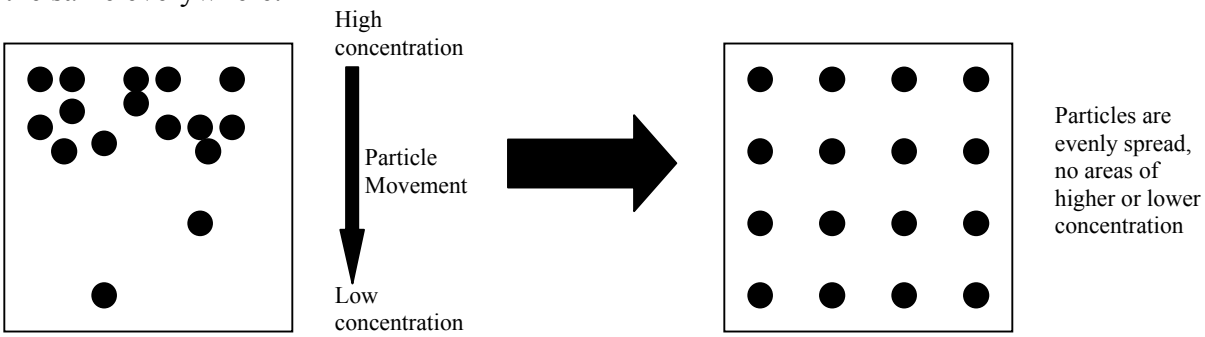
_____

_____

Station 2: Passive Transport

Have you ever heard the word diffusion before? Diffusion is the tendency for chemicals or elements to spread out from areas of high concentration so that concentration becomes equal over a given area. Chemicals diffuse, so do people! Think about a crowded beach during the summer. A lot of people arrive at the beach at one small area (where there is a parking lot or where a path leads down to the beach); do they all stay clumped together right at the entrance? Not usually, normally they spread out. People want to leave the area where it is really crowded and go to an area where there are less people.

The trend that you see with people and with particles is the same; you see movement from areas of high concentration to areas of low concentration until the concentration is the same everywhere.



Activity: Your group is going to carefully add **5** drops of food coloring to your container of water, make sure to put them all in at the same place. Watch what happens after you add the food coloring and write down any observations.

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_____

Question 1: Where is the concentration of the food coloring the highest when you first added the drops?

_____

Question 2: Does the food coloring stay where you first added it to the water? If not, where does it go?

_____

_____

What you saw happening was diffusion. Nutrients can diffuse into a cell if the concentration of that nutrient is lower inside of the cell than it is outside of the cell (remember, the nutrients don't like to be crowded!). Waste products from the cell can also diffuse out of the cell.

Question 3: Do you think it would be easier for a particle with a neutral charge or a particle with a positive or negative charge to diffuse in or out of a cell? Why?

_____

_____

_____

Station 3: Facilitated Diffusion

This is the same idea as the diffusion that we just talked about, the main difference is that facilitated diffusion is faster than the diffusion we talked about at Station 2.

Fill in the blanks: Diffusion is movement from areas of _____ concentrations to areas of _____ concentration.

Sometimes nutrients need a little help to diffuse into the cell, when they get this help it is called facilitated diffusion. The cell membranes of algae cells are made up of a lipid bilayer (lipid= fat, bilayer= 2 layers).

This part (the head) is hydrophilic. Hydro = water, philic = love
So hydrophilic = loves water

This part (the tail) is hydrophobic. Hydro = water, phobic = fear
So hydrophobic = afraid of water

The hydrophobic part of this membrane is a barrier for charged nutrients (ions), so how do they get through the membrane and into the cell? They need some help!

Activity 1:

Question 1: Can you think of anything that is hydrophobic (afraid of water)? If you can write you answer here: _____

Question 2: How do you know it is "afraid" of water? What does it do that shows you that?_____

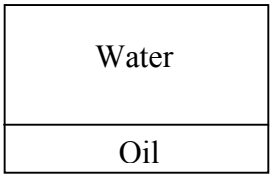
_____

Pour a small amount of oil into your container of water.
Question 3: What does it do? If you stir the container can you get the oil to mix with the water? Describe what happens: _____

_____

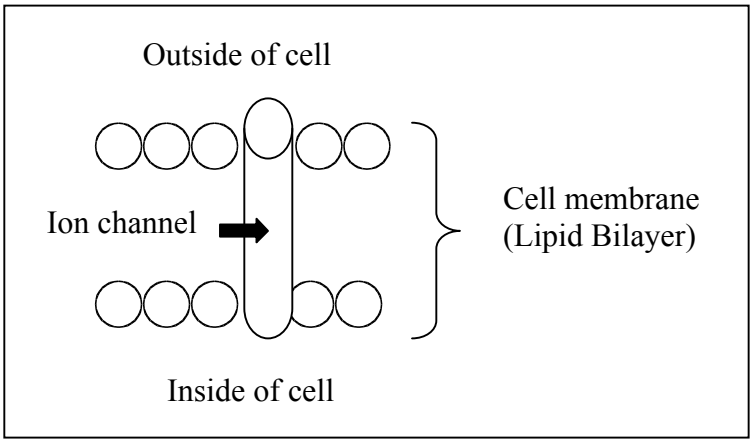
_____

It would be difficult to get your oil to stay at the bottom of the water:



How would you do this? If you think of the top of the container as the surface of an algae cell, and the bottom of the container as the middle of the algae cell (where it wants to get nutrients), you see the problem the algae face. So how do they do it?

They can get charged molecules (ions) into their cells two different ways which are both considered facilitated diffusion, the two ways may work together (scientists are trying to figure it out). The first way is by having a carrier. The carrier grabs the ion at the cell membrane and helps it to get inside the cell. This would be like trying to get into a very exclusive club and knowing a member who can help you get in. The second way is through something called an ion channel. An ion channel is a protein that goes through the cell membrane (see picture).



Ion channels will allow charged nutrients to get inside of the cell without being stopped by the lipid bilayer. The nutrients are still diffusing into the cell because their concentration is greater outside of the cell than it is inside of the cell- so they are still moving from areas of high concentration to areas of low concentration. A carrier and an ion channel can work together (the carrier would take the charged molecule though the ion channel.

Activity 2: Carefully pour a little of the colored water on top of the oil. Does it mix with the water below the oil or stay on top of the oil? (Circle your answer).
Now, place your straw so that it goes through the layer of oil and into the water below. Pour a small amount of colored water through the straw. Does it get trapped above the oil like before, or does it reach the water? (Circle your answer)
The straw is just like the ion channels, allowing charged nutrients to make it through the membrane and into the cell!

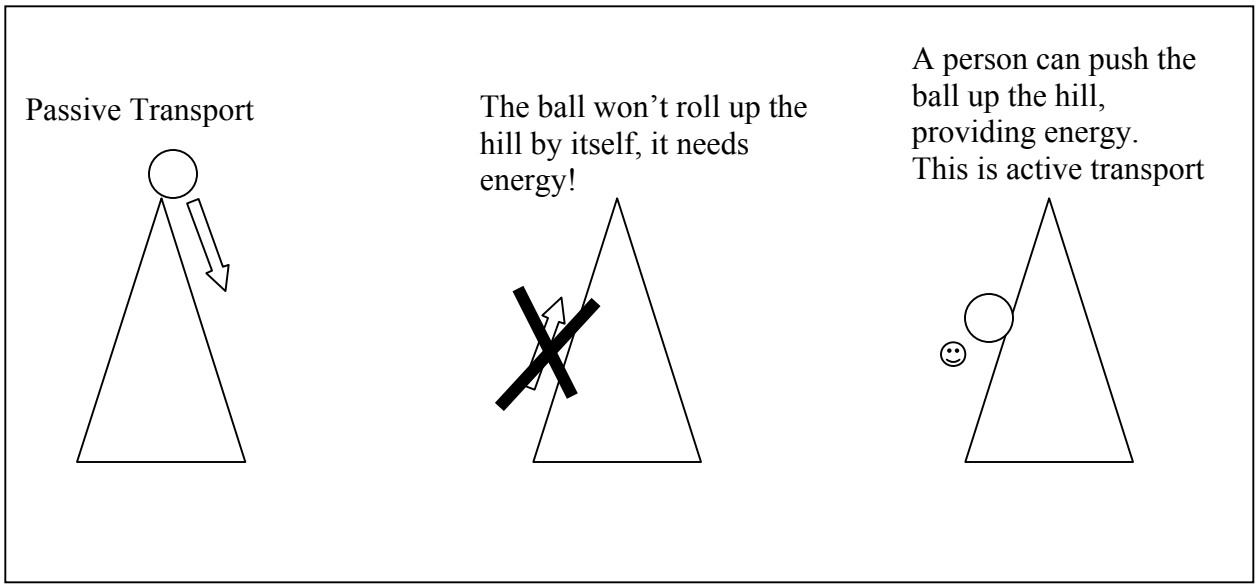
Question 4: What do you think would happen to an alga cell that doesn't have any ion channels? Would it still be able to get the nutrients it needs or would it starve?

_____

_____

Station 4: Active Transport

Active transport is different from the other three methods of nutrient transport because it requires energy in order to get the nutrients into the cell. It forces nutrients from areas of low concentration into areas of high concentration (and remember; nutrients don't like to be crowded!). The other three methods of nutrient transport can be thought of as downhill processes: a ball balancing at the top of a hill is naturally going to roll down the hill, but a ball at the bottom of a hill definitely won't roll up the hill by itself! In this example, active transport is the process of pushing the ball up the hill; it takes energy.



Activity: Your group has several balloons at your station.

Question 1: Do you think the concentration of air is greater inside of the balloon, outside of the balloon or is it equal inside and outside of the balloon? Circle your answer.

Question 2: If you were to blow up the balloon, you would be increasing the concentration of air inside of it. Would this take energy? Yes or No (circle your answer)

Question 3: Does a balloon ever spontaneously fill up with air? Why or why not?

_____

_____

Question 4: If you blow up a balloon and you do not tie the end, does the air want to stay inside of the balloon or does it want to come out? Why?

_____

_____

Everyone in your group should take a balloon and blow it up.

Question 5: Is it easier to blow it up when you first start, or when the balloon starts to get very full? Why do you think that is the case? _____

_____

_____

Carefully (please don't let your balloon go zooming out of control!), let a little air out of the balloon.

Question 6: Is it easier to get the air out of the balloon than it was to put the air into the balloon? Yes or No (circle)
Does it take energy? Yes or No (circle)

Question 7: Which of the 4 transport methods (adsorption, passive transport, facilitated diffusion or active transport) brings the air <u>out</u> of the balloon? Circle your answer.

Question 8: Draw the concentration of air particles (just draw them as dots, lots of dots for high concentration and just a few dots for low concentration) you think are in the balloon and outside of the balloon in each situation below:

Empty Balloon	Inflated Balloon	Balloon Losing Air

Question 9: Zinc (Zn) is a metal and a micronutrient that algae need to survive, however alga only need low concentrations of zinc and if the concentrations get too high, zinc can actually become toxic to the algae and poison them! Zinc is brought into alga cells by active transport. Why do you think algae would continue to bring zinc into their cells when the concentration of it gets high enough to be toxic? Can they control it?

_____

_____

_____

_____

Conclusion: Hopefully you have learned something about how another type of organism "eats" their food. Even though algae don't go to the fridge and make a sandwich, they still have to get nutrients everyday just like us! So, the next time you are eating lunch, think about all of the algae "munching" on nitrogen, phosphorus, carbon and all of the other macro and micro nutrients they like so much.

Vocabulary List

Active Transport: the transport of a substance against a concentration gradient (from an area of low concentration to an area of high concentration – the opposite of diffusion). Active transport requires energy.

Adsorption: the binding of a particle (nutrient) to the surface of a solid (cell membrane).

Alga (plural algae): Any one of a wide diversity of protists. Most live in the water, where they are the dominant autotrophs; most are unicellular, but a minority are multicellular.

Anion: a negatively charged ion (an atom that gained electrons).

Atom: the smallest unit of a chemical element. Consists of a nucleus and one or more electrons.

Cation: a positively charged ion (an atom that lost electrons).

Diffusion: movement of molecules or other particles from areas of high concentrations to areas of low concentrations, resulting in even distribution of the particles.

Electron: a fundamental part of an atom, it has a charge of -1 and surrounds the nucleus of an atom.

Facilitated Diffusion: something that helps diffusion happen and usually speeds it up. Two possible facilitators are carriers and ion channels.

Hydrophilic: love for water.

Hydrophobic: afraid of water.

Ion: an atom or group of atoms with electrons added or removed, giving it a negative or positive electrical charge.

Ion Channel: a membrane protein that can let ions pass across the cell membrane.

Limiting Factors: any abiotic (non-living) or biotic (living) factor that restricts the number of individuals in a population.

Lipid Bilayer: the cell membrane of a cell, made up of 2 layers of hydrophobic tails and hydrophilic heads.

Neutron: a fundamental part of an atom, it has no charge and is found in the nucleus of an atom.

Passive Transport: doesn't require energy, see "Diffusion" definition.

Proton: a fundamental part of an atom, it has a charge of +1 and is found in the nucleus of an atom.

Name_____ **Period**_____

Algae Experiments

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.

Garfield cartoon is pasted on here

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?

_____

_____

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.

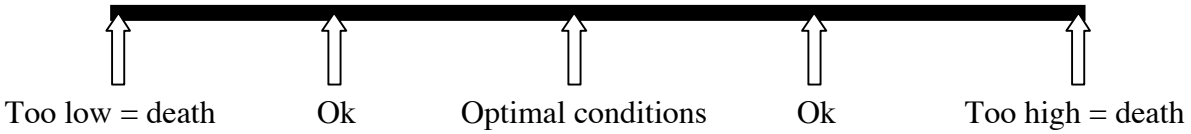
Nitrogen is found in fertilizers and even in pet feces. Phosphorus is also found in fertilizers and is a common ingredient in different types of soap. It used to be found in almost all laundry detergents, but now if you read the labels on laundry detergent almost all of them say "contains no phosphates". 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.

Algae Experiment Report Rubric

Name_____

Introduction **5 points**

- Restate problem/question
- Develop a hypothesis
- Provide relevant background information (from algae experiments handout or other appropriate sources)

Methods and Materials **5 points**

- List of equipment
- Quantity of each piece of equipment
- Procedure for your experiment written in paragraph form
- Create data tables appropriate for the type of data you will be collecting in your experiment

Results **8 points**

- Data from experiment in data table
- Data table is labeled appropriately and has a title
- Units are included on all measurements
- Graph (if appropriate)
- All graphing rules are followed

Conclusion **8 points**

- Restate problem and hypothesis
- How did you come to the hypothesis you created?
- Explain how data did or did not support hypothesis
- Discuss variables that may have effected experiment
- Did you use a control? Why or why not?
- What variables were controlled in the experiment?
- What variables were left uncontrolled?
- Did human error influence the results?
- Did you need to change your original procedure? If so, why?
- Did anything unexpected happen?
- Did this experiment help you answer your question or solve the problem?
- What new questions were generated by this experiment?
- What new experiments would you suggest performing?
- How would you make this experiment better, scientifically speaking?

Format **4 points**

- 12 point font in Times New Roman, Arial, or Georgia font
- Single spaced paragraphs with headings for each section
- Space between each section
- No excessive spelling or grammatical errors
- Correct use of present and past tense
- Thoroughness: Enough detail is provided to understand thought

Possible Points: 30 **Total**_____

Chemistry Connection

Created by Sara Heintzelman, Interdepartmental Graduate Program in Marine Science
University of California Santa Barbara

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University of California Santa Barbara

Santa Barbara Coastal Long Term Ecological Research Project

The National Science Foundation

Marine Science Institute
University of California, Santa Barbara

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

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

- Structure of Matter
  3. Each of the more than 100 elements of matter has distinct properties and a distinct atomic structure.
    a. Students know the structure of the atom and know it is composed of protons, neutrons, and electrons.

b. Students know that compounds are formed by combining two or more different elements and that compounds have properties that are different from their constituent elements.

f. Students know how to use the periodic table to identify elements in simple compounds.

- 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.

  c. Students know that living organisms have many different kinds of molecules, including small ones, such as water and salt, and very large ones, such as carbohydrates, fats, proteins, and DNA.

- Periodic Table

  7. The organization of the periodic table is based on the properties of the elements and reflects the structure of atoms.

  b. Students know each element has a specific number of protons in the nucleus (the atomic number) and each isotope of the element has a different but specific number of neutrons in the nucleus.

- 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.

Chemistry Connection Instructions

In this lesson the students will learn how and what algae "eat". This hands-on lab activity has four stations (Adsorption, Passive Transport, Facilitated Diffusion, and Active Transport) each focusing on one way that algae obtain the nutrients they need to survive. Students have guiding questions to help them focus as they work their way through this fun and messy lab. The students will not only learn the four transport mechanisms, they will actually experience them; allowing them to see the important connections between chemistry and biology.

Objectives:
* The students will learn the basic nutrient requirements of algae including types of nutrients and uptake methods.
* The students will learn fundamental chemistry principles as they relate to algal biology.
Specifications:

a. The students will learn which macronutrients and micronutrients algae require for growth.
b. The students will learn the basic concept of an atom, the parts of an atom, and the idea of ions (both anions and cations).
c. The students will be able to calculate the charge on an atom when given the number of neutrons, electrons and protons.
d. The students will learn the 4 main methods of nutrient transport into an algal cell: adsorption, passive transport, facilitated diffusion, and active transport.

Materials: Chemistry Connection Worksheet (1 copy per student), soap and newspaper (newspaper not supplied, but it is highly recommended to cover tables with newspaper before lab activity as it gets messy!)

- *Station 1: Adsorption:* 3 pairs of magnets (1 pair at each station) with + and – charges labeled (** Please remind students to be gentle with the magnets; they are ceramic and will break if students are rough with them**).
- *Station 2: Passive Transport:* 3 plastic containers, 1 at each station (1 small Rubbermaid and 2 large plastic containers- box 1 and box 2 which normally hold supplies), and 3 small food coloring bottles (1 at each station).
- *Station 3: Facilitated Diffusion:* 6 plastic bottles (2 at each station- 1 filled with vegetable oil and 1 filled with water with food coloring added), 3 small Tupperware containers (1 at each station and fill about halfway with water), and 3 straws (1 at each station).
- *Station 4: Active Transport:* 1 balloon for each student.

