SAVVAS

Sample Labs & Activities

CHAPTER 4

FOR REVIEW PURPOSES ONLY

Miller & Levine

Biology

Grades 9-12

Miller & Levine

Biology

TABLE OF CONTENTS

Experience Science Phenomena

Do more inquiry! Guided, Open-Ended, and Argument-Based Inquiry labs let students actively engage with natural phenomena. Students investigate key questions, apply science and engineering practices, and interpret data as part of their results.

Quick Labs

- Students interact with chapter concepts at point of use
- Focus on science and engineering practices to build three-dimensional skills
- Easy set-up and clean-up saves valuable time
- Guided Inquiry or Open Ended Inquiry
- One in every chapter

Quick Lab Guided Inquiry

Why Do Different Earth Surfaces Have Different Temperatures?

1. Review the procedure. Prepare a data table to record the temperature measurements.
2. Half fill each of three cups: one cup with gravel, a second cup with soil, and a third cup with water.
3. Place a thermometer inside each cup. Record the temperatures.
4. Place each cup under the heat lamp. Wait 30 minutes and then record the temperatures again.

Chapter Labs

- Download and edit from Savvas Realize™
- Differentiate with two versions available online
- Strengthen inquiry skills as students make models, study local science issues, and complete experiments
- Students plan and conduct experiments and then aggregate, interpret, and present results
- Use appropriate laboratory equipment and technologies
- Guided Inquiry, Open Ended Inquiry, or Argument-Based Inquiry
- One in every chapter

Exploration Lab

Guided Inquiry

The Effect of Fertilizer on Algae

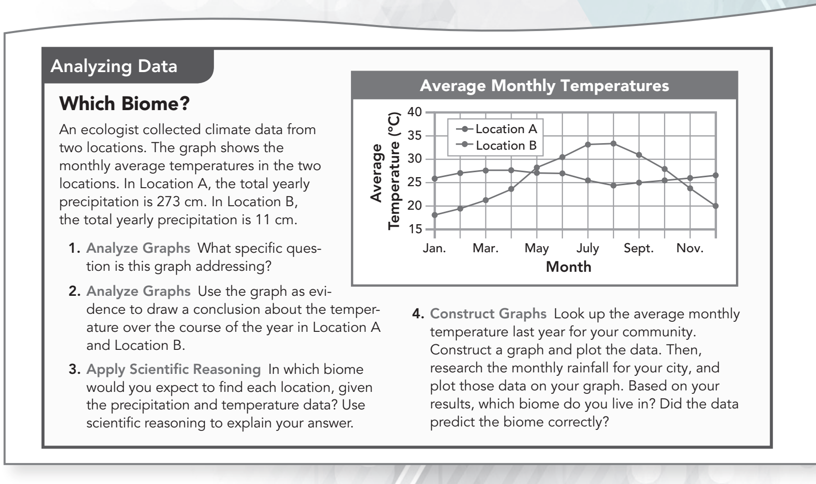
Problem How do excess nutrients affect the growth of algae?

In this lab, you will plan and carry out an investigation that tests the effects of fertilizer concentration on algae growth. You will select nutrient amounts and compare the growth of algae when nutrients are limited and when nutrients are abundant.

You can find this lab in your digital course.

Analyzing Data Labs

- Use graphs and tables featuring real data
- Hone science and engineering skills as students make math connections
- Easily locate answers in margins of the Teacher Edition


Analyzing Data

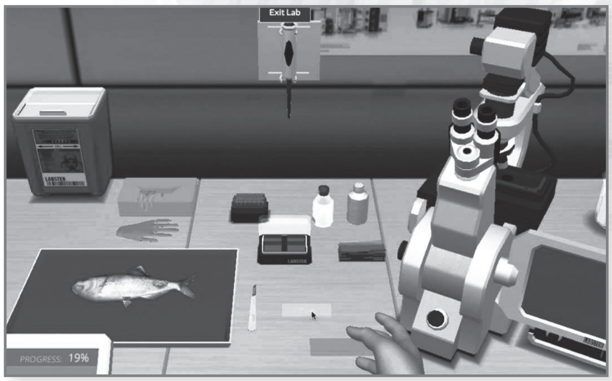
Which Biome?

