

Objectives

After completing the lesson, students will be able to

A.3.2.1 Describe the causes and effects of red tides.

A.3.2.2 Describe the causes and effects of eutrophication.

Target Reading Skill

Comparing and Contrasting Explain that comparing and contrasting information shows how ideas, facts, and events are similar and different. The results of the comparison can have importance.

Answers

Saltwater blooms—Effects: Toxins concentrated in fish and shellfish that eat algae can cause illness to people and other large organisms when they consume the fish or shellfish. Freshwater blooms—Causes: Nutrients build up, causing a rapid increase in algae growth; Effect: Fishes and other organisms in the water die.

All in One Teaching Resources

- [Transparency A23](#)

Preteach**Build Background Knowledge**

L2

Visualizing Abundant Algae

Remind students that algae live on the surface of ponds, lakes, and oceans. Ask: **What do you think would happen if there were so many algae on the water's surface that they blocked sunlight from getting into the water?** (Sample: *The organisms in the water that need sunlight to make food would die.*)

Reading Preview**Key Concept**

- What are the causes and effects of saltwater and freshwater algal blooms?

Key Terms

- algal bloom
- red tide
- eutrophication

Target Reading Skill

Comparing and Contrasting As you read, compare and contrast the two types of algal blooms in a table like the one below.

Algal Blooms		
Properties	Saltwater Blooms	Freshwater Blooms
Causes	Increase in nutrients or temperature	
Effects		

Lab zone

Discover Activity**How Can Algal Growth Affect Pond Life?**

1. Pour water into a plastic petri dish until the dish is half full. The petri dish will represent a pond.
2. Sprinkle a spoonful of green paper punches into the water to represent green algae growing in a pond.
3. Sprinkle two more spoonfuls of paper punches into the water to represent one cycle of algae reproduction.
4. Sprinkle four more spoonfuls of paper punches into the water to represent the next reproduction cycle of the algae.

Think It Over

Predicting How might algae growing near the surface affect organisms living deep in a pond?

Over a five week period one year, the bodies of 14 humpback whales washed up along beaches on Cape Cod, Massachusetts. The whales showed no outward signs of sickness. Their stomachs were full of food. Their bodies contained plenty of blubber to insulate them from changes in water temperature. What caused such seemingly healthy animals to die?

When biologists examined the dead whales' tissues, they identified the cause of the puzzling deaths. The whales' cells contained a deadly toxin produced by a dinoflagellate called *Alexandrium tamarense*. The population of these algae had grown rapidly in the ocean waters through which the whales were migrating. When the whales fed on the toxin-producing algae or on fishes that had eaten the algae, the toxins reached a deadly level and killed the whales.

Algae are common in oceans, lakes, and ponds. They float near the surface of the waters and use sunlight to make food. The rapid growth of a population of algae is called an **algal bloom**. Algal blooms can occur in both saltwater and freshwater environments. **In general, algal blooms occur when nutrients increase in the water.**



◀ A humpback whale

Lab zone

Discover Activity

Skills Focus Predicting

Materials clear plastic container, water, green paper punches, spoons

Time 15 minutes

Tips Use a hole punch to make green paper punches. After students complete their models, ask: **What does your model show about how algae can grow on a**

L1 pond? (How rapidly the number of algae can increase)

Expected Outcome The green paper punches will eventually cover the surface of the water.

Think It Over If algae cover the pond's surface, less light and air will reach the bottom, and organisms deep in the pond will die.



Saltwater Blooms

In Figure 13, you see an algal bloom in ocean water. Saltwater algal blooms are commonly called **red tides** because the algae that grow rapidly often contain red pigments and turn the color of the water red. But red tides do not always look red. Some red tides are brown, green, or even colorless, depending on the species of algae that blooms. Dinoflagellates and diatoms are two algae that frequently bloom in red tides.