Activity: (approximate time: 50 minutes)

- Have the students read the 1st 2 pages of the Chemistry Connection Worksheet and answer the questions on those pages prior to the lab activity (either as homework or in class the day before). If your students don't read the 1st 2 pages previous to the lab activity, the activity will take longer than 50 minutes.

- In class before beginning the lab activity, assign each group to a station and have them read the directions for that activity and report back to the rest of the class on what to do at that station. Alternatively, you could go over the directions for all 4 stations as a group.
- There are enough supplies to set up 3 copies of each of the 4 stations (12 in total). Depending on the number of students in your class you may choose to set up all 3 copies of each or less depending on your needs. Decide how your students will rotate through the stations (it is recommended that they work in groups of 3-4).
- It is highly recommended that you cover the tables/countertops where lab activities will be taking place with newspaper (the vegetable oil gets messy). Soap is provided in the kits for students to get oil off of their hands (you may want to ask them why the oil won't come off with just water to get them thinking more about hydrophobic substances).
- Station 4: Active Transport uses balloons. It may be best to not set up this station and instead have the students rotate through stations 1-3 and then all do station 4 as a class (students seem to get very excited about balloons!).

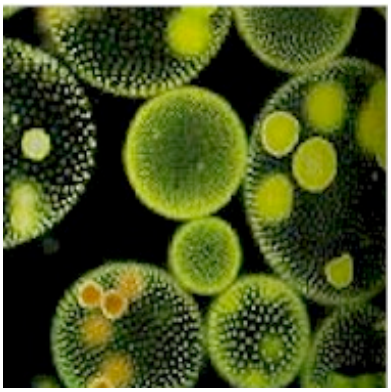
Name_____ Period _____

Chemistry Connection Worksheet

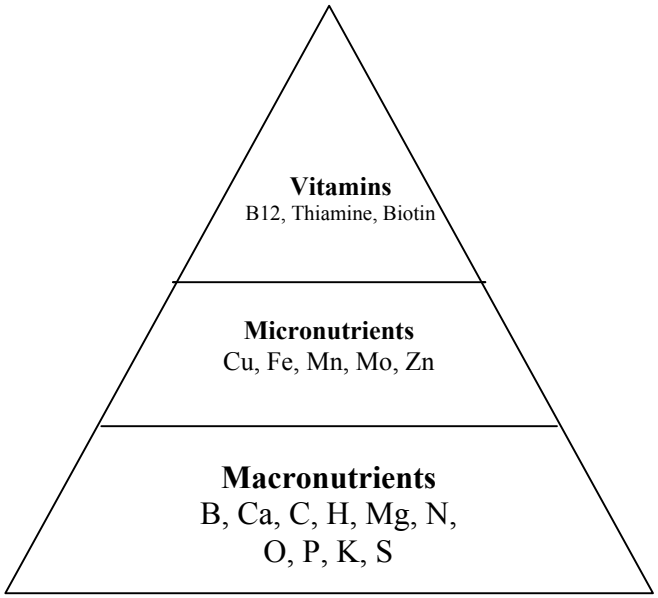
Nutrients

Every living organism needs to eat to stay alive, what they eat and how they eat it is going to vary a lot though! I'm sure that all of your parents have encouraged you to eat more fruits, veggies, and "healthy" food instead of eating junk food like candy and desserts. You are also probably familiar with the food pyramid, describing how many servings of each food group you should eat every day. Algae have their own food pyramid, and while they aren't eating sandwiches and fruit, they do have their own nutrition requirements. Food for algae falls into two major categories: macronutrients and micronutrients. Macronutrients are the "food" that the algae need a lot of while they tend to need less of the micronutrients.

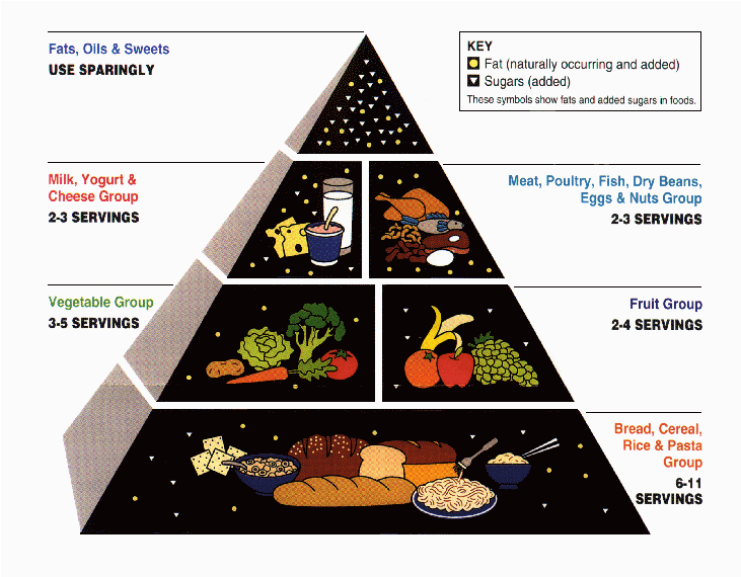
Algae Nutrients



Macronutrients	**Micronutrients**
Boron (B)	Copper (Cu)
Calcium (Ca)	Iron (Fe)
Carbon (C)	Manganese (Mn)
Hydrogen (H)	Molybdenum (Mo)
Nitrogen (N)	
Oxygen (O)	**Vitamins**
Phosphorus (P)	B12
Potassium (K)	Thiamine
Sulfur (S)	Biotin



The Algae Food Pyramid



The Human Food Pyramid

Limiting Nutrients

Do you remember when we talked about limiting factors? We defined limiting factors as any abiotic or biotic factor that restricts the number of individuals in a population. An example is houses. If there are no more houses for sale and no land to build more houses on in a town; the population of that town cannot increase. In this case, housing would be a limiting factor. Nutrients can be a limiting factor as well. If you didn't have food to eat, you wouldn't be able to grow- in fact it could lead to death. In this case, nutrients would be the limiting factor, limiting your growth.

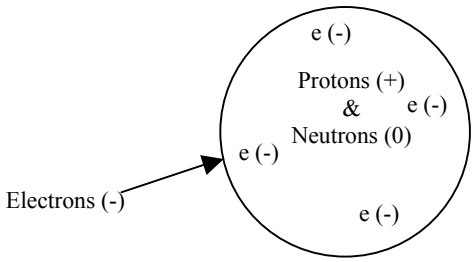
Algae frequently face a problem of having limited nutrients. Nitrogen (N), phosphorus (P), iron (Fe), copper (Cu), zinc (Zn), manganese (Mn), and carbon (C) have all been shown to limit algae growth in different situations. The first two nutrients, nitrogen and phosphorus, limit algae growth most regularly.

Do you remember any products that might put these nutrients (nitrogen and phosphorus) into the aquatic environment? Write your answer below:

Car soap, fertilizer, animal waste

Algae food isn't quite like human food….

You may have noticed that the type of food algae eats is really different than what we eat. Instead of eating a nice slice of pizza, algae enjoy some yummy nitrogen! The favorite foods of algae, such as nitrogen and phosphorus, are all elements that you might be familiar with from the periodic table of elements. Each element on the periodic table is made up of three parts: protons, neutrons and electrons. Protons have a positive charge, neutrons have no charge and electrons have a negative charge. Protons and neutrons make up the core of the element and are surrounded by the electrons. Usually the number of electrons is equal to the number of protons so the element has no charge. Sometimes though, an element may either lose or gain electrons and this will give it a charge. When an element has a charge, it is called an ion. It can gain a positive charge, which makes it a cation, or it can gain a negative charge, making it an anion.



Ions

6 protons (+) & 6 electrons (-) = no charge

6 protons (+) & 5 electrons (-) = +1 charge (cation)

6 protons (+) & 7 electrons (-) = -1 charge (anion)

Practice Questions:

1. Nitrogen (N) normally has 7 protons and 7 electrons. It loses 1 electron, calculate its charge and indicate if it is negative or positive:

positive one

2. Phosphorus (P) normally has 15 protons and 15 electrons. It gains 1 electron, calculate its charge and indicate if it is positive or negative:

negative one

How do Algae "Eat" their Nutrients?

When you need some nutrients, you might make a sandwich or go to the store and get something that is already made. You take bites of it, digest it, and voila: your body gets nutrients! All of the nutrients that algae need are found in the water around them, but how do they "eat" them? How do they get the nutrients from the water into their cells?

There are 4 ways that algae take nutrients into their cells:

1. Adsorption
2. Passive Transport
3. Facilitated Diffusion
4. Active Transport

Activity: You and your group will visit 4 lab stations, at each one there will be an activity and some questions that you need to answer. You will rotate through each station and learn about the 4 ways that algae take nutrients into their cells.

Station 1: Adsorption

Have you ever heard the phrase "opposites attract"? Well that is basically what is happening in the case of adsorption. There are certain negatively charged molecules (such as proteins with sulfate, carboxyl, and phosphate groups) which are found in the cell wall of algae. When a cation (a positively charged ion) tries to enter the cell, it gets trapped by these negatively charged molecules because the negative charge and the positive charges attract one another. One cation that algae needs is the sodium ion (Na^+), it has a charge of +1 and the negatively charged molecules in the cell wall are going to try and grab it and use it to neutralize their charge (+1 and -1= 0 charge). Most things want to be neutral if they can, that is their most comfortable condition.

Question 1: Do you think 2 positive charges would attract or repel? How about 2 negative charges? Answer below

They would repel because they are both positives or negatives

Activity: See for yourself! Magnets have a positively charged end and a negatively charged end. Using the magnets at your station, what happens when you try to put 2 positively charged ends together? (Please be gentle with the magnets, they break easily!)

They repel

What happens when you try to put 2 negatively charged ends together?

They repel

What happens when you put 1 positively charged end with 1 negatively charged end?

The two ends are attracted to each other and thus come together

Which of these 3 set-ups (2 positive charges, 2 negative charges or 1 positive and 1 negative charge) is most like adsorption? Circle your answer.

Question 2: If you had a sodium ion (Na+), which of the following would it probably want to combine with?

a) Carbon (C, charge = 0)
b) Chlorine (Cl-, charge = -1)
c) Oxygen (O, charge = 0)

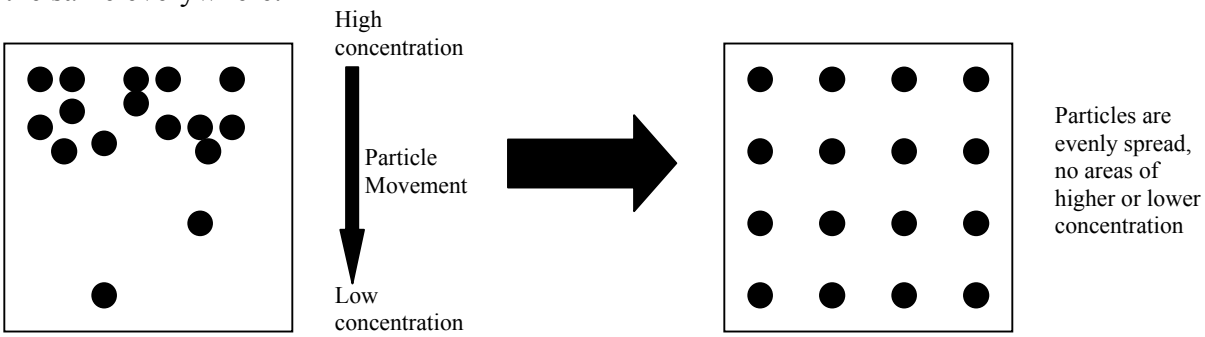
Question 3: Lead (Pb) is often added to aquatic environments as a result of pollution (burning fossil fuels releases lead into the air and it reaches the earth when it rains). Lead is a positively charged metal and is adsorbed by algae cells. Lead can poison humans, what do you think its affect on algae is? Adsorption usually happens quickly, would fast uptake of lead be bad for algae?

The algae would be instantly killed

Station 2: Passive Transport

Have you ever heard the word diffusion before? Diffusion is the tendency for chemicals or elements to spread out from areas of high concentration so that concentration becomes equal over a given area. Chemicals diffuse, so do people! Think about a crowded beach during the summer. A lot of people arrive at the beach at one small area (where there is a parking lot or where a path leads down to the beach); do they all stay clumped together right at the entrance? Not usually, normally they spread out. People want to leave the area where it is really crowded and go to an area where there are less people.

The trend that you see with people and with particles is the same; you see movement from areas of high concentration to areas of low concentration until the concentration is the same everywhere.



Activity: Your group is going to carefully add **5** drops of food coloring to your container of water, make sure to put them all in at the same place. Watch what happens after you add the food coloring and write down any observations.

Slowly spreads, yet does not combine together

Question 1: Where is the concentration of the food coloring the highest when you first added the drops?
The highest concentration is where the color was dropped

Question 2: Does the food coloring stay where you first added it to the water? If not, where does it go?
It tends to move out around itself

What you saw happening was diffusion. Nutrients can diffuse into a cell if the concentration of that nutrient is lower inside of the cell than it is outside of the cell (remember, the nutrients don't like to be crowded!). Waste products from the cell can also diffuse out of the cell.

Question 3: Do you think it would be easier for a particle with a neutral charge or a particle with a positive or negative charge to diffuse in or out of a cell? Why?
Neutral because it is the most comfortable condition

Station 3: Facilitated Diffusion
This is the same idea as the diffusion that we just talked about, the main difference is that facilitated diffusion is faster than the diffusion we talked about at Station 2.

Fill in the blanks: Diffusion is movement from areas of ___**high**____ concentrations to areas of ____***low***____ concentration.
Sometimes nutrients need a little help to diffuse into the cell, when they get this help it is called facilitated diffusion. The cell membranes of algae cells are made up of a lipid bilayer (lipid= fat, bilayer= 2 layers).

This part (the head) is hydrophilic. Hydro = water, philic = love
So hydrophilic = loves water

This part (the tail) is hydrophobic. Hydro = water, phobic = fear
So hydrophobic = afraid of water

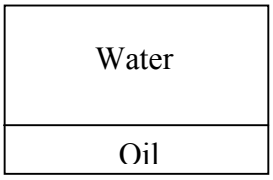
The hydrophobic part of this membrane is a barrier for charged nutrients (ions), so how do they get through the membrane and into the cell? They need some help!

Activity 1:
Question 1: Can you think of anything that is hydrophobic (afraid of water)? If you can write you answer here: ***oil***

Question 2: How do you know it is "afraid" of water? What does it do that shows you that? ***The water does not dilute the oil, instead it sits at the surface***

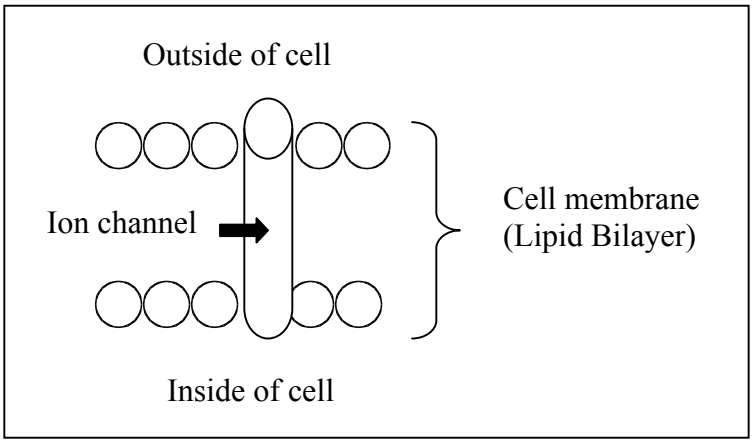
Pour a small amount of oil into your container of water.
Question 3: What does it do? If you stir the container can you get the oil to mix with the water? Describe what happens: ***the oil went from a big mass into tiny parts***

It would be difficult to get your oil to stay at the bottom of the water:



How would you do this? If you think of the top of the container as the surface of an algae cell, and the bottom of the container as the middle of the algae cell (where it wants to get nutrients), you see the problem the algae face. So how do they do it?

They can get charged molecules (ions) into their cells two different ways which are both considered facilitated diffusion, the two ways may work together (scientists are trying to figure it out). The first way is by having a carrier. The carrier grabs the ion at the cell membrane and helps it to get inside the cell. This would be like trying to get into a very exclusive club and knowing a member who can help you get in. The second way is through something called an ion channel. An ion channel is a protein that goes through the cell membrane (see picture).

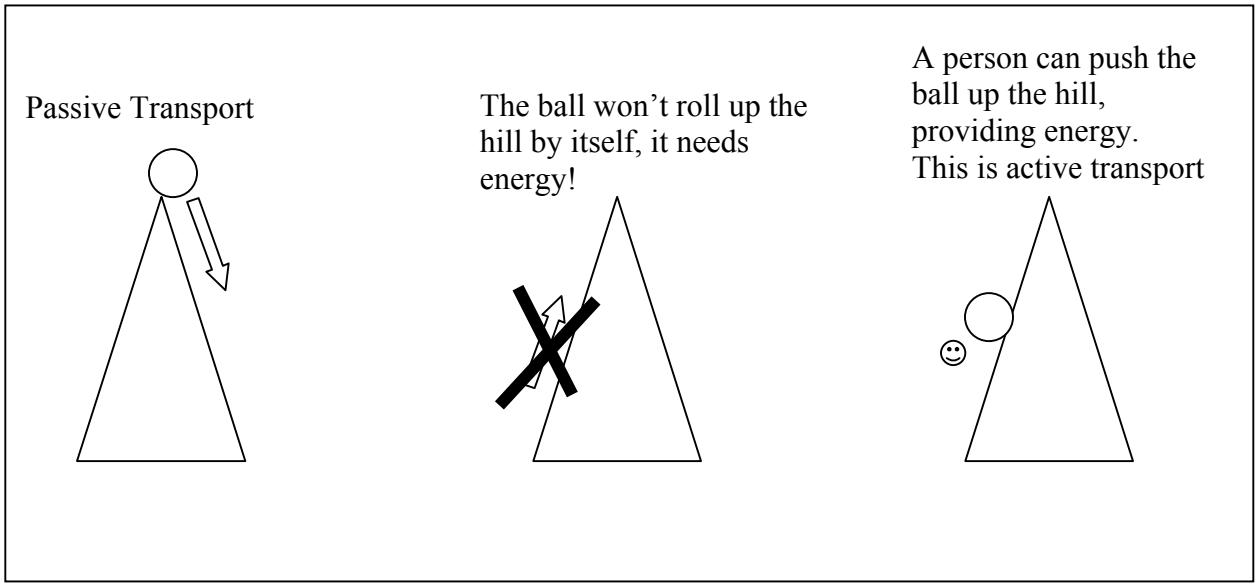


Ion channels will allow charged nutrients to get inside of the cell without being stopped by the lipid bilayer. The nutrients are still diffusing into the cell because their concentration is greater outside of the cell than it is inside of the cell- so they are still moving from areas of high concentration to areas of low concentration. A carrier and an ion channel can work together (the carrier would take the charged molecule though the ion channel.