An ecologist collected climate data from two locations. The graph shows the monthly average temperatures in the two locations. In Location A, the total yearly precipitation is 273 cm. In Location B, the total yearly precipitation is 11 cm.

1. **Analyze Graphs** What specific question is this graph addressing?
2. **Analyze Graphs** Use the graph as evidence to draw a conclusion about the temperature over the course of the year in Location A and Location B.
3. **Apply Scientific Reasoning** In which biome would you expect to find each location, given the precipitation and temperature data? Use scientific reasoning to explain your answer.
4. **Construct Graphs** Look up the average monthly temperature last year for your community. Construct a graph and plot the data. Then, research the monthly rainfall for your city, and plot those data on your graph. Based on your results, which biome do you live in? Did the data predict the biome correctly?

Labster Virtual Lab Simulations

- Immersive, interactive learning
- Life-like 3D animations
- Gamified missions and storytelling
- Real-life, open-ended cases
- No expensive lab equipment
- Eliminates all safety issues
- Variety of packages available



Interactivities—Virtual Simulations

- Students manipulate visuals and interactive content to deepen understanding
- Variety of options, including digital art, drag and drop, art review, videos, and vocabulary cards
- Located throughout the narrative to enhance explanations

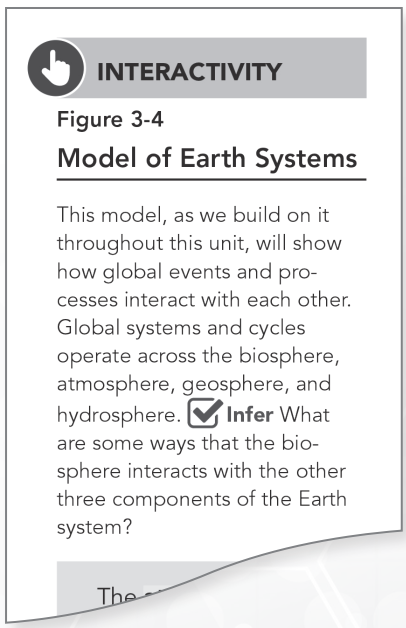

INTERACTIVITY

Figure 3-4

Model of Earth Systems

This model, as we build on it throughout this unit, will show how global events and processes interact with each other. Global systems and cycles operate across the biosphere, atmosphere, geosphere, and hydrosphere. **Infer** What are some ways that the biosphere interacts with the other three components of the Earth system?

The

Name ______________________ Class ____________ Date __________

Quick Lab Open-Ended Inquiry

How Can You Model Energy Flow in Ecosystems?

1. Using materials of your choice, develop a mathematical model of energy flow through four trophic levels in an ecosystem. To start, decide what will represent one energy unit. Then, decide what will represent the trophic levels.
2. Model the amount of available energy in the first trophic level. Set up a data table to record the number of energy units available in your model.
3. Next, model how this energy transfers to the second, third, and fourth trophic levels. Record your data in your data table.

Analyze and Conclude

1. **Use Models** About how much energy is transferred from one trophic level to the next? How does your model show this flow of energy?
2. **Evaluate Claims** A classmate claims that energy is conserved as it flows through an ecosystem. Use your model and scientific reasoning to support or refute this claim.
3. **Support Claims** Support the claim that matter is conserved when one organism eats another.

Quick Lab Open-Ended Inquiry

How Can You Model Energy Flow in Ecosystems?

Purpose Students develop a model of the amounts and flows of energy in four trophic levels.

Planning Note The activity is available online as an **editable** document.

Review the content on pyramids of energy before students complete this activity. Gather possible materials from which students can choose, or have students bring them to class. The materials will be used to represent energy units and trophic levels. If you would prefer to make this less open-ended, distribute plastic containers (to represent the trophic levels) and beads (to represent energy units) to each group.

Materials Possible materials include containers, plastic bags, or paper bags (4 per group), and beads, paper clips, or marbles (10 or 100 per group).