Causes of Red Tides Scientists are not sure why some populations of saltwater algae increase rapidly at times. But red tides occur most often when there is an increase in nutrients in the water. Some red tides occur regularly in certain seasons. For example, the cold bottom layers of the ocean contain a lot of nutrients. When this cold water mixes with the surface waters, more nutrients become available to surface organisms. With greater concentrations of nutrients present in the surface waters, blooms of algae occur. Increases in ocean temperature due to climate changes also affect the occurrence of red tides.

Effects of Red Tides Red tides are dangerous when the toxins that the algae produce become concentrated in the bodies of organisms that consume the algae. Shellfish, such as clams and mussels, feed on large numbers of the algae and store the toxins in their cells. Fishes may also feed on the algae and store the toxins. When people or other large organisms eat these shellfish and fishes, it may lead to severe illness or even death. Public health officials close beaches in areas of red tides to prevent people from fishing or gathering shellfish.



What determines the color of saltwater blooms?

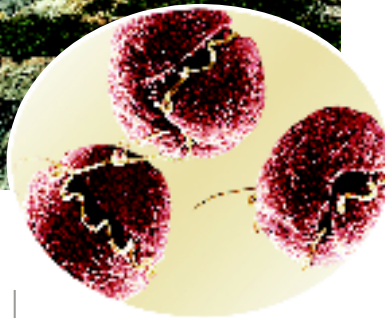


FIGURE 13

Red Tide

Rapid algae growth has caused a red tide in this small bay off the coast of California. Blooms of toxic dinoflagellates such as *Gymnodinium* (inset) can have serious consequences.

Relating Cause and Effect What organisms are affected by red tides?



For: Links on algae
Visit: www.SciLinks.org
Web Code: scn-0132

Instruct

Saltwater Blooms

Teach Key Concepts

L2

Exploring Algal Blooms in Salt Water

Focus Explain that scientists know only general causes of red tides.

Teach Ask: Why are saltwater algal blooms called “red tides”? (Because the algae that form them often contain red pigments that turn the water red) **Under what water conditions are red tides most likely to occur?** (When nutrients in the water increase; sometimes seasonally, or when water temperatures increase with changes in climate conditions) **When and how can red tides prove dangerous to humans?** (Algae that form red tides may produce toxins harmful to people; these toxins build up in shellfish and fish that eat the algae. People that eat organisms containing the toxins can die or become seriously ill.)

Apply Ask: What function does the red pigment provide the algae in red tides? (The ability to absorb sunlight so that the algae can make their own food) **learning modality:** verbal

Independent Practice

L2

All in One Teaching Resources

- [Guided Reading and Study Worksheet: Algal Blooms](#)



Student Edition on Audio CD



For: Links on algae
Visit: www.SciLinks.org
Web Code: scn-0132

Download a worksheet that will guide students' review of Internet resources on algae.

Differentiated Instruction

Gifted and Talented

Flowcharts Have small groups of students create large flowcharts that show the processes that cause red tides and eutrophication. Tell them to include pictures that they draw or get from magazines or the Internet. Remind them to include both natural events and human activities that affect each process. **learning modality:** logical/mathematical

L3

Special Needs

Describing Red Tides Allow students needing extra instruction to work with those completing the Gifted and Talented exercise. Students can assist in gathering pictures and organizing them for the display. **learning modality:** visual

L1

Monitor Progress

L2

Answers

Figure 13 Fish, other organisms in the water, and people



Pigments contained by the species of algae that bloom

Freshwater Blooms

Teach Key Concepts

L2

Examining Freshwater Blooms

Focus Ask students to observe the thick layer of algae in Figure 14.

Teach Define *eutrophication* and discuss how it can be harmful to bodies of water. Ask: **When does eutrophication occur?** (*When excess nutrients build up, causing algae to grow*) **What human sources increase eutrophication?** (*Fertilizer runoff; sewage treatment wastewater*) **Why do pond organisms die with eutrophication?** (*Plants and algae beneath the surface can't make food; they die and their decomposers use up oxygen needed by other organisms, such as fish.*)

Apply Ask: **How are saltwater and freshwater blooms similar?** (*Both occur when nutrients in water increase.*) **Learning modality: verbal**