Activity 2: Carefully pour a little of the colored water on top of the oil. Does it mix with the water below the oil or stay on top of the oil? (Circle your answer).
Now, place your straw so that it goes through the layer of oil and into the water below. Pour a small amount of colored water through the straw. Does it get trapped above the oil like before, or does it reach the water? (Circle your answer)
The straw is just like the ion channels, allowing charged nutrients to make it through the membrane and into the cell!

Question 4: What do you think would happen to an alga cell that doesn't have any ion channels? Would it still be able to get the nutrients it needs or would it starve?
The algae would starve or die

Station 4: Active Transport
Active transport is different from the other three methods of nutrient transport because it requires energy in order to get the nutrients into the cell. It forces nutrients from areas of low concentration into areas of high concentration (and remember; nutrients don't like to be crowded!). The other three methods of nutrient transport can be thought of as downhill processes: a ball balancing at the top of a hill is naturally going to roll down the hill, but a ball at the bottom of a hill definitely won't roll up the hill by itself! In this example, active transport is the process of pushing the ball up the hill; it takes energy.



Activity: Your group has several balloons at your station.
Question 1: Do you think the concentration of air is greater inside of the balloon, outside of the balloon or is it equal inside and outside of the balloon? Circle your answer.

Question 2: If you were to blow up the balloon, you would be increasing the concentration of air inside of it. Would this take energy? Yes or No (circle your answer)

Question 3: Does a balloon ever spontaneously fill up with air? Why or why not?
No, because it takes energy to become filled with air

Question 4: If you blow up a balloon and you do not tie the end, does the air want to stay inside of the balloon or does it want to come out? Why?
It wants to come out because of diffusion, meaning the air wants to go to a lower concentrated area

Everyone in your group should take a balloon and blow it up.
Question 5: Is it easier to blow it up when you first start, or when the balloon starts to get very full? Why do you think that is the case? ***It is harder in the end because there is less room***

Carefully (please don't let your balloon go zooming out of control!), let a little air out of the balloon.

Question 6: Is it easier to get the air out of the balloon than it was to put the air into the balloon? Yes or No (circle)
Does it take energy? Yes or No (circle)

Question 7: Which of the 4 transport methods (adsorption, passive transport, facilitated diffusion or active transport) brings the air out of the balloon? Circle your answer.

Question 8: Draw the concentration of air particles (just draw them as dots, lots of dots for high concentration and just a few dots for low concentration) you think are in the balloon and outside of the balloon in each situation below:

Empty Balloon	Inflated Balloon	Balloon Losing Air

Question 9: Zinc (Zn) is a metal and a micronutrient that algae need to survive, however alga only need low concentrations of zinc and if the concentrations get too high, zinc can actually become toxic to the algae and poison them! Zinc is brought into alga cells by active transport. Why do you think algae would continue to bring zinc into their cells when the concentration of it gets high enough to be toxic? Can they control it?
The algae can not control the intake of the zinc, it is just like breathing, it is an involuntary action

Conclusion: Hopefully you have learned something about how another type of organism "eats" their food. Even though algae don't go to the fridge and make a sandwich, they still have to get nutrients everyday just like us! So, the next time you are eating lunch, think about all of the algae "munching" on nitrogen, phosphorus, carbon and all of the other macro and micro nutrients they like so much.

Chemistry Connection References

Images:
All images without a reference are from Microsoft Clipart.

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From the Whale Rescue Team
(http://www.whalerescueteam.org/rescues.html#domoic_anchor)

Domoic Acid Poisoning
By Peter Wallerstein

LOS ANGELES COUNTY In the spring of 2002 a crisis fell upon hundreds, if not thousands, of pregnant California sea lions, dolphins and pelicans along the Pacific coast of the United States. Domoic acid, a naturally occurring marine biotoxin, produced by marine diatoms which are members of the genus *Pseudo-nitzschia*, forced pregnant sea lions to beach themselves suffering major seizures, foaming from their mouths, and the whites of their eyes bloody red. The sea lions were completely disoriented from the neurotoxin. Dozens of Common dolphins and pelicans also suffered from attacks on their brains and nervous systems by the rapid reproduction of the toxic single-cell plankton.

California sea lion suffering from domoic acid poisoning.
Photo: Jonathon Alcorn

The Marine Mammal Care Center at Fort MacArthur in San Pedro, California accepts mammals for rehabilitation from Los Angeles County and parts of Orange and Ventura Counties. The Center's staff and volunteers did an excellent job during the domoic crisis, but Fort MacArthur was overloaded for weeks which prompted the National Marine Fisheries Service (NMFS) to enact a 48 hour monitoring period before an animal may be rescued. Only “non-responsive” animals could be assisted before the 48 hour period expired. NMFS policy caused members of Whale Rescue Team (WRT) to have to triage dozens of sea lions daily leaving them unassisted on the beach.

Hoop netting a sea lion during a rescue on Pacific Palisades beach.
Photo: Rich Schmitt

It was very difficult to leave a suffering animal on the beach that we would normally rescue immediately. From 7 o'clock in the morning to 10 o'clock at night we located the animals, gave each of them multiple evaluations throughout the day, rescued as many of the animals as possible and evaluated the new ones that arrived daily. The WRT hotline was receiving over 60 calls a day. We would receive calls at 2 o'clock in the morning from irate citizens wanting to know why we weren't helping the animal they were calling us about. But most citizens after hearing what was truly going on understood and were sympathetic. Some citizens even assisted WRT with the safer parts of our rescues.

In April, some of the sea lions began birthing their pups prematurely. Some were stillborn, others alive. We were advised that at this point the pup's lungs were so under developed that they wouldn't survive no matter what anyone did. We decided to keep those pups with their moms for the few hours they had to live. It was heartbreaking. We did observe that many of the pregnant sea lions that gave birth prematurely, were gaining strength and returning to the water with added vigor on their own.

The mis-education people receive from captive display facilities was very obvious during this crisis. A sea lion beached on a busy day in Venice, California and was quickly surrounded by 200 people trying to pet the frightened and distressed sea lion. I am amazed that more people weren't bitten. Luckily for the citizens the domoic caused most of the sea lions to be very incoherent to their surroundings. We saw people attempting to bounce balls off a sea lions nose or take family photos next to the suffering and unpredictable sea lions. Other well intentioned, but misguided citizens tried to pull the sea lions back into the water not knowing how dangerous this could be and also that their actions might cause death to the sea lion. Some people would even hold the head of a sea lion while it was suffering a seizure. One out of ten sea lions awoke from their seizures looking for something to attack. In one incident, in Venice Beach, a woman got too close to a sea lion as it awoke from a seizure. She got bit severely and the sea lion, up on all fours charged at anything near it. It was very sad to see these normally non-aggressive animals act so violently and out of control. They were scared and sick. The sea lion charged the Lifeguards upon their arrival and also charged WRT volunteers when we arrived. Due to her aggressiveness and her location we received permission to rescue her. With assistance from County Lifeguards we rescued the sea lion and brought her in for treatment at Fort McArthur

We've seen and rescued many animals suffering from gill net entanglement and gun shot wounds. But, in 20 years of Southern California rescue experience, I have never seen anything on our local beaches that compares to the horrific and heartbreaking suffering caused by the toxic algae bloom in the spring of 2002. WRT volunteers gave each and every animal our very best efforts.

Sick, dying sea otters turn up in Morro Bay
Scientists suspect naturally occurring algae bloom poison

- Jane Kay, Chronicle Environment Writer
Thursday, April 15, 2004

More than 20 California sea otters, nearly 1 percent of the wild population, have turned up dead or sick around Morro Bay over the past week, most likely the victims of a natural marine toxin, scientists said Wednesday.

The animals have been discovered suffering from seizures or muscle tremors, or comatose. Wildlife experts believe they may have eaten mussels, clams and scallops contaminated with a naturally occurring toxin sometimes found in algae blooms at this time of year.

"It's really, really sad. Everybody loves the sea otters," said Dr. Michael J. Murray, staff veterinarian at the Monterey Bay Aquarium. "It's sad to read about it. It's said to hear about it. It's even sadder to see seizing and comatose sea otters, and to see them lying out on that stainless steel autopsy table."

State and federal agencies are waiting for results of post-mortem examinations on 12 otters and tests on tissue samples to confirm whether to blame the toxin, called domoic acid.

The state Department of Health Services has issued a health advisory, alerting the public not to eat sport-caught shellfish in San Luis Obispo County.

"Unfortunately, we think it's probably a naturally occurring substance, and there's nothing we can do about it," said Dana Michaels, a spokeswoman for the state Department of Fish and Game.

Other marine mammals, such as sea lions and dolphins, as well as birds and humans, are susceptible to nervous system damage from consuming shellfish and fish containing domoic acid.

The southern sea otter is protected as a threatened species under federal law. A 2003 census counted only 2,505 otters between Santa Barbara and Half Moon Bay, its current range. Biologists say the population must exceed 3,000 for the government to consider it no longer threatened.

Southern sea otters were once plentiful. But the otter has been hunted for its fur, shot by fishermen, hit by boats, snagged by nets, eaten by sharks and contaminated by PCBs, pesticides, sewage and other pollutants.

A year ago this month, 48 otters died, the highest short-term mortality rate in modern times. Those deaths were attributed to marine toxins; parasites, including one linked to cat waste; and shark bites.

But in just one week this year, the Monterey Bay Aquarium and the Marine Mammal Center have been receiving calls from upset beach-goers around Morro Bay who have found more than 20 sick or dead animals.

"The big thing that is alarming is that we're having so many animals dying in such a short time period. We're seeing in the post-mortems very similar changes, suggesting that the same thing is killing the animals," said Murray, the veterinarian.

"We suspect a marine biotoxin, but we're not sure yet. We need to get confirmation on this. We've got the best minds working on it, and we're searching for answers."

Domoic acid is produced by algae called diatoms that collect in algae blooms on the coast. Lilian Busse, a Scripps post-doctoral researcher, said it's unclear what makes algae produce domoic acid.

In recent years, domoic acid has been found in sea water in Monterey Bay, Santa Barbara and Los Angeles.

On Friday, researchers at the Scripps Institution of Oceanography in La Jolla reported that domoic acid was found in sea water as far south as San Diego. The toxin may be responsible for sea lion strandings in Southern California this year, they said.

E-mail Jane Kay at jkay@sfchronicle.com.

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URL: http://sfgate.com/cgi-bin/article.cgi?file=/chronicle/archive/2004/04/15/MNGF9651U433.DTL

Local News ----------

Posted on Wed, Jun. 04, 2003

News briefs from California's Central Coast

Associated Press

SANTA BARBARA, Calif. (AP) – Federal officials want the county to provide details on the dead sea lions and dolphins found along beaches.

With carcasses rotting on beaches for days at a time, most coastal residents are well aware of the toll taken by domoic acid on local sea mammals. But the federal government hasn't been in the loop.

For the past decade, Santa Barbara County hasn't shared that information with the National Marine Fisheries Service, a violation of federal law that could put efforts to fight the outbreak at risk.

A directive from the federal agency - prompted by last week's strangling of a dying sea lion by a county worker - requests the county Public Works Department submit a monthly report on the local death toll by July 10.

The Marine Mammal Protection Act of 1972, in addition to protecting the sea lion killed on May 27, requires state and municipal officials to provide a monthly report on the beached mammals they bury.

"We need to know how many animals are coming in dead in a certain area," said Joe Cordero, a wildlife biologist with the Fisheries Service office in Long Beach, which is investigating the strangling incident. "If we know the timeline, we can establish a pattern.

"Right now, we have no idea how many are dying in Santa Barbara County."

Cordero said his office has sent several letters to the county requesting reports since the mid-1990s, but there has been little response.

Public Works director Phillip Demery said, however, that he's never received any letter. County Administrator Mike Brown also said he couldn't recall seeing a letter.

Santa Barbara County is last behind other counties in submitting reports about deaths due to domoic acid, Cordero said.

The domoic acid outbreaks began in Southern California in 1998, but until last year had not hit the waters off Santa Barbara County.

Domoic acid is carried by a common algae that blooms in early summer. Most of the sea lions and dolphins, and even some pelicans who fall victim to the illness, are pregnant. Symptoms of domoic acid poisoning include seizures, shaking and head-waving.

Last year, domoic acid killed 685 sea lions in Santa Barbara and Ventura counties, and stranded another 518, Cordero said. Since April, about 104 sea lions have died and another 177 have fallen ill in Santa Barbara and Ventura counties.

February 24, 2000
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Merrik Bush-Pirkle, San Francisco State University, (415) 338-6747; merrik@sfsu.edu

Sewage in urban runoff may spur growth of harmful algal blooms

Researchers find that urea from urban waste, generally ignored as a pollutant by environmental agencies, contributes to growth of potentially toxic blooms of a common phytoplankton species

For Immediate Release

SANTA CRUZ, CA--In nature, there's no accounting for taste. New research shows that a common type of marine algae may prefer urea, an organic nitrogen compound found in urine and in agricultural and urban runoff, over inorganic fare such as ammonium and nitrate that occurs naturally in the ocean. When excess nutrients cross their paths, these single-celled organisms, called dinoflagellates, can grow into potentially toxic blankets of algae commonly known as red tides.

The new findings, published in the current issue of Aquatic Microbial Ecology, suggest that urea in urban and agricultural runoff may play a greater role than previously thought in triggering or sustaining harmful algal blooms found growing off California's coastline.

"The particular bloom we looked at, which extended from the upper Baja peninsula in Mexico to the Monterey Bay, occurred after heavy urban runoff events in the southern California region," said Raphael Kudela, assistant professor of ocean sciences at the University of California, Santa Cruz. "Our data suggests it was probably triggered by the increased concentration of urea introduced to the ocean by urban runoff," Kudela said.

Kudela and coauthor William Cochlan of San Francisco State University's Romberg Tiburon Center for Environmental Studies examined the physiology and ecology of the bloom, which occurred in 1995 and was the largest and most widespread red tide found off California's coast since 1902. Though marine scientists usually monitor marine ecosystems for high concentrations of common inorganic nutrients known to spur harmful algal blooms, urea is generally ignored, the researchers said.

Previous studies have shown that urea can nourish the growth of dinoflagellates under laboratory conditions. The new study shows for the first time, however, that the naturally occurring red-tide dinoflagellate responsible for the 1995 bloom--known scientifically as Lingulodinium polyedrum--can use organic urea as a nutrient source and even prefers it over traditionally measured inorganic forms of nitrogen.

"Although urea as a source of pollution is generally ignored by state and federal environmental agencies, research shows that urea represents an average of one-third of the total nitrogen uptake supporting growth of phytoplankton in regions where red tides

can occur," Cochlan said. "In some estuarine areas, such as the Chesapeake Bay, urea can represent 60 percent of the nitrogen uptake at certain times of the year."

Phytoplankton serve as the base of the marine food web, but unusually high levels of nutrients together with abundant sunlight can spur rapid growth, or blooms, of these single-celled plants, leading to dense patches of algae floating near the surface of the ocean that can double in size daily. While most blooms are not harmful, a small number of phytoplankton species can produce potent neurotoxins when they form into a bloom, sometimes poisoning or killing higher life forms such as zooplankton, shellfish, fish, birds, marine mammals, and even humans as the toxin is transferred up the food chain.

Although Lingulodinium polyedrum has been reported to produce yessotoxin, a compound related to the class of poisons that cause paralytic shellfish poisoning, the researchers found no evidence that the 1995 bloom was toxic. However, large algal blooms of any type pose an additional risk by lowering the available oxygen in the surrounding water when they decay, causing small marine animals, such as zooplankton and fish, to suffocate.

"Considering the role urea seems to play in spurring or sustaining growth of phytoplankton, including harmful algal blooms, this organic nitrogen source should be taken into consideration by environmental agencies that conduct bloom mitigation efforts," Cochlan said.

According to Kudela, these harmful bloom events are becoming more common off the California coastline. In addition to the dinoflagellate Lingulodinium polyedrum, the diatom species Pseudo-nitzschia australis also plagues California's coastal waters in deadly bloom form. Pseudo-nitzschia was recently identified as the culprit when more than 400 sea lions died and many more suffered from domoic acid poisoning on California's Central Coast in 1998. "However, there's no evidence that Pseudo-nitzschia responds to urea," Kudela noted.

The researchers emphasized that red-tide-causing phytoplankton species are driven to bloom by varying mechanisms and nutrients, so it's important to examine and understand each species individually. Toward that end, the researchers have been awarded a grant from the National Oceanic and Atmospheric Administration's Coastal Ocean Program to conduct a comprehensive field and lab study, along with several other groups on the West Coast, of the more deadly Pseudo-nitzschia.

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Note to reporters: Article reprints and images are available on request.

Opinion vs. Fact Student Worksheet

I'm not biased!

Actually, most people have certain biases; a bias is "an attitude that always favors one way of feeling or acting over any other." In other words, if you have ever felt partial to something, had a preconceived notion, or played favorites- you have probably experienced what it is like to feel a bias towards something. It is normal that people will favor a certain way of acting or feeling; it may be what you have learned at home, at school, or through different experiences in your life. For example, if you have had a science class that you didn't like in the past, you may have come into this one expecting not to like it. That would be a preconceived notion, or a bias towards science! It is important to figure out what your own biases are so that you can be aware of them and realize when they are and aren't appropriate. In recognizing your own biases, you will become better at picking out other people's biases as well.

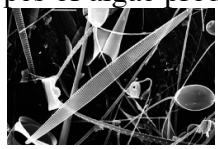
Fact or Opinion?

When you are reading a newspaper article, a magazine article, information on the internet, or even a book; how do you know what is fact and what is opinion? Can you tell from reading one of these if the author has any biases or if they are being completely objective? It is good for people to express their own opinions, but they need to make it clear what is opinion and what is actual fact. So how do you tell?

One way may be the language that they use. For example, if I were to say "everyone loves the ocean, the ocean is great" would that be a fact or an opinion? It would be an opinion; not everyone loves the ocean and not everyone thinks the ocean is great. I love the ocean and am therefore a little biased towards it and may not understand how anyone wouldn't like it. Alternatively, if I were to say "many people enjoy the ocean and think that it is great" that would be a fact. It would be even more accurate if I gave proof of my fact and said "I conducted a survey of all of the students in my class and found that 25 of 30 students enjoy the ocean and think its great".

Another way would be to look at the author's credentials, what qualifies the author to make certain statements? This can be a little difficult sometimes, especially with all of the information that we can access so easily through the internet- how do you know what to trust? Usually the information that you get from big, well-known agencies is reliable (for example, information from a museum or a city office). If you are ever in doubt, try to double check the information by looking at another source or ask someone! When you are reading an article, it usually tells you who the author is, it may say that the author is a researcher at UCSB, or a government official, or it may not say much. You can also look at the company that the author, or the people who are quoted in the article, work for. If you read something in the LA Times it's a safe bet that it will be more reliable than something you read in the National Enquirer. You need to learn how to judge when you are reading information from a reliable source, and when you may not be. This takes practice.

Activity 1:
The 4 quotations below are taken from articles about marine mammals getting sick and, in some cases, dying. Scientists think that these illnesses and deaths may be due to a toxin that some types of algae produce called domoic acid.



This is a picture of the diatom (an algae) Psuedonitzschia, which can produce the toxin domoic acid.

For each quotation below you need to decide if it is fact or opinion. If you think that it is a fact highlight it yellow, if you think that it is an opinion, highlight it blue.

#1: "One possible reason for the large number of pregnant sea lions coming in is that during pregnancy the mothers have to eat more to sustain themselves along with their unborn pups- and by eating more, they also take more domoic acid into their systems."

#2: "In 2002, 685 California Sea lion deaths were documented, as were the deaths of 75 dolphins".

#3: "Common effects of domoic acid seen in animals washed ashore include head weaving and seizures, which may lead to permanent brain damage and eventual death if not treated".

#4: "Why are domoic cases confined to coastal waters? Several researchers suspect connection with human activities."

Activity 2:
As you read your article highlight fact in yellow and opinion in blue just like you did in activity 1. Also as you read, try and figure out (not all articles provide the following information, so just do your best!):
1. Who is the author? _____
2. What are the author's qualifications? _____
_____
3. What company or organization does the author work for? _____
_____
4. What possible biases might the author have about the topic of the article? Why? _____
_____
_____
_____
5. Does the author interview anyone? Yes/ No (circle)
If yes, what are the qualifications of the person who was interviewed? _____
_____
Who do they work for? _____
What possible biases might they have? Why? _____
_____
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Media Activity

Created by Sara Heintzelman, Interdepartmental Graduate Program in Marine Science
University of California Santa Barbara

Supported by:

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The Marine Science Institute,
University of California Santa Barbara

Santa Barbara Coastal Long Term Ecological Research Project

The National Science Foundation

Marine Science Institute
University of California, Santa Barbara

California Department of Education Science Standards

6th Grade

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

8th Grade

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

Media Coverage Activity

This lesson explores the ideas of biases and the differences between fact and opinion while helping the students to better understand when material that they are reading, listening to or watching is reliable. Students discuss the normality of having biases and the importance of being able to recognize your own biases as well as those of other people. They will practice identifying statements as fact or opinion and will apply these skills to a critical reading of an article. Being able to identify credible sources is crucial to good research skills; and with the increasing access to the internet, knowing which material to trust is more important then ever. Students will gain skills that will help them throughout this unit as well as in the rest of their subjects.

Objectives:

* The students will be able to read a newspaper, magazine, or internet article critically.
* The students will discuss biases and understand that everyone has them. The students will learn to identify the interests of the different people involved in an issue.

Specification: At the end of this lesson, the students should be able to:

a. Identify who the author is (what is their job, qualifications, company, etc).
b. Identify what the author's position on the subject is.
c. Pick out which parts of the article are facts and which are opinions.
d. Explain what bias is.
e. Describe the possible biases of two authors or people involved in the topic of an article that they read.

Introduction:

I'm not biased!

Actually, most people have certain biases; a bias is "an attitude that always favors one way of feeling or acting over any other". In other words, if you have ever felt partial to something, had a preconceived notion, or played favorites- you have probably experienced what it is like to feel a bias towards something. It is normal that people will favor a certain way of acting or feeling; it may be what you have learned at home, at school, or through different experiences in your life. For example, if you have had a science class that you didn't like in the past, you may have come into this one expecting not to like it. That would be a preconceived notion, or a bias towards science! It is important to figure out what your own biases are so that you can be aware of them and realize when they are and aren't appropriate. In recognizing your own biases, you will become better at picking out other people's biases as well.

Fact or Opinion?

When you are reading a newspaper article, a magazine article, information on the internet, or even a book; how do you know what is fact and what is opinion? Can you tell from reading one of these if the author has any biases or if they are being completely

objective? It is good for people to express their own opinions, but they need to make it clear what is opinion and what is actual fact. So how do you tell?

One way may be the language that they use. For example, if I were to say "everyone loves the ocean, the ocean is great" would that be a fact or an opinion? It would be an opinion; not everyone loves the ocean and not everyone thinks the ocean is great. I love the ocean and am therefore a little biased towards it and may not understand how anyone wouldn't like it. Alternatively, if I were to say "many people enjoy the ocean and think that it is great" that would be a fact. It would be even more accurate if I gave proof of my fact and said "I conducted a survey of all of the students in my class and found that 25 of 30 students enjoy the ocean and think its great".

Another way would be to look at the author's credentials, what qualifies the author to make certain statements? This can be a little difficult sometimes, especially with all of the information that we can access so easily through the internet- how do you know what to trust? Usually the information that you get from big, well-known agencies is reliable (for example, information from a museum or a city office). If you are ever in doubt, try to double check the information by looking at another source or ask someone! When you are reading an article, it usually tells you who the author is, it may say that the author is a researcher at UCSB, or a government official, or it may not say much. You can also look at the company that the author, or the people who are quoted in the article, work for. If you read something in the LA Times it's a safe bet that it will be more reliable than something you read in the National Enquirer. You need to learn how to judge when you are reading information from a reliable source, and when you may not be. This takes practice.

Activity: (approximate time: 30-45 minutes)

Materials: Newspaper articles and Opinion vs. Fact Worksheet

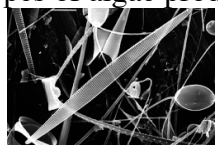
- Start by going over the information in the introduction (*on the student worksheet*) with the students. Ask the students to share (only if they feel comfortable) any of their own biases. (*Remind the students to be respectful and not to say anything that will offend other class members*). Share 1 or 2 of your own biases with the class to make them feel more comfortable. This can also be done as a journal writing activity or in small groups.
- Ask the students if they have ever read an article or book where the author seemed biased to them? How could they tell? Discuss some of the ways that you can figure out an author's biases from their writing and how it can help you distinguish opinion from fact. (*Language, credentials, company, others?*) This can also be done as a journal writing activity or in small groups. *If you would like to give the students a real example, this one makes for a good (and funny) story. One of my college biology professors came into our class one day very excited about this great new marine biology website that he had found. The following week he came into class looking a little bit embarrassed and told us that he had researched the great new website he*

had found and he had discovered that it had been created by a 12 year old boy! It just goes to show that you really need to be careful about what information you trust; and how important it is to figure out the source of the information, especially on the internet!

- Tell the students that as a class you are going to read an article and that as you read it everyone needs to figure out what the qualifications of the author or people interviewed are, what company they work for, what possible biases the author or interviewees might have, and what clues students see that might help them distinguish facts from opinions. Are there any definite facts? Are there any definite opinions? (*Use the sample article with all of this outlined for you to guide the students*)
- Tell the students that they are each going to read an article (*you can pass out copies of the articles provided or have the students find an article on the topic on the internet, in a magazine, or in the newspaper as homework*) and that it is their job to analyze it just as you did as a class. Have them use the Opinion vs. Fact Worksheet, first to practice with selected quotations and then to guide them as they read an article. (*Tell the students that some articles are easier to analyze than others and to do their best and ask for help if they need it*). This piece could be homework instead of an in-class activity.
- After the students have read their articles, open up a class discussion. All of the articles are going to be on the same topic, but may be written from different perspectives. Ask the students to share what they found when they analyzed their article, what was the general topic of their article, what clues helped them figure out pieces of information about the author and the author's opinion? This can also be done as a journal writing activity.

Activity 1: Teacher's Sample

The 4 quotations below are taken from articles about marine mammals getting sick and, in some cases, dying. Scientists think that these illnesses and deaths may be due to a toxin that some types of algae produce called domoic acid.



This is a picture of the diatom (an algae) Psuedonitzschia, which can produce the toxin domoic acid.

For each quotation below you need to decide if it is fact or opinion. If you think that it is a fact highlight it yellow, if you think that it is an opinion, highlight it blue.

#1: "One possible reason for the large number of pregnant sea lions coming in is that during pregnancy the mothers have to eat more to sustain themselves along with their unborn pups- and by eating more, they also take more domoic acid into their systems."

#2: "In 2002, 685 California Sea lion deaths were documented, as were the deaths of 75 dolphins".

#3: "Common effects of domoic acid seen in animals washed ashore include head weaving and seizures, which may lead to permanent brain damage and eventual death if not treated".

#4: "Why are domoic cases confined to coastal waters? Several researchers suspect connection with human activities."

Activity 2:

As you read your article highlight fact in yellow and opinion in blue just like you did in activity 1. Also as you read, try and figure out (not all articles provide the following information, so just do your best!):

1. Who is the author? Jane Kay
2. What are the author's qualifications? She is the environment writer for the SF Gate.com, I can't tell anymore from the information provided.
3. What company or organization does the author work for? She works for the San Francisco Chronicle.
4. What possible biases might the author have about the topic of the article? Why? She doesn't seem to have any biases in her writing; everything she writes is pretty objective. However, because she is the environment writer, she might really like the environment and have a bias in that way, maybe she wants to protect it.
5. Does the author interview anyone? Yes/ No (circle)

If yes, what are the qualifications of the person who was interviewed? She interviewed Dr. Micheal J. Murray, he is a veterinarian; Dana Micheals, who is a spokesman, and Lilian Busse, a post-doctoral researcher.

Who do they work for? Dr. Murray works for the Monterey Bay Aquarium, Micheals works for the State Department of Fish and Game, and Dr. Busse works for the Scripps Institution of Oceanography.

What possible biases might they have? Why? Dr. Murray might be biased towards sea otters since he works with them and wants to make sure that sea animals are healthy. In the article he says how sad it is to see them dying, but some people (like fisherman who compete with the sea otters) might not think that is sad. Michaels might be biased to the issue because if people are scared to eat fish because of possible poisoning, then it would be a concern for the DFG, also depending on Micheal's background which wasn't apparent from the article, she might have a personal interest of attachment to marine life. Busse might be biased because she studies toxic algae and so an outbreak of sick animals might be exciting for her since it would provide a chance to study it and learn more about HAB's.

Teacher's Example

Sick, dying sea otters turn up in Morro Bay

Scientists suspect naturally occurring algae bloom poison

- Jane Kay, Chronicle Environment Writer

Thursday, April 15, 2004

More than 20 California sea otters, nearly 1 percent of the wild population, have turned up dead or sick around Morro Bay over the past week, most likely the victims of a natural marine toxin, scientists said Wednesday.

The animals have been discovered suffering from seizures or muscle tremors, or comatose. Wildlife experts believe they may have eaten mussels, clams and scallops contaminated with a naturally occurring toxin sometimes found in algae blooms at this time of year.

"It's really, really sad. Everybody loves the sea otters," said Dr. Michael J. Murray, staff veterinarian at the Monterey Bay Aquarium. "It's sad to read about it. It's said to hear about it. It's even sadder to see seizing and comatose sea otters, and to see them lying out on that stainless steel autopsy table."

State and federal agencies are waiting for results of post-mortem examinations on 12 otters and tests on tissue samples to confirm whether to blame the toxin, called domoic acid.

The state Department of Health Services has issued a health advisory, alerting the public not to eat sport-caught shellfish in San Luis Obispo County.

"Unfortunately, we think it's probably a naturally occurring substance, and there's nothing we can do about it," said Dana Michaels, a spokeswoman for the state Department of Fish and Game.

Other marine mammals, such as sea lions and dolphins, as well as birds and humans, are susceptible to nervous system damage from consuming shellfish and fish containing domoic acid.

The southern sea otter is protected as a threatened species under federal law. A 2003 census counted only 2,505 otters between Santa Barbara and Half Moon Bay, its current range. Biologists say the population must exceed 3,000 for the government to consider it no longer threatened.

Southern sea otters were once plentiful. But the otter has been hunted for its fur, shot by fishermen, hit by boats, snagged by nets, eaten by sharks and contaminated by PCBs, pesticides, sewage and other pollutants.

A year ago this month, 48 otters died, the highest short-term mortality rate in modern times. Those deaths were attributed to marine toxins; parasites, including one linked to cat waste; and shark bites.

But in just one week this year, the Monterey Bay Aquarium and the Marine Mammal Center have been receiving calls from upset beach-goers around Morro Bay who have found more than 20 sick or dead animals.

"The big thing that is alarming is that we're having so many animals dying in such a short time period. We're seeing in the post-mortems very similar changes, suggesting that the same thing is killing the animals," said Murray, the veterinarian.

"We suspect a marine biotoxin, but we're not sure yet. We need to get confirmation on this. We've got the best minds working on it, and we're searching for answers."

Domoic acid is produced by algae called diatoms that collect in algae blooms on the coast. Lilian Busse, a Scripps post-doctoral researcher, said it's unclear what makes algae produce domoic acid.

In recent years, domoic acid has been found in sea water in Monterey Bay, Santa Barbara and Los Angeles.

On Friday, researchers at the Scripps Institution of Oceanography in La Jolla reported that domoic acid was found in sea water as far south as San Diego. The toxin may be responsible for sea lion strandings in Southern California this year, they said.

E-mail Jane Kay at jkay@sfchronicle.com.

URL: http://sfgate.com/cgi-bin/article.cgi?file=/chronicle/archive/2004/04/15/MNGF9651U433.DTL

Media Coverage Activity References

Images:
All images without a reference are from Microsoft Clipart.

1. Psuedonitzschia: http://www.whoi.edu/redtide/species/species/html

Information:

Definition of Bias: http://www.wordcentral.com/

Articles Quoted:

Howorth, P. 2003. Deadly domoic acid still holds mysteries. *Pacific Log*. June 8th.**

Thomas-Anderson, M. 2003. Domoic acid sickens sea mammals. *Daily Nexus*. Volume 83, Issue 130, Wednesday May 21st.**

Articles Provided:

1. Student Worksheet Example:

Kay, J. 2004. Sick, dying sea otters turn up in Morro Bay: Scientists suspect naturally occurring algae bloom poison. *SFGate.com*. April 15th. **

2. Recommended:

Wallerstein, P. 2004. Domoic acid poisoning. *From the Whale Rescue Team: http://www.whalerescueteam.org/rescues.html#domoic_ancher*

3. Others:

News Brief from California's Central Coast. 2003. *Associated Press*. June 4th.**

Sewage in urban runoff may spur growth of harmful algal blooms. 2000. *UC Santa Cruz Press Releases*. February 24th.

**These articles are available on the HAB-TrAC webpage:
http://www.habtrac.ucsb.edu/News.html

Name_____ Watershed Worksheet Period ____

After watching the watershed demonstration, answer the following questions based on what you observed:

1. Where does the water go when it lands on the mountain model?

2. How did the land influence how and where the water flowed?

3. Did the water soak into the mountain or flow over the surface?

4. The mountain model was made out of paper, what would you expect to happen if the mountain was made out of:

A. dirt:

B. sand:

C. concrete:

5. What materials do you think the rain is flowing over in the real watershed?

6. Based on what you have observed, how would you define a watershed?

Name_____ Period_____

Watershed Zone Notes

Zone:
Presenters:
Important Information:

Zone:
Presenters:
Important Information:

Zone:
Presenters:
Important Information:

Name_____ Period_____

Watershed Zone Notes

Zone:
Presenters:
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What is a Watershed?

Created by Sara Heintzelman, Interdepartmental Graduate Program in Marine Science
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California Department of Education Science Standards

6th Grade

- Shaping Earth's Surface
  2. Topography is reshaped by the weathering of rock and soil and by the transportation and deposition of sediment.
    a. Students know water running downhill is the dominant process in shaping the landscape, including California's landscape.
    b. Students know rivers and streams are dynamic systems that erode, transport sediment, change course, and flood their banks in natural and recurring patterns.
- 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.
    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.
    c. Communicate the logical connection among hypotheses, science concepts, tests conducted, data collected, and conclusions drawn from the scientific evidence.

8th Grade

- 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.

Watershed Ecosystem Lessons

In this lesson the students will learn the concept of a watershed, something that has been mentioned in the previous lessons but not fully explored until now. Students will observe what a watershed is in a hands-on demonstration. Using brown butcher paper, the students will create a landscape with mountains, valleys and plains. They will also create a rain storm with a spray bottle. Students will be able to see for themselves what the water does and where it goes when it falls on their land formations. Students will record their observations from the demonstration and answer questions that connect their model landscape to the real landscape and help them to define and truly understand the concept of a watershed.

B. What is a Watershed?
Objectives:
*The students will understand what a watershed is, which watershed they live in and the importance of a watershed.
Specification: At the end of this lesson, the students should be able to:

a. Provide a written definition of a watershed.
b. Identify the name and boundaries of the watershed that they live in.
c. Explain how a watershed gets its name.
d. Explain why the watershed is important and provide 2-3 examples to support their explanation.

Introduction:

A watershed is "the land area that drains water to a particular stream, river, or lake. It is a land feature that can be identified by tracing a line along the highest elevations between two areas on a map, often a ridge. Large watersheds may contain thousands of smaller watersheds." (http://wwwga.usgs.gov/edu/dictionary.html#W)

A watershed is important because…..

1. Everyone lives in a watershed; in fact you are in one right now at school.

2. We depend on it as a source for water, food and homes.

3. Plants and animals depend on it as well.

4. If the watershed is polluted we might drink polluted water and get sick, certain pollutants might cause cancer- you don't want to drink those! Also, if the watershed is contaminated, the animals and plants won't have clean food and water either (From Holt: Life Sciences, 7th grade, p. 446).