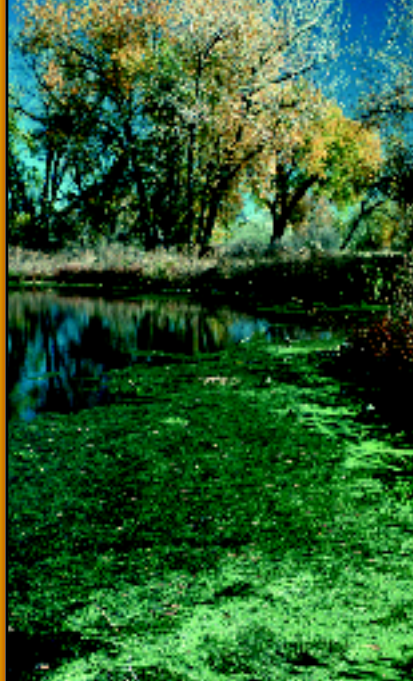


FIGURE 14
Eutrophication
The thick layer of algae on the surface of a pond can threaten other organisms in the water.

Freshwater Blooms

Have you ever seen a pond or lake that looked as if it was coated with a layer of green paint or scum? The green layer usually consists of huge numbers of green algae.

Lakes and ponds undergo natural processes of change over time. **Eutrophication** (yoo troh fih KAY shun) is a process in which nutrients, such as nitrogen and phosphorus, build up in a lake or pond over time, causing an increase in algae growth.

Causes of Eutrophication Certain natural events and human activities can increase the rate of eutrophication. For example, when farmers and homeowners spread fertilizers on fields and lawns, some of the nutrients can run off into nearby lakes and ponds. Sewage treatment plants can leak wastewater into the soil. The nutrients in the wastewater make their way from the soil into water that leads into lakes and ponds. These events cause a rapid increase in algae growth. If the nutrient sources can be eliminated and the nutrients used up, eutrophication slows to its natural rate.

Effects of Eutrophication Eutrophication triggers a series of events with serious consequences. First, the layer of algae prevents sunlight from reaching plants and other algae beneath the surface. Those organisms die and sink to the bottom. Then decomposers, such as bacteria, which break down the bodies of the dead organisms, increase in number. Soon the bacteria use up the oxygen in the water. Without oxygen, fishes and other organisms in the water die. About the only organisms that survive are the algae on the surface.



Reading Checkpoint What natural process of change occurs over time in a pond or a lake?

Monitor Progress

L2

Answer



Eutrophication

Section 2 Assessment



Target Reading Skill Comparing and Contrasting Use the information in your table about algal blooms to help you answer the questions below.

Reviewing Key Concepts

- a. Defining** What is an algal bloom?
- b. Comparing and Contrasting** What might cause an algal bloom to occur in an ocean? In a lake? How would the algal bloom affect organisms living in each?
- c. Predicting** Would it be easier to control saltwater or freshwater blooms? Explain.

Writing in Science

News Report Something strange has happened to the local pond. It is covered with green scum and dead fish are floating on the surface. You have interviewed scientists about possible causes. Write a news report explaining to the public what has happened.

Assess

Reviewing Key Concepts

- a.** Rapid growth of a population of algae
- b.** Ocean: increased nutrients, change in water temperatures; organisms that eat algae build up toxins harmful to organisms that eat them. Lake: increased nutrients from natural and human activities (fertilizer, sewage); organisms die from lack of food and oxygen.
- c.** Freshwater blooms—smaller areas, easier to identify nutrient sources and measure effects.

Reteach

L1

Sketch flow charts illustrating the processes that occur in both types of algal blooms.

All in One Teaching Resources

- [Section Summary: Algal Blooms](#)
- [Review and Reinforce: Algal Blooms](#)
- [Enrich: Algal Blooms](#)



Chapter Project

Keep Students on Track By now, your teacher should have approved your plan, and you should have started growing your mushrooms. Make careful observations of growth daily, including appropriate sketches and measurements. Use a table to organize the data you collect. (*Hint: As you make your observations, be careful not to disturb the experiment or introduce any new variables.*)

Writing in Science

Writing Mode Description

Scoring Rubric

- 4 Includes definition of *eutrophication*, explains causes and effects; tone is clear and engaging.
- 3 Includes all criteria; writing not engaging
- 2 Minimally covers criteria
- 1 Includes inaccurate or incomplete information



An Explosion of Life

Problem

How does the amount of fertilizer affect algae growth?