5. People enjoy being outside in the environment and like to do outdoor activities such as hiking, biking, rock climbing, swimming, surfing, etc. If the watershed where they are

doing all of these activities isn't well taken care of and is polluted, they won't be able to enjoy the outdoors and may even get sick (swimming in really polluted water).

How does a watershed get its name?

A watershed is usually named after the largest creek, stream or river that it drains into.

Activity: (approximate time: 30-45 minutes)

Materials: Brown butcher paper (2 pieces), 2 plastic tubs, 2 spray bottles, Watershed Worksheet, black and white copies of maps with watershed boundaries for each student and 1 color copy for the whole class to look at, and the LTER Runoff Web tool and Watershed flyover tool (found on the included CD-ROM).

- Start by asking the students if they have heard of a watershed before.
- If they have, ask them to explain their idea of a watershed. Open this discussion up to the whole class for a few minutes to get as many ideas as possible. Record the students' ideas up on the board so everyone can keep track of what has been discussed. This can also be done as a journal writing activity.
- Once the students have a general idea of a watershed, use the paper watershed model to demonstrate the boundaries of a watershed.
- Before beginning the demonstration, hand out the "Watershed Worksheet" and have the students read through the questions to help focus their attention for the demonstration.
- Break the students into 2 groups. In each group ask the students for a volunteer. Have the volunteer crumple up the piece of butcher paper, the more crumpled the better! Unfold the paper and you now have a landscape complete with mountains, plains and valleys.
- You (or one of the students) will use a spray bottle to simulate rain at the top of the mountains; all of the students will watch the rain and see where it falls, what its path down the mountain is and where it ends up.
- After watching the demonstration, have the students fill out their "Watershed Worksheet" while the demonstration is fresh in their minds.
- Once the students have filled out the worksheets, ask them to share their ideas and observations. You can use the LTER runoff computer demonstration to illustrate the idea of runoff if you have access to computers in your classroom or on your campus.
- After watching the demonstration, filling out the worksheet and discussing their observations as a class, ask the students if they can improve their definition of a watershed.
- Present the students with the formal definition of a watershed: a watershed is "the land area that drains water to a particular stream, river, or lake. It is a land feature that can be identified by tracing a line along the highest elevations between two areas on a map, often a ridge. Large watersheds may contain thousands of smaller watersheds." (http://wwwga.usgs.gov/edu/dictionary.html#W)
- Ask the students where the bottom of the watershed is (*the ocean*).

- Ask the students how the water gets from the mountains to the ocean (*rivers, creeks and streams*).
- So, what feature of a watershed is found throughout the whole watershed? (*water: rivers, creeks and streams*) Based on this, ask the students if they have any ideas about how a watershed might get its name? (*usually its named after the largest river, creek or stream*)
- Ask the students if anyone knows which watershed we live in (or our school is in). If they don't, ask them if they know the names of any rivers, creeks or streams nearby. Use the map of Santa Barbara to show the students where our watershed boundaries are.
- Now that the students have an idea of what a watershed is and where the boundaries of their watershed are, ask them why a watershed is important? This can also be done as a journal activity. (*There are many right answers to this question; the most important things to come up with are that: the watershed impacts our food and water supply as well as the habitats of all of the other organisms that live in the watershed. There are some possible answers in the introduction but it is far from a comprehensive list. If the discussion needs some guiding, bring up the idea of pollution and how that would affect things.*)
- At the end of this lesson you could have the students view the LTER Watershed Flyover on the computer. This will provide them with another way to view what a watershed is. The LTER Watershed Flyover tool is available on the included CD-ROM.

Name_____ Watershed Worksheet Period ____

After watching the watershed demonstration, answer the following questions based on what you observed:

1. Where does the water go when it lands on the mountain model?

It goes off the edge of the model.

2. How did the land influence how and where the water flowed?

There were ridges on the mountain. The ridges made the water go a certain way.

3. Did the water soak into the mountain or flow over the surface?

The water soaked into the mountains, and it flowed over it.

4. The mountain model was made out of paper, what would you expect to happen if the mountain was made out of:

A. dirt: *The water would soak into the dirt, then it would flow over it.*

B. sand: *It would soak into the sand.*

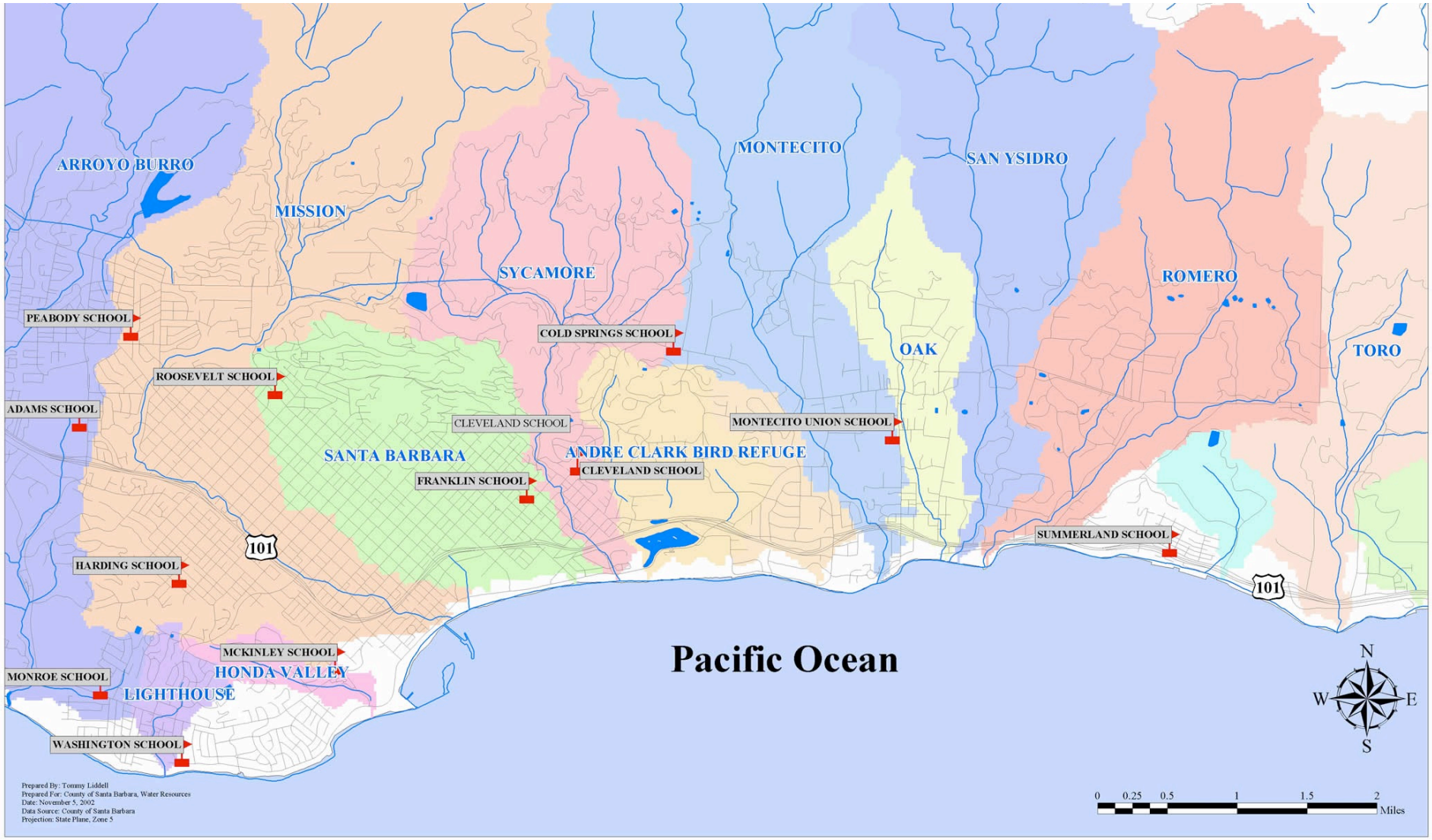
C. concrete: *It would flow over the concrete.*

5. What materials do you think the rain is flowing over in the real watershed?

The rain is flowing over the rocks, dirt, leaves, and branches.

6. Based on what you have observed, how would you define a watershed?

A watershed is an area where the rain flows and leads into one place.



'atershed.htm

What is a watershed? References

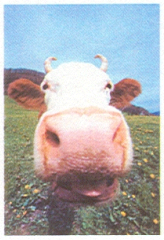
Images:
All images without a reference are from Microsoft Clipart.
Where Are You in the Watershed? : www.sbwater.org/CentralWatershed.htm

Information:

Definition of a watershed: http://www.ga.usgs.gov/edu/dictionary.html#W

Holt, Rinehart and Winston. Holt Science & Technology: Life Science. 2001. Harcourt Classroom Education Company, Austin.

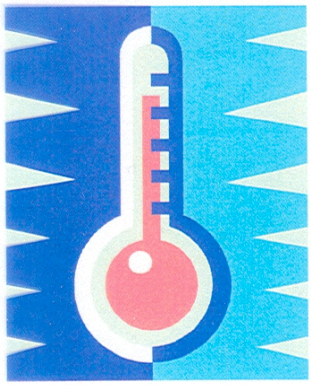
Biotic Factors are the living or once-living organisms in the environment.



Abiotic Factors are nonliving, physical features of the environment such as soil, sunlight, water, temperature, and air.

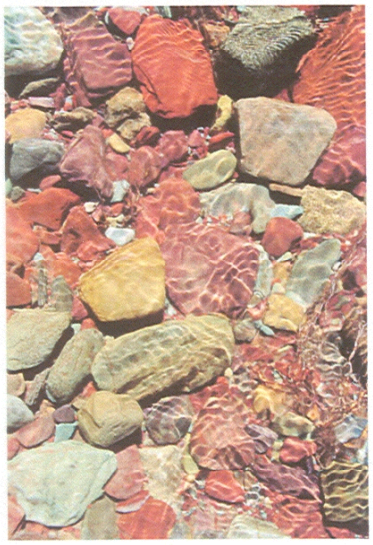
Air

Sunlight



Temperature

Water



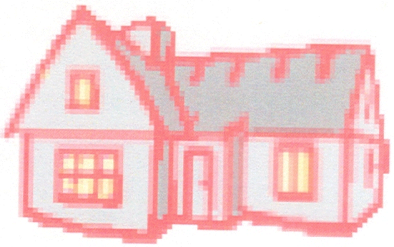
Rocks and Soil

Limiting Factors are any biotic or abiotic factor that restricts the number of individuals in a population.

If there are no more houses for sale and no land to build more houses on in a town, the population of that town can't increase. In this case, housing would be a limiting factor.

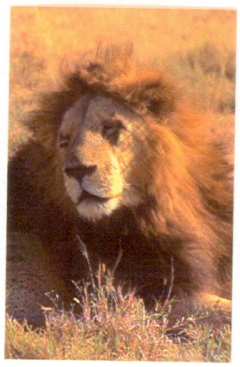
A Habitat is the physical location where an organism lives.

A few habitats……



Human

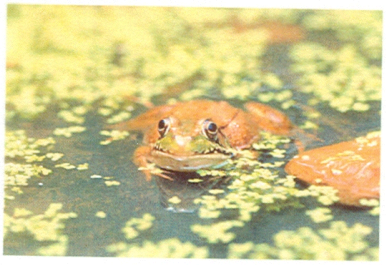
Bird



Lion

Fish

Frog

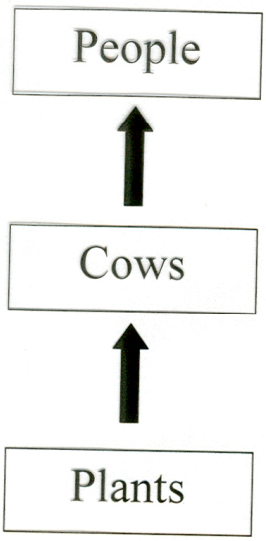


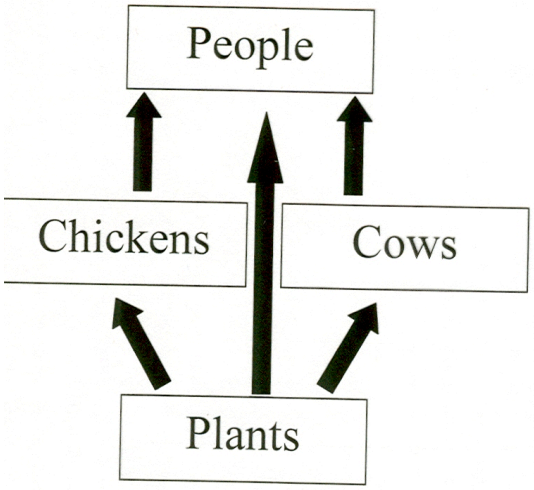
A **Niche** is the role of an organism in the ecosystem.

A niche is your role in your environment. Maybe you have certain chores around the house such as taking out the trash or doing the dishes, that is your role in your home environment.

Another role that you have is as a part of your family, maybe you are a brother, sister, son, or daughter- that is part of your role in your environment as well.

A food chain is a simple way of showing how energy in the form of food passes from one organism to another- usually have 3-4 links, no more than 5 because energy is lost at each transfer.





A food web is a series of overlapping food chains, which provides a more complete model for the way energy moves through a community, also more accurate because they show that many organisms feed on more than one level of an ecosystem.

Levels of Biological Organization:

An organism is a single individual from a population

A population is all of the individuals of one species that live and reproduce in the same area at the same time

A community is made up of populations of different species that interact in some way

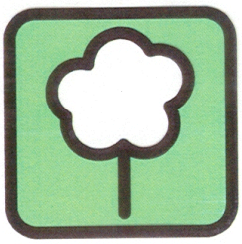
An ecosystem consists of communities and the abiotic factors that affect them

A biosphere is the highest level of biological organization; it is made up of all of the ecosystems on earth.

Succession is the process of gradual change from one community of organisms to another.

If a forest fire or other type of disturbance occurs, a community may be completely wiped out.

2. Next, slightly bigger and slower growing shrubs will grow.



1. The first plants to come back are going to be small and will grow quickly, we commonly think of these plants as weeds.

3. Finally larger tree will begin to come back to the area and eventually they will reform the forest!

Pioneer Communities are the first community of organisms to move into a new environment.

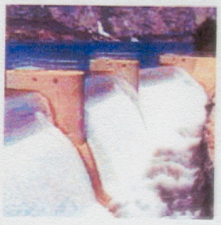
These are going to be the fast growing, small, weedy organisms.

A Climax Community is when a community has reached the final stage of ecological succession.

These are going to be the more complex mix of larger plants and trees that you would find in an old forest.

Disturbances:
Which are Natural? Which are Human Caused? Which are both?

Erosion

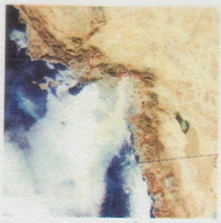


Changing Water Flow

Drought

Fishing

Earthquake



Fire

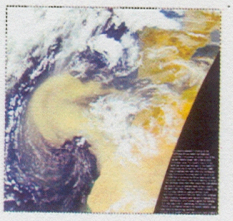
Flood

Cutting Lumber

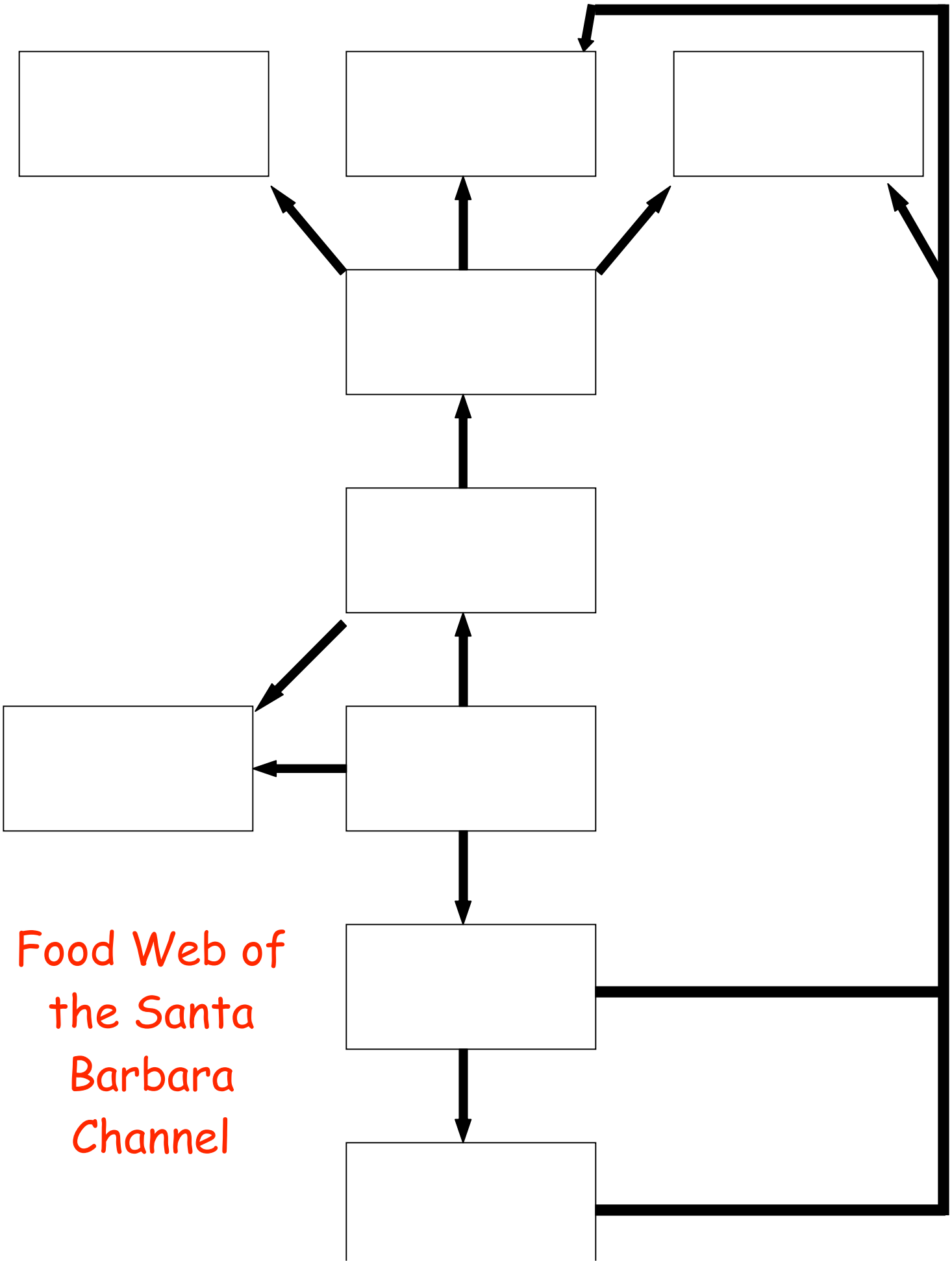
Mining (oil)

Hurricane

Farming



Sand Storm



Food Web of the Santa Barbara Channel

10 Important Principles of Ecology

1. Biotic Factors: are the _____ or once-living organisms in the _____.

2. Abiotic Factors: are nonliving, _____ features of the environment such as _____, sunlight, _____, temperature, and _____.

3. Limiting Factors: Any _____ or abiotic factor that _____ the number of _____ in a population.

4. Habitat: The _____ location where an organism _____.

5. Niche: The _____ of an organism in the _____.

6. Food Chain/Web: A food chain is a _____ way of showing how _____ in the form of food passes from one organism to another. They usually have _____ links, no more than 5 because energy is lost at each transfer. A food web is a series of _____ food chains, which provides a more _____ model for the way energy moves through a community, also more accurate because they show that many organisms feed on _____ _____ ____ level of an ecosystem.

7. Levels of Biological Organization:
_____ (a single individual from a population) →
_____ (all of the individuals of one species that live and reproduce in the same area at the same time) →
_____ (made up of populations of different species that interact in some way) →
_____ (consists of communities and the abiotic factors that affect them) →
_____ (highest level of biological organization, it is made up of all of the ecosystems on earth).

8. Succession: The process of _____ change from one community of organisms to another.

9. Pioneer Communities: The _____ community of organisms to move into a new environment.

10. Climax Communities: When a community has reached the _____ stage of ecological succession.

Name_____ Date_____ Period_____

1. What is an ecosystem?

2. Class definition of an ecosystem:

3. What do you think of when you hear the word disturbance?

Disturbances

Human	Natural

4. Are there any connections between the natural and human caused disturbance?

Food Web Questions:

5. Would removing the anchovies affect any other organisms? Explain your answer. What other organisms would be affected and how? Would the other populations of organisms increase or decrease when the anchovies are removed?

6. Are there any organisms that would not be affected by the removal of the anchovies? Why or why not? Explain your answer.

What is an Ecosystem?

Created by Sara Heintzelman, Interdepartmental Graduate Program in Marine Science
University of California Santa Barbara

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Santa Barbara Coastal Long Term Ecological Research Project

The National Science Foundation

Marine Science Institute
University of California, Santa Barbara

California Department of Education Science Standards

6th Grade

- Shaping Earth's Surface
  2. Topography is reshaped by the weathering of rock and soil and by the transportation and deposition of sediment.
    d. Students know earthquakes, volcanic eruptions, landslides, and floods change human and wildlife habitats.
- 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.
    c. Students know populations of organisms can be categorized by the functions they serve in an ecosystem.
    d. Students know different kinds of organisms may play similar ecological roles in similar biomes.
    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.

7th Grade

- Earth and Life History (Earth Science)
  4. Evidence from rocks allows us to understand the evolution of life on Earth.
    b. Students know the history of life on Earth has been disrupted by major catastrophic events, such as major volcanic eruptions or the impacts of asteroids.
- Investigation and Experimentation
  7. Scientific progress is made by asking meaningful questions and conducting careful investigations.
    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.

Watershed Ecosystem Lessons

In this lesson students will be introduced to, or reminded of, the concept of an ecosystem. Students will learn 10 important principles of ecology through an overhead guided lecture and fill-in notes and will have the chance to review the newly learned principles with an active matching game. Students will discuss the idea of a disturbance and think about how disturbances (both human caused and natural) affect an ecosystem. In addition the students will more closely examine the marine food web of the Santa Barbara Channel and will have to predict what would happen to this ecosystem when faced with a disturbance.

A. What is an Ecosystem?

Objectives:

* The students will understand the concept and definition of an ecosystem.
* The students will become familiar with basic ecological principles including: succession, pioneer communities, climax communities, abiotic factors, biotic factors, levels of biological organization (organism→ biosphere), limiting factors, habitat, niche and food chains/webs.
* The students will understand what the role of an ecosystem is and the effects of a disturbance on an ecosystem.

Specification: At the end of this lesson, the students should be able to:

a. Write a definition for an ecosystem.
b. Explain the ecological principles covered in the lesson.
c. Explain the role of an ecosystem and describe how an ecosystem may change if disturbed using evidence or explanations to back up their thinking.

Introduction:

An Ecosystem is "a functioning natural unit with interacting biotic (living or once living organisms) and abiotic (non-living, physical features) components in a system whose boundaries are determined by the cycle and flux of energy, materials and organisms" (http://www.epa.gov/owowwtr1/watershed/academy/acad2000/ecology/ecology2.html).
OR….
An Ecosystem is "all the interacting parts of the physical and biological worlds" (Ricklefs, R.E. *The Economy of Nature 5th Edition*. 2001. W.H. Freeman and Co., New York, NY, p. 523).

Ecology is "the study of the interactions that take place among organisms and between organisms and the physical features of the environment" (Glencoe Science Voyages: Life and Physical Science, p. 823). The word ecology comes from the Greek word *oikos*, meaning household, therefore ecology is the study of the earth household or ecosystems

(Capra, F. The Center for Ecological Literacy: Guide to Ecoliteracy: A new context for school restructuring).

10 important Ecological Principles: (Glencoe Science Voyages: Life and Physical Sciences)

1. Biotic Factors: "Living or once-living organisms in the environment" (p.825).

2. Abiotic Factors: "Nonliving, physical features of the environment such as soil, sunlight, water, temperature, and air" (p.823).

3. Limiting Factors: "Any biotic or abiotic factor that restricts the number of individuals in a population. They may also indirectly affect other populations in the community" (p. 829).

4. Habitat: "The physical location where an organism lives" (p. 833).

5. Niche: "The role of an organism in the ecosystem" (p. 833).

6. Food Chain/Web: "A food chain is a simple way of showing how energy in the form of food passes from one organism to another- usually have 3-4 links, no more than 5 because energy is lost at each transfer. A food web is a series of overlapping food chains, which provides a more complete model for the way energy moves through a community, also more accurate because they show that many organisms feed on more than one level of an ecosystem" (p. 838).

7. Levels of Biological Organization: "organism (a single individual from a population) _ population (all of the individuals of one species that live and reproduce in the same area at the same time) _ community (made up of populations of different species that interact in some way) _ ecosystem (consists of communities and the abiotic factors that affect them) _biosphere (highest level of biological organization, it is made up of all of the ecosystems on earth)" (p. 825).

8. Succession: "The process of gradual change from one community of organisms to another" (p. 850).

9. Pioneer Communities: "The first community of organisms to move into a new environment" (p. 851).

10. Climax Communities: "When a community has reached the final stage of ecological succession" (p. 853).

What is a Disturbance?

A disturbance is "a process or event that results in changes to the physical and biological characteristics of the environment" (http://www.epa.gov/watertrain/agents/agents2.html).

Not all disturbances are bad… think about the weather, if it has been raining for a long time (maybe not in Santa Barbara!), and then the sun comes out; the physical environment changes, but not necessarily in a negative way.

There are natural disturbances all the time: floods, droughts, fires, windstorms, erosion, and earthquakes just to name a few.

There are also a lot of disturbances that humans can cause such as: changing the way a river flows, agriculture, cutting down trees, building, stopping fires, mining, hunting and fishing, and introducing exotic species. These are often tied to the natural disturbances but may happen at a faster pace or on a larger scale.
(http://www.epa.gov/watertrain/agents/agents2.html).

Activity: (approximate time: 45-60 minutes)

Materials: Ecological principles overheads, student fill-in notes, ecosystem/ disturbance/ food web handout, disturbance overhead, ecological principles matching pieces (10 words/10 definitions, 20 pieces total), blank food web handout, food web cut-outs, scissors and tape or glue.

- Start off by asking the students if they know the term ecosystem. If they do know it, ask them what their idea or definition of an ecosystem is.
- Have a class discussion where the students brainstorm ideas about the meaning of "ecosystem" and write these ideas up on the board. This can also be done as a journal activity.
- Present the 10 basic ecological principles outlined in the discussion in a mini-lecture using the overheads as visuals to help the students grasp the concepts. Have the students fill in the student notes on the ecological principles while they listen to the lecture.
- After the lecture, give each student 1 piece of the ecological principles matching game. Each student should either have a word/term or a definition. Tell the students that they need to walk around the room, talking to the other students to find the other half of their piece. They should figure it out based on the information on their card, but as a double check, the pieces should fit together when the students are right.
- Ask the students what they think of when they hear the word disturbance. This could be a journal question as well.
- Explain to them that there are always disturbances in the environment, both natural and human caused. Ask the students if they can think of any natural or human caused disturbances; make a list on the board.
- Ask them if they see any connections between the natural and human caused disturbances (*it will depend on which ones they list, but try and highlight the connection between human disturbances being very similar to natural disturbances but often faster and larger. Use the lists in the introduction to help guide the discussion if necessary*).
- At this point, you can use the disturbance overhead to help them with their list. For each disturbance on the overhead, ask the students if it is natural, human caused or both.

- Tell the students that you are going to play a food web game. (*Give each student a copy of the hand-out with the blank food web and a copy of the pieces of the food web that they need to cut out and place on the food web).*
- Explain the instructions to the students: 1. First, they need to cut out the pieces with the organisms on them. 2. Next they need to think about what each organism will eat, keeping in mind that each one may eat or be eaten by more than one organism. 3. The students need to arrange the cut outs on the blank foodweb to complete the ecosystem. Once they have all of the pieces in the proper place (and have checked their answer with you) they can glue or tape the pieces in place. (*If you have the students do this as homework; have them write in their answers and then the next day in class everyone can correct their food web together and glue the pieces down).*
- The arrows should be pointing from the prey to the predator. For example:

  Sandwich → Human.
- After all of the students have finished their foodweb, tell them that a disturbance has occurred. Suddenly, the Northern Anchovy became extremely popular (maybe people decided anchovies on pizza were great!), and local fishermen went on a fishing frenzy and caught almost all of the anchovy! The students need to figure out how removing all of the anchovy would affect the rest of the foodweb and the ecosystem. Have them write responses to the following questions on the ecosystem/disturbance/food web handout:
  1. Would removing the anchovies affect any other organisms? If yes, which other organisms would it affect and how (would their populations increase or decrease?) Explain.
  2. Are there any organisms that wouldn't be affected by the removal of the anchovies? Why or why not?

Wrap up the activity by asking the students to share their ideas about how the disturbance would affect the rest of the foodweb and ecosystem. Make sure that the students understand that all of the pieces of the foodweb are connected.

Teacher Lecture Notes- 10 Important Ecological Principles

** These are just meant to give you a little extra information about these principles and some examples that may help you better explain them to the students by relating the ideas to their lives. The references are also provided so that if you want further information you may go straight to the source.

An Ecosystem is "a functioning natural unit with interacting biotic (living or once living organisms) and abiotic (non-living, physical features) components in a system whose boundaries are determined by the cycle and flux of energy, materials and organisms" (http://www.epa.gov/owowwtr1/watershed/academy/acad2000/ecology/ecology2.html).
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3. Limiting Factors: "Any biotic or abiotic factor that restricts the number of individuals in a population. They may also indirectly affect other populations in the community" (p. 829).
Example: A biotic factor that could restrict the number of individuals in a population would be something like food- if you don't have enough food to feed yourself, there is no way you are going to increase your population, you would die. An abiotic factor would be something like space, if there aren't any more empty lots of land to build houses on in Santa Barbara it will prevent any more people from moving here and the population won't increase.

4. Habitat: "The physical location where an organism lives" (p. 833).
Example: What is your habitat? It could be your room, your house, your neighborhood or even Santa Barbara.

5. Niche: "The role of an organism in the ecosystem" (p. 833).

Example: Instead of just the physical location where you live, a niche is your role, so your niche is student or brother, sister, son, or daughter. Maybe you have certain chores around the house such as taking out the trash or doing the dishes; that is your role in your home environment.

6. Food Chain/Web: "A food chain is a simple way of showing how energy in the form of food passes from one organism to another- usually have 3-4 links, no more than 5 because energy is lost at each transfer. A food web is a series of overlapping food chains, which provides a more complete model for the way energy moves through a community, also more accurate because they show that many organisms feed on more than one level of an ecosystem" (p. 838)
Example: A simple human food chain might consist of plants at the bottom which feed cows, which feed you hamburgers. The idea of a food web is that there are more complicated links- you don't only eat hamburgers, you probably (hopefully) also eat plants (fruits, veggies and grains). That would mean that you are eating at different levels of the food chain. Other animals do this too and when you connect all of the different animals and plants in all of the possible combinations of who eats who or what, it gets complicated and looks like a big spider web.

7. Levels of Biological Organization: "organism (a single individual from a population) _ population (all of the individuals of one species that live and reproduce in the same area at the same time) _ community (made up of populations of different species that interact in some way) _ ecosystem (consists of communities and the abiotic factors that affect them) _biosphere (highest level of biological organization, it is made up of all of the ecosystems on earth)" (p. 825).
Example: If we look at how you fit into the levels of biological organization- you would be an organism, one individual, you would live in a population of other people who live nearby (maybe your neighborhood or school), Santa Barbara would be a community of these smaller populations, our ecosystem would include our community, nearby communities (Ventura, Goleta, Oxnard) and would also include the abiotic factors (waters, soil, air, etc) that make up the physical environment where we live and the animals and plants that live in that environment along with us. Finally, our biosphere would be all of the different ecosystems that you would find all over the world.

8. Succession: "The process of gradual change from one community of organisms to another" (p. 850).
Example: After something disturbs the environment (for example a forest fire), there may not be anything left except dirt. When species do start to grow back there is usually an order that they come back in, this is called succession. The first species to come back will be quick growing, usually weedy species. They are usually small. These are generally followed by slightly larger, slower growing plants like shrubs, which are followed by even slower growing larger things like trees. Eventually the community will return to the composition that it began with before the fire; or a similar one at least.

9. Pioneer Communities: "The first community of organisms to move into a new environment" (p. 851).

Example: Have you ever noticed that your garden or lawn always seems to have weeds in it? Weeds seem to be able to grow anywhere in any conditions and even when you keep pulling them out, they always seem to grow back. When something disturbs the environment, or even wipes it out completely, usually when plants start growing again you see weedy species first. The quick growing species that can grow in a wide variety of conditions usually grow first.

10. Climax Communities: "When a community has reached the final stage of ecological succession" (p. 853).
Example: This is the end of succession when the largest, slowest growing plants and trees have re-established themselves in the environment. Generally people think that when a community reaches the climax community at the end of succession it is somewhat stable, but of course, there are always changes in the environment so it is never going to stay exactly the same.

10 Important Principles of Ecology

1. Biotic Factors: are the *living* or once-living organisms in the *environment*.

2. Abiotic Factors: are nonliving, *physical* features of the environment such as *soil*, sunlight, *water*, temperature, and *air*.

3. Limiting Factors: Any *biotic* or abiotic factor that *restricts* the number of *individuals* in a population.

4. Habitat: The *physical* location where an organism *lives.*

5. Niche: The *role* of an organism in the *ecosystem.*

6. Food Chain/Web: A food chain is a *simple* way of showing how *energy* in the form of food passes from one organism to another. They usually have *3-4* links, no more than 5 because energy is lost at each transfer. A food web is a series of *overlapping* food chains, which provides a more *complete* model for the way energy moves through a community, also more accurate because they show that many organisms feed on *more than one* level of an ecosystem.

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An *ecosystem* consists of communities and the abiotic factors that affect them →
A *biosphere* is the highest level of biological organization; it is made up of all of the ecosystems on earth.

8. Succession: The process of *gradual* change from one community of organisms to another.

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Disturbances:
Which are Natural? Which are Human Caused? Which are both?