Skills Focus

controlling variables, drawing conclusions, predicting

Materials

- 4 glass jars with lids
- marking pen
- aged tap water
- aquarium water
- graduated cylinder
- liquid fertilizer

Procedure

1. Read through the steps in the procedure. Then write a prediction describing what you think will happen in each of the four jars.
2. Copy the data table into your notebook. Be sure to allow enough lines to make entries for a two-week period.
3. Label four jars A, B, C, and D. Fill each jar half full with aged tap water.
4. Add aquarium water to each jar until the jar is three-fourths full.
5. Add 3 mL of liquid fertilizer to jar B, 6 mL to jar C, and 12 mL to jar D. Do not add any fertilizer to jar A. Loosely screw the lid on each jar. Place all the jars in a sunny location where they will receive the same amount of direct sunlight.

Data Table				
	Observations			
Day	Jar A (no fertilizer)	Jar B (3 mL of fertilizer)	Jar C (6 mL of fertilizer)	Jar D (12 mL of fertilizer)
Day 1				
Day 2				

Analyze and Conclude

1. Jar D was the darkest green, with jars C and B increasingly lighter, and jar A the lightest. Answers regarding predictions will vary.
2. Jar A served as the control.
3. The difference: fertilizer input. Eutrophication—increased nutrients causing rapid algal growth—caused the color changes.

6. Observe the jars every day for two weeks. Compare the color of the water in the four jars. Record your observations.

Analyze and Conclude

1. **Observing** How did the color in the four jars compare at the end of the two-week period? Did your observations match your prediction?
2. **Controlling Variables** What was the purpose of jar A? Explain.
3. **Drawing Conclusions** How can you account for any color differences among the four jars? What process and organisms were responsible for causing that color change?
4. **Predicting** Predict what would have happened if you placed the four jars in a dark location instead of in sunlight. Explain your prediction.
5. **Communicating** Write a warning label to be placed on a bag of fertilizer. On the label, explain what might happen to fish and other organisms if the fertilizer gets into a body of fresh water. Also, outline steps consumers can take to prevent these problems.

Design an Experiment

Some detergents contain phosphates, which are also found in many kinds of fertilizer. Design an experiment to compare how regular detergent and low-phosphate detergent affect the growth of algae. *Obtain your teacher's permission before carrying out your investigation.*

4. Without light for algae to make food, jars would stay the same as the first day.
5. Labels should explain that fertilizer runoff speeds up algal growth, which eventually kills pond plants and animals. Consumers can prevent fertilizer runoff by using appropriate amounts, applying according to directions, and ensuring runoff is contained.

An Explosion of Life


Prepare for Inquiry

Skills Objectives

After this lab, students will be able to

- control variables;
- predict relative algae growth;
- draw conclusions about nutrient use.


 **Prep Time** 30 minutes

 **Class Time** 30 minutes first day; 10 minutes per day on subsequent days

Advance Planning

The tap water should stand for 3 days before the lab.

Safety

 Review the safety guidelines in Appendix A. Dispose of the algae and all other materials according to the proper procedures. Be sure to check your district's and state's guidelines for the proper disposal of algal cultures.

All in One Teaching Resources

- [Lab Worksheet: An Explosion of Life](#)

Guide Inquiry

Invitation

Ask students what agricultural runoff after a rainstorm might contain. (*Soil, fertilizers*) Students will test the effect of fertilizer on algal growth.

Introduce the Procedure

Provide a display of the four labeled jars, filled to the appropriate levels, and the correct measures of fertilizer.

Extend Inquiry

Design an Experiment Use regular detergent in one set of jars and low-phosphate detergent in another.

Expected Outcome

Algae will grow fastest in jar D and slowest in jar A.