Erosion

Changing Water Flow

Drought

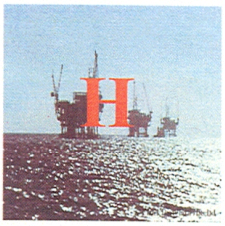
Fishing

Earthquake

Fire

Flood

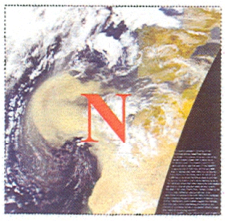
Cutting Lumber



Mining (oil)

Hurricane

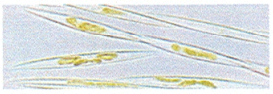
Farming



Sand Storm

Cut out the following pieces and arrange them into the proper order on the food web chart

Marine Mammal
Ex: Sea Lion


Algae
Ex: *Psuedo-nitzschia*


Fish
Ex: Northern Anchovy


Crabs
Ex: Sheep Crab


Birds
Ex: Brown Pelican


Bivalves
Ex: California Mussel

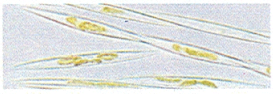

Fish Larvae


Zooplankton


Humans


Cut out the following pieces and arrange them into the proper order on the food web chart

Marine Mammal
Ex: Sea Lion

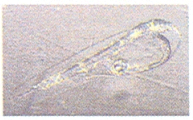

Algae
Ex: *Psuedo-nitzschia*


Fish
Ex: Northern Anchovy


Crabs
Ex: Sheep Crab

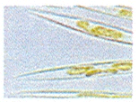

Birds
Ex: Brown Pelican

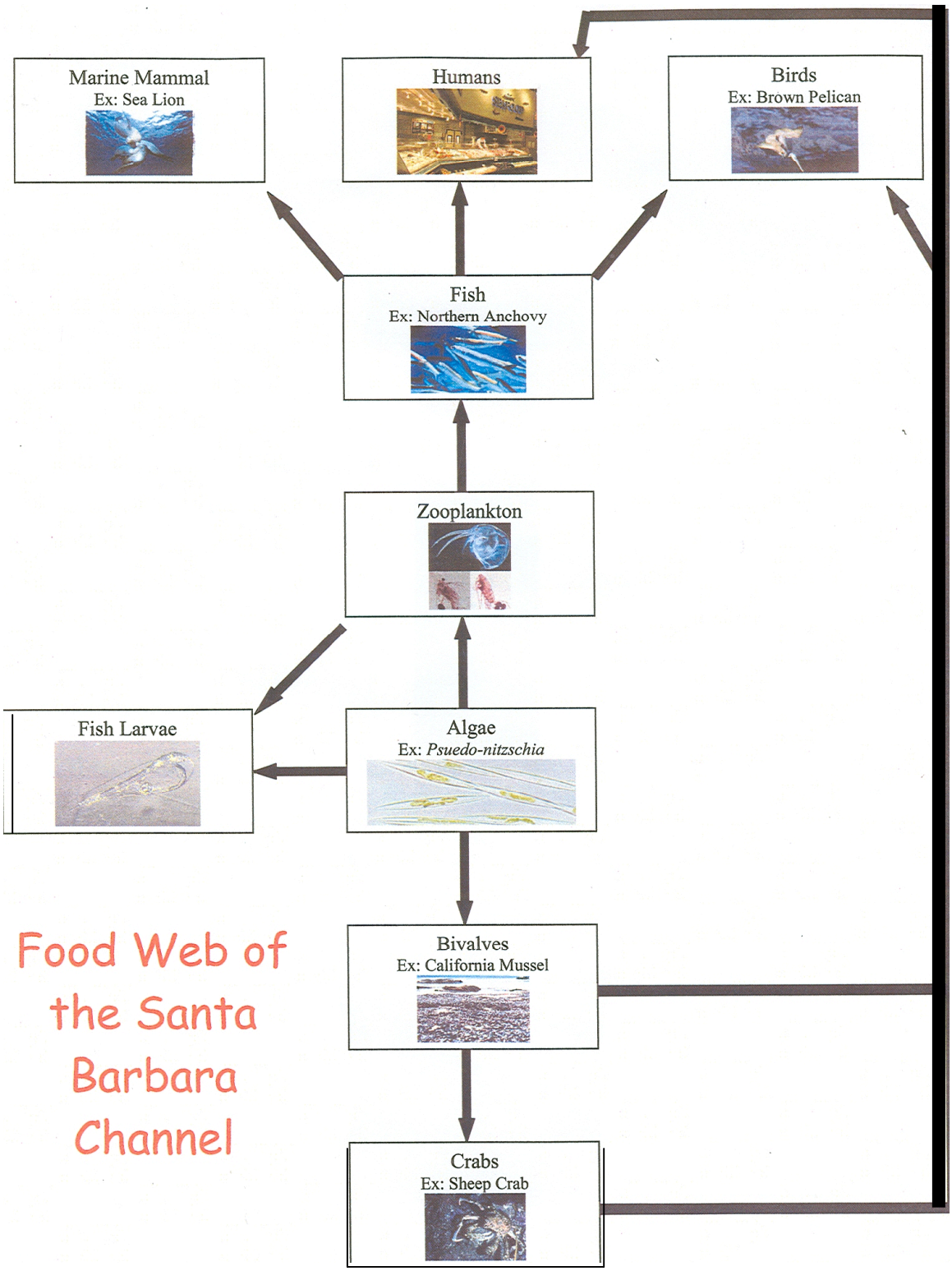

Bivalves
Ex: California Mussel


Fish Larvae


Zooplankton

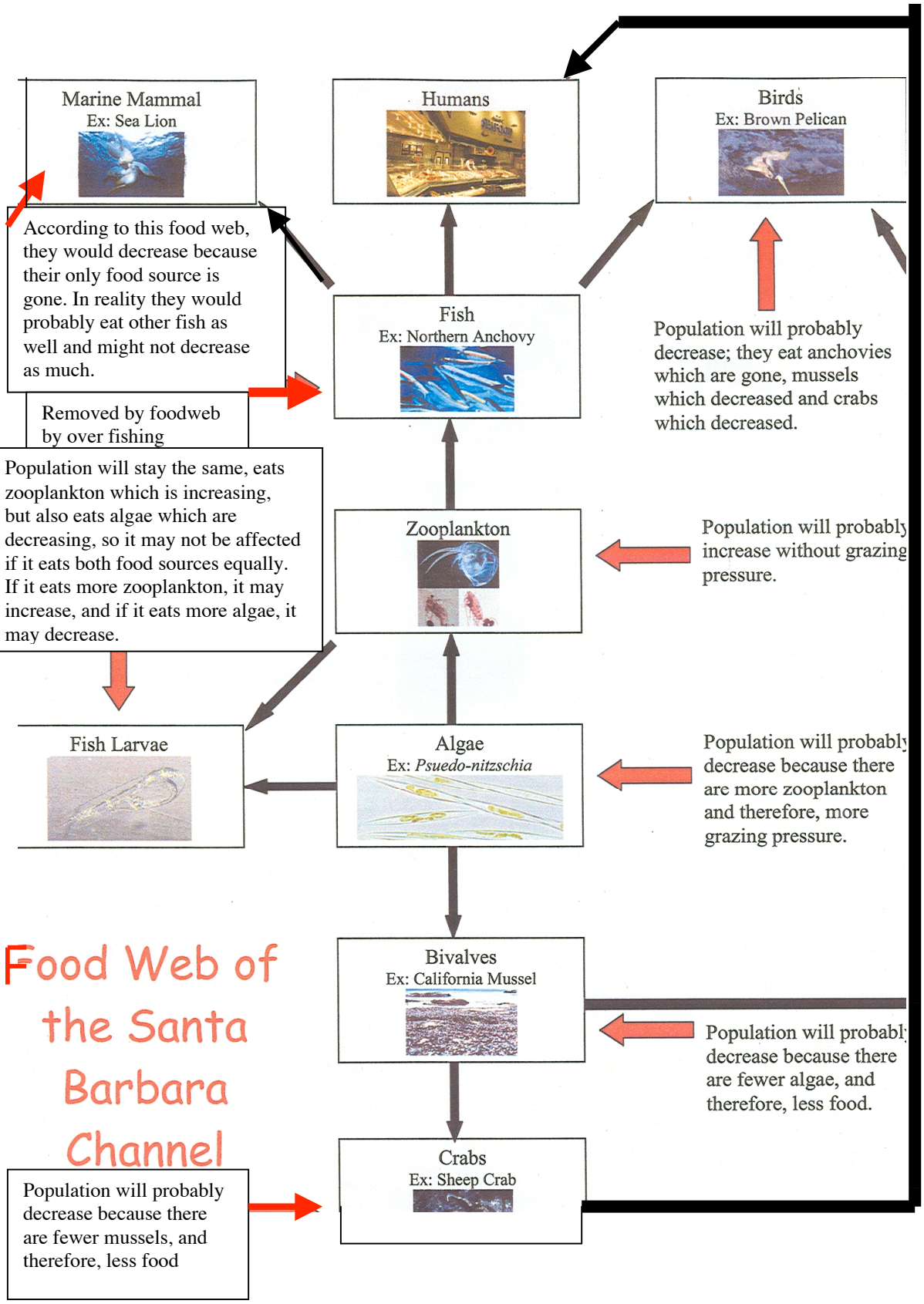

Humans


Name	Distribution	Habitat	Diet	Fact	Picture
Algae/ Phytoplankton Example: *Psuedo-nitzschia*	World wide	Water (fresh and salt) as long as there is some sunlight.	Primary producers: Light, CO_2, Micro and Macro Nutrients	They are the base of the marine food web.	
Birds Example: Brown Pelican	Farallon Islands to Mexico.	Mostly coastal, occasionally found inland or over open ocean.	Fish and sometimes shrimp.	Almost went extinct in 1970's because of pesticide poisoning from DDT.	
Bivalves Example: California Mussel	Coastal areas from Alaska to Mexico.	Intertidal zone to 150 feet deep.	Filter feed plankton.	To collect enough food, mussels filter 2-3 liters of water per hour.	
Crabs Example: Sheep Crab	Northern California to Baja California.	Rocky reef and sand.	Invertebrates, fish and scavenged food.	Commonly called spider crabs because of their long spindly legs.	
Fish Example: Northern Anchovy	Temperate and subtropical Pacific waters.	Surface to 1000 feet deep. Coast to 300 miles offshore.	Zooplankton, phytoplankton and small fish.	They often times eat their own eggs!	
Fish Larvae	Worldwide.	Marine and Freshwater.	Phytoplankton and small zooplankton.	They are actually considered to be zooplankton since they are floating animals.	
Humans	Worldwide.	All types!	Animals and Plants.	Based on yearly seafood catches and world population, the average person eats 26 lbs of seafood a year!	
Marine Mammal Example: Sea Lion	Canada to Mexico.	Open water, kelp beds, offshore rocks and sandy beaches.	Fish, squid and octopus.	Stomachs often contain 100's of pieces of gravel, which are possibly used to reduce hunger pains.	
Zooplankton	Worldwide.	Marine and Freshwater.	Phytoplankton	Zooplankton means floating animal- they usually just drift, however some are weak swimmers.	



Food Web of the Santa Barbara Channel

Food Web of the Santa Barbara Channel



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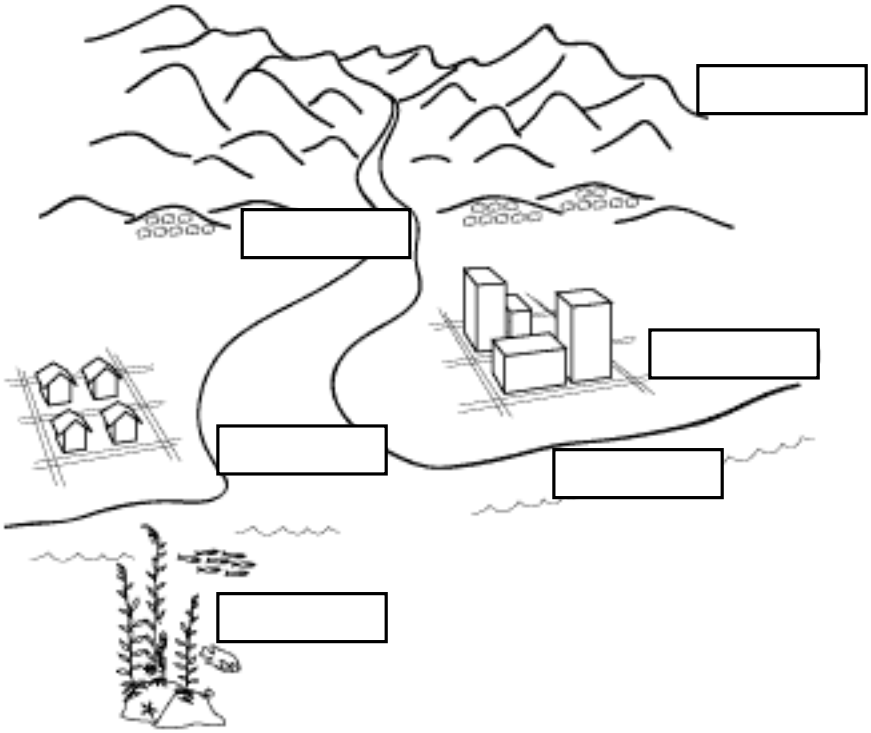
Name _____ Date _____ Period_____



Label the zones of the watershed pictured above. After reviewing the Natural History section of the UCSB LTER CD-ROM, please answer these questions.
***Questions are bonus questions!

Mountains:

1. What is the zone that is the beginning of most watersheds here in Santa Barbara?

2. A _____ is the highest part of a mountain ridge where rain drains to either side of the mountain marking the dividing line of a watershed.

3. What are watersheds usually named after?

4. Do you think more or less rain falls in the mountain zone as compared to the sandy beach?

5. How do the slope, bare rocks, and amount of plants affect the rainfall once rain reaches the mountains?

6. Why are the mountains in Santa Barbara usually dry most of the year? Where does the water go?

7. ***Can you name three watersheds in Santa Barbara?

Foothills

8. Where are the foothills?

9. Describe the slope of the foothills. How does that affect the flow of water in this zone?

10. How would you characterize the soil in this zone?

11. In Santa Barbara the foothill zone has some agricultural production. What fruits are typically but not exclusively grown in this area?

12. ***Surrounding avocado trees there is often bare soil. How does runoff from agricultural land affect the rest of the watershed?

Coastal Plain

13. How would you characterize the slope and flow of water in the coastal plain zone?

14. Why do the streams in the coastal plain meander? Explain the process of how this occurs.

15. How have humans affected this zone?

16. ***How do concrete channels affect the flow of water during a storm? How do concrete channels affect the ability of wildlife to live in the stream?

Estuary

17. What is an estuary?

18. What kind of water would you expect to find at the bottom of an estuary? At the top?

19. What do plants and animals that live in the estuary have to be tolerant of?

20. How is the mouth of the estuary (part of the creek closer to the ocean) different from parts of the estuary more inland?

21. *** What time of year do you expect the water to be freshest in the estuary?

Sandy Beach

22. Why is the sand in the sandy beach zone constantly changing?

23. Where does the sand come from?

24. What are the main sources of food for sandy beach animals?

25. ***Why do we have to dredge the harbor but bring sand to Goleta Beach?

Kelp Forest

26. What is the largest marine plant that exists in the kelp forest?

27. After a large rainstorm, muddy water is pushed into the kelp forest zone from local creeks, rivers, and streams. How does this muddy water affect the kelp and other marine organisms in the kelp forest zone?

28. ***How is the kelp forest zone affected by actions that take place in different zones of the watershed? Pick a specific example in a specific zone.

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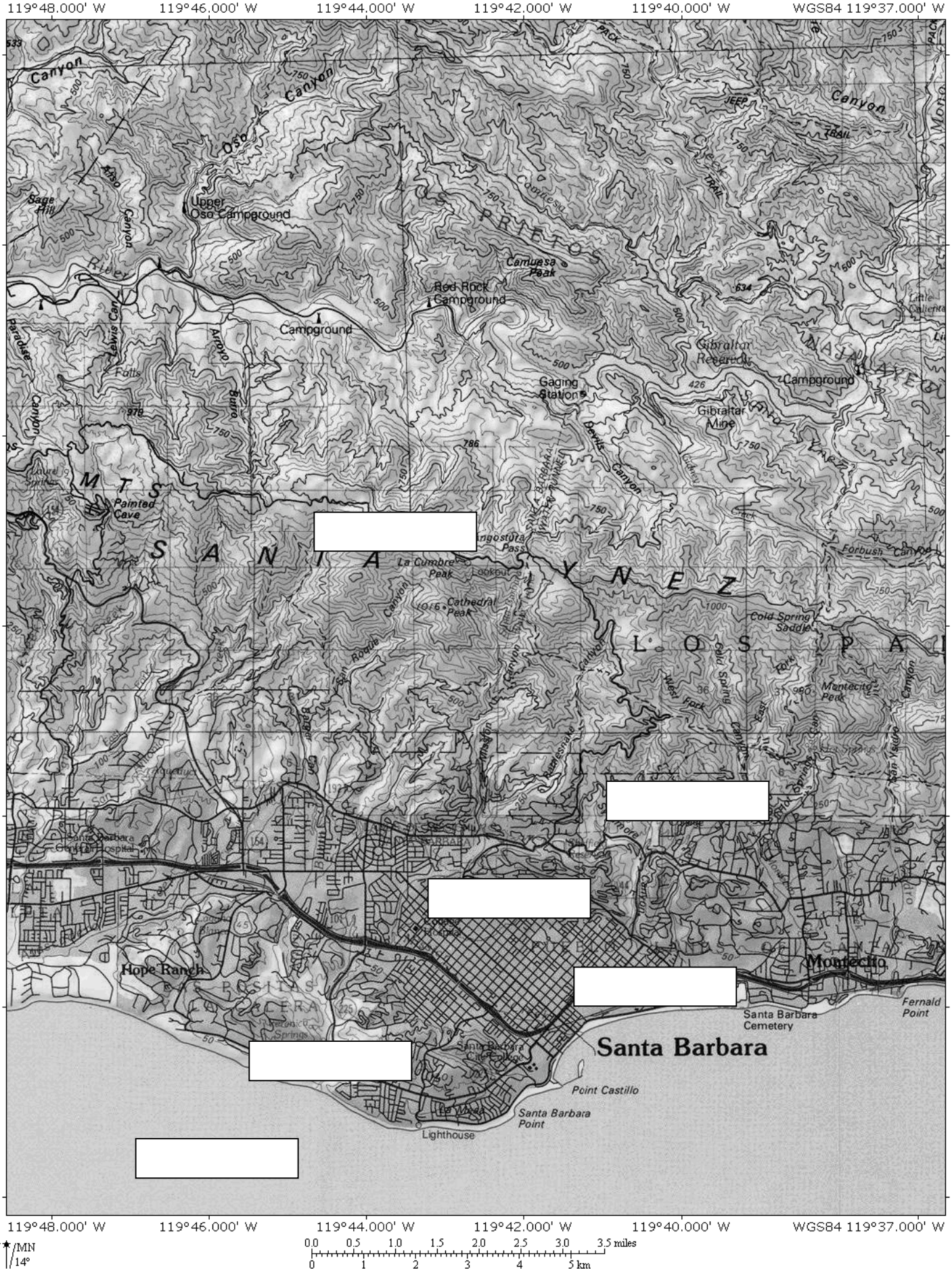

The Zones of a Watershed

Created by Sara Heintzelman, Interdepartmental Graduate Program in Marine Science
University of California Santa Barbara

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Santa Barbara Coastal Long Term Ecological Research Project

The National Science Foundation

Marine Science Institute
University of California, Santa Barbara

California Department of Education Science Standards

6th Grade

- Shaping Earth's Surface
  2. Topography is reshaped by the weathering of rock and soil and by the transportation and deposition of sediment.
    a. Students know water running downhill is the dominant process in shaping the landscape, including California's landscape.
    b. Students know rivers and streams are dynamic systems that erode, transport sediment, change course, and flood their banks in natural and recurring patterns.
    c. Students know beaches are dynamic systems in which the sand is supplied by rivers and moved along the coast by the action of waves.
    d. Students know earthquakes, volcanic eruptions, landslides, and floods change human and wildlife habitats.
- Investigation and Experimentation
  7. Scientific progress is made by asking meaningful questions and conducting careful investigations.
    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.
    f. Read a topographic map and a geologic map for evidence provided on the maps and construct and interpret a simple scale map.

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

Watershed Ecosystem Lessons

In this lesson students will be reintroduced to the six zones of the coastal watershed (ocean, beach, estuary, coastal plains, foothills and mountains) that they first traveled through in the Watershed Mystery Game. Topographic maps of Santa Barbara will help the students visualize and identify the different zones before they dive into a research project and become "experts" on one of the six zones. Using the LTER CD-ROM and guiding questions as the basis for their research, students will prepare a group presentation on their zone and will share what they have learned with the rest of the class.

C. The Zones of a Watershed

Objectives:

* The students will become familiar with the different zones found in the coastal watershed: mountains, foothills, coastal plains, estuaries, sandy beaches and the ocean.
* Students will learn the characteristics and geographical locations of each zone.
* Students will understand that each zone blends into the next, there are not definite boundaries.

Specification: At the end of this lesson, the students should be able to:

a. List all 6 watershed zones.
b. Describe 2-3 of the main characteristics of each zone.
c. Roughly sketch the position of each zone in relation to the others.
d. Describe the boundaries between each zone and communicate that the boundaries are gradual rather than definite.

Introduction:

The Zones of a Coastal Watershed are….

Mountains_ Foothills_ Coastal Plains_ Estuaries_ Sandy Beaches_ Ocean
(*See the LTER zone handout/CD-ROM for detailed information about each zone*)

Zone Boundaries: Are they gradual or sudden?

While there are definite zones, the boundaries are a little fuzzier. In the transition areas between zones you will find characteristics of both zones in a unique combination. Therefore, zones gradually blend into each, rather than having a definite boundary like a wall. These boundaries may have even more plant and animal species than the zones themselves. Since there are characteristics of both zones, the animals and plants from both zones may be able to do well there so you may see more species than you would find in just one zone.

Activity: (approximate time: 90 minutes)

Materials: LTER zone handout or CD-ROM, Student Presentation Notes Handout, Watershed Zones Worksheet, and topographic maps of Santa Barbara for each student (2 copies- 1 blank and 1 with fill in spaces).

- Start by giving each student an unlabeled topographic map of Santa Barbara. Many students probably won't be familiar with topographic maps and a simple introduction to topographic maps will be necessary for this activity. Explain that topographic maps show the physical features of land (not just boundaries between cities, states, and countries); they include features like mountains, valleys and plains. A simple way to demonstrate this is with a demo on your (and/or their) knuckles. Show the students how a knuckle resembles a mountain, draw evenly spaced circles around your knuckles while making a fist. Then, flatten your hand and show the students what they circles look like. They will see that the circles are closer together where the knuckle or "mountain" was steeper and that the circles are further apart where the knuckle was flatter.
- Have them look at their maps and tell them to think about what they already know about watersheds and ecosystems. Based on what they know, ask them how they think we might split the watershed into zones. Have them brainstorm ideas of what the zones might be called and guide the discussion as needed. This can also be done as a journal activity. (*Remind them to think back to the watershed mystery game where they did hear the names of all 6 zones in the coastal watershed*).
- Have the students try to label all 6 zones of the coastal watershed on the blank topographic map. After they have made an attempt, give them a copy of the topographic map with fill-in spots at each of the zones and have them label these.
- After the students have identified the 6 zones, split the class into 6 groups and assign each group a zone. Either pass out copies of the LTER zone handout or help the students get to the LTER Natural History section of the CD-ROM on the computer, and have each group read about their zone to become "experts".
- Have them read the information on their zone and decide as a group which characteristics are the most important/defining for their zone. You may choose to use the Watershed Zones Worksheet to guide their presentations if you wish.
- Have each group prepare a short presentation for the rest of their class in which they report their findings and tell the rest of the class what they need to know about their zone. Have the students take notes on the presentations of the other students on the "Student Presentation Notes Handout" so that they end up with information about all of the zones.
- You can have the students answer the questions on the Watershed Zones Worksheet after the presentations to evaluate their understanding. This could also be an optional extra credit assignment.
- After the students have presented, ask the students what they think the boundaries between the zones are like? Are they obvious like walking from inside your house to outdoors? Are they subtle, like how the light fades away at sunset? Have the students discuss and explain their reasoning. This can also be done as a journal activity. Help guide the discussion so that students realize that the transitions are usually subtle or gradual and that all of the zones affect one another and blend into one another.

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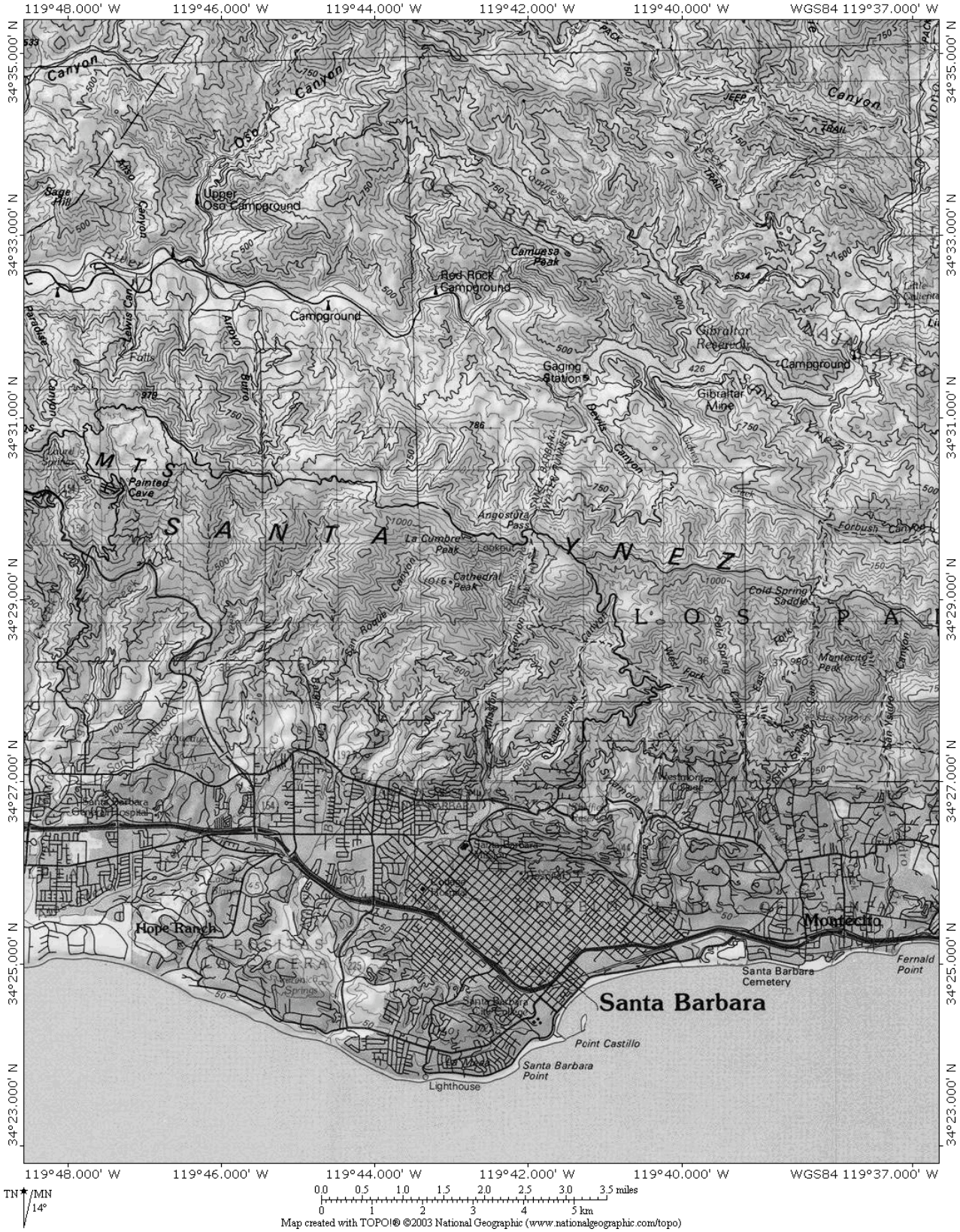

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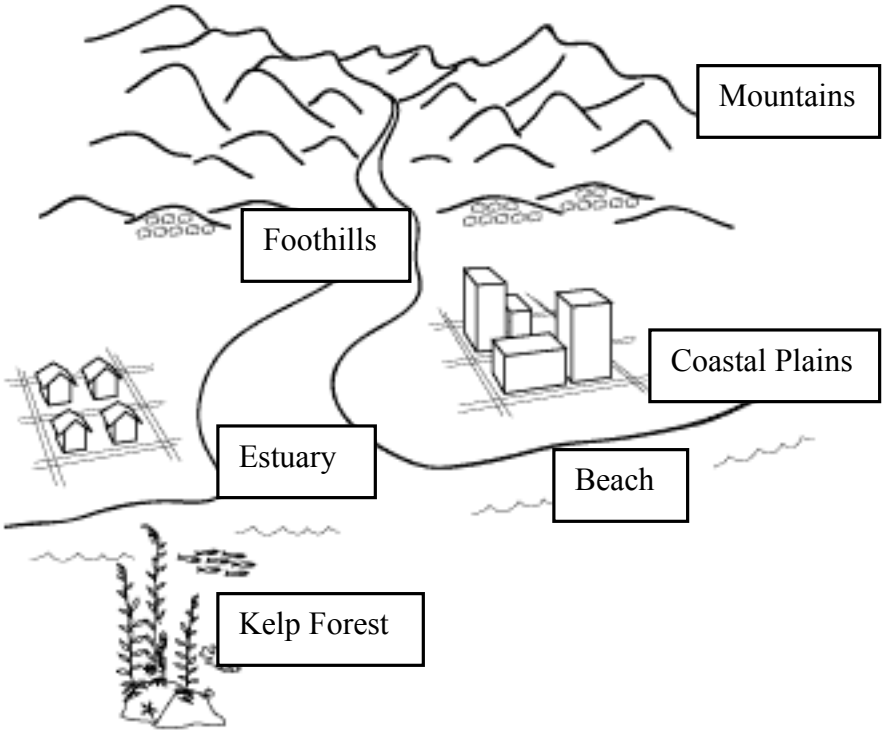
Name ____Student Answers_____ Date _____ Period_____



Label the zones of the watershed pictured above. After reviewing the Natural History section of the UCSB LTER CD-ROM, please answer these questions.
***Questions are bonus questions!

Mountains:

1. What is the zone that is the beginning of most watersheds here in Santa Barbara?

Mountains

2. A *divide* is the highest part of a mountain ridge where rain drains to either side of the mountain marking the dividing line of a watershed.

3. What are watersheds usually named after?

Largest creek, stream or river they drain into

4. Do you think more or less rain falls in the mountain zone as compared to the sandy beach?

It falls more on the mountain zone because of the high elevation of the mountains, weather, like rain and fog behaves differently.

5. How do the slope, bare rocks, and amount of plants affect the rainfall once rain reaches the mountains?

It does not absorb the water, instead rain water runs downhill very rapidly in the narrow stream channels.

6. Why are the mountains in Santa Barbara usually dry most of the year? Where does the water go?

7. ***Can you name three watersheds in Santa Barbara?

Foothills

8. Where are the foothills?

The place where the landscape becomes flatter and gentler.

9. Describe the slope of the foothills. How does that affect the flow of water in this zone?

The soil is flatter and gentler, thus water flow more slowly as the slope decreases.

10. How would you characterize the soil in this zone?

The soil is thick and full of nutrients and rich organic matter. It is good for planting and farming.

11. In Santa Barbara the foothill zone has some agricultural production. What fruits are typically but not exclusively grown in this area?

Avocados and lemons

12. ***Surrounding avocado trees there is often bare soil. How does runoff from agricultural land affect the rest of the watershed?

The water clarity decreases and has a higher chance of becoming damaged. It can also give birth to algae blooms.

Coastal Plain

13. How would you characterize the slope and flow of water in the coastal plain zone?

The slopes are flatter, thus the water slows down.

14. Why do the streams in the coastal plain meander? Explain the process of how this occurs.

The stream channel has lots of bends and the ends erode the bank. They drop off sands, rocks, and other materials on inside of bends.

15. How have humans affected this zone?

Humans has channelized concrete streambeds, culverts, and narrow bridges.

16. ***How do concrete channels affect the flow of water during a storm? How do concrete channels affect the ability of wildlife to live in the stream?

Rainwater cannot meander so it rushes though channel. Animals can no longer live there.

Estuary

17. What is an estuary?
Wetlands where the freshwater from streams and salty water from the ocean meet and mix.

18. What kind of water would you expect to find at the bottom of an estuary? At the top?
The salt water is at the bottom because it is denser, while fresh water is at the top.

19. What do plants and animals that live in the estuary have to be tolerant of?
They need to tolerate water with varying amounts of salt.

20. How is the mouth of the estuary (part of the creek closer to the ocean) different from parts of the estuary more inland?
The mouth has freshwater, while inland is salty.

21. *** What time of year do you expect the water to be freshest in the estuary?
Summer

Sandy Beach

22. Why is the sand in the sandy beach zone constantly changing?
It is due to waves and longshore currents.

23. Where does the sand come from?
Large waves move sand to surf where it forms sandbars, then sand migrates back. The sand comes from the mountains.

24. What are the main sources of food for sandy beach animals?
The food comes from the ocean: phytoplankton, drift kelp, and seaweeds.

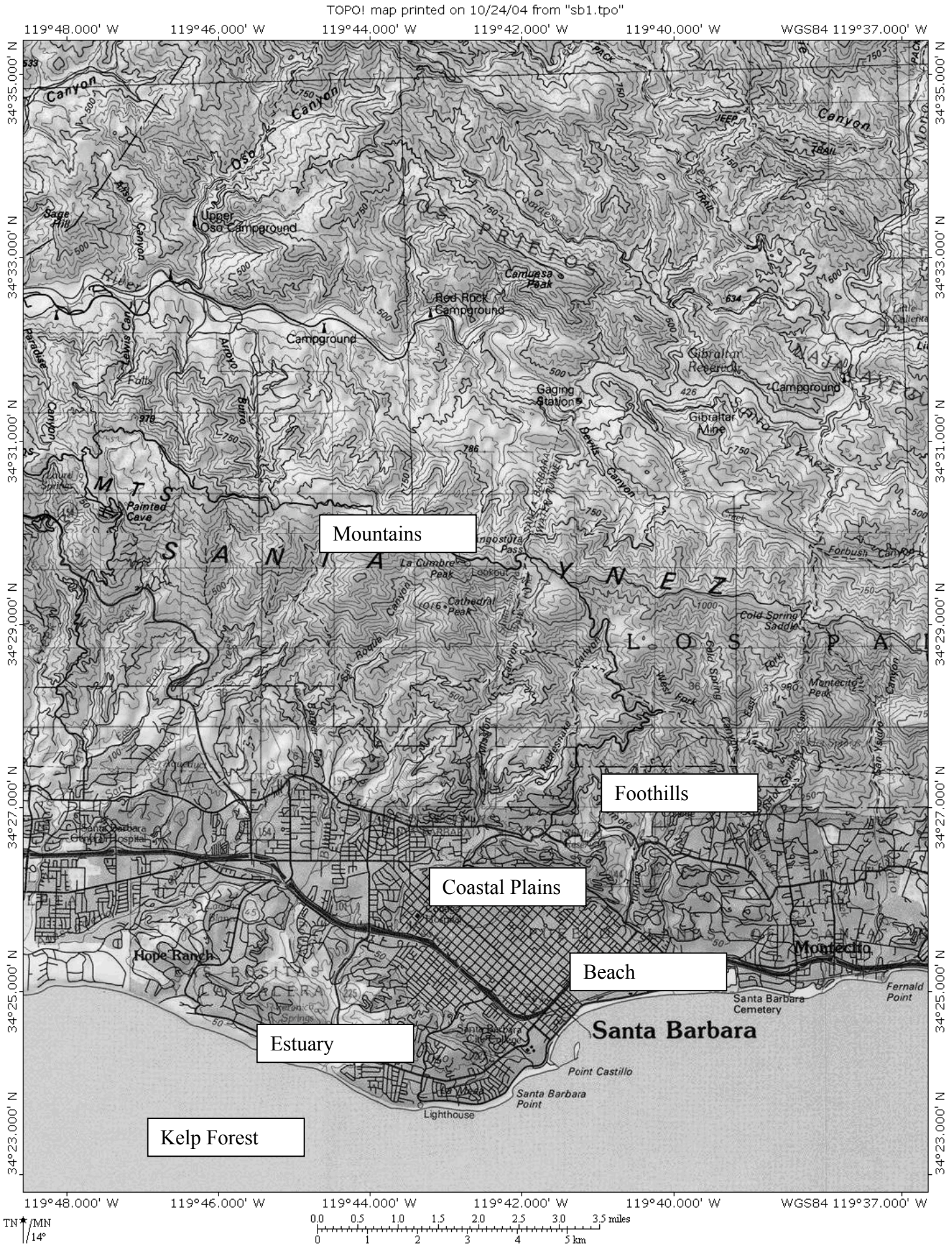
25. ***Why do we have to dredge the harbor but bring sand to Goleta Beach?
They dredge the harbor because sand piles up. They use the sand to rebuild Goleta Beach because El Nino eroded it, which lead to continuous erosion.

Kelp Forest

26. What is the largest marine plant that exists in the kelp forest?
Giant Kelp (macrocystis)

27. After a large rainstorm, muddy water is pushed into the kelp forest zone from local creeks, rivers, and streams. How does this muddy water affect the kelp and other marine organisms in the kelp forest zone?
It makes it harder for the kelp to go through their process of photosynthesis because it needs sunlight. The kelp could die, which kills urchin and the that eat it.

28. ***How is the kelp forest zone affected by actions that take place in different zones of the watershed? Pick a specific example in a specific zone.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Mountains
Foothills
Coastal Plains
Beach
Estuary
Kelp Forest
Santa Barbara
Montecito
Hope Ranch
Upper Oso Campground
Red Rock Campground
Campground
Gaging Station
Gibraltar Reservoir
Gibraltar Mine
Camuesa Peak
La Cumbre Peak
Cathedral Peak
Painted Cave
Santa Barbara Cemetery
Fernald Point
Point Castillo
Santa Barbara Point
Lighthouse
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0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 miles
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Zones of a watershed References

Images:
All images without a reference are from Microsoft Clipart.

Santa Barbara Coastal Long Term Ecological Research Project (SBC-LTER) Web Tools: http://www.msi.ucsb.edu/SBCLTER
Funded by NSF OCE-9982105

Topographic maps created using: National Geographic TOPO! California Software. 2003. National Geographic Holdings, Inc.

Information:

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