Expected Outcome Students' models should show the amount of energy decreasing by 90 percent with each trophic level.

Analyze and Conclude

1. About 10 percent of the energy from one trophic level is transferred to the next. Student models should show that only one tenth of the materials they used to represent energy was transferred.
2. Students' evidence will vary; possible refutation: Energy enters an ecosystem and flows through a food chain, where some is lost as heat, so the energy is not conserved within the ecosystem.
3. Sample answer: Matter is conserved when one organism eats another because the matter that the consumer doesn't use for its life processes is released as wastes, which are consumed by decomposers and detritivores.

Ocean Water and Oxygen Concentration Analyzing Data Lab

Name ______________________________ Class ____________ Date __________

Analyzing Data

Ocean Water and Oxygen Concentration

Samples of ocean water are taken at different depths, and the amount of oxygen in the water at each depth is measured. The results are shown in the data table.

Concentration of Oxygen	
Depth of Sample (m)	**Oxygen Concentration (ppm)**
0	7.5
50	7.4
100	7.4
150	4.5
200	3.2
250	3.1
300	2.9

1. **Analyze Data** Describe what happens to the amount of available oxygen as you get deeper in the ocean.
2. **Infer** Light can penetrate to only a depth of between 50 and 100 m in most ocean water. What effect does this have on the water's oxygen concentration? Explain.

Ocean Water and Oxygen Concentration Analyzing Data Lab

Fruits, such as berries are easy to digest, and are usually rich in energy and nutrients. So it isn't surprising that many birds and mammals feed on these types of foods. The world's human population also gets much of its energy from the seeds of grasses: rice, corn, wheat, oats, and barley.

Leaves are plentiful in many ecosystems, but are low in energy and tough to digest. Why? Leaves are composed largely of cellulose. No multicellular organism can manufacture an enzyme to break down cellulose molecules. Only fungi and certain single-celled organisms manufacture those enzymes. So how can many animals eat leaves? Animals that eat leaves have microorganisms inside their guts that digest cellulose for them!

Cattle and many other grazing animals spend a long time chewing their food into a pulp. When they swallow this pulp, it enters a complex digestive tract, part of which supports microorganisms that can break down cellulose. Many grazers periodically regurgitate the mixture of food and bacteria, which is called cud. Then they chew the cud and reswallow it. Even with all this extra work, grazers can extract relatively little energy from each mouthful of leaves. They therefore spend a lot of their time eating. What's more, the kind of digestive system needed to extract energy and nutrients from leaves is very heavy. That's why only a handful of birds eat leaves.

Analyzing Data

Ocean Water and Oxygen Concentration

Samples of ocean water are taken at different depths, and the amount of oxygen in the water at each depth is measured. The results are shown in the data table.

1. **Analyze Data** Describe what happens to the amount of available oxygen as you get deeper in the ocean.
2. **Infer** Light can penetrate to only a depth of between 50 and 100 m in most ocean water. What effect does this have on the water's oxygen concentration? Explain.

Concentration of Oxygen

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200	3.2
250	3.1
300	2.9

LESSON 4.1 Review

KEY QUESTIONS

1. What are the two primary sources of energy that power living systems?
2. How do consumers obtain energy?

CRITICAL THINKING

3. **Develop Models** Draw a model to illustrate the flow of energy from a nonliving source to an herbivore.
4. **Construct an Explanation** Termites are insects that feed on wood, which contains cellulose. Scientists have observed that some termite species prefer wood that has been attacked by fungi. Construct an explanation for this observation.

LESSON 4.1 Review Answers

KEY QUESTIONS

1. Light energy from the sun, and chemical energy from inorganic molecules such as hydrogen sulfide **DOK 1**
2. Consumers get energy by eating other organisms or the remains of other organisms. **DOK 1**

CRITICAL THINKING

3. Drawings will vary, but should represent an accurate food chain that includes the sun or a source of chemical energy, a producer that engages in photosynthesis or chemosynthesis, and an herbivore that eats the producer.
4. Sample answer: Cellulose fibers are difficult to digest. The fungi likely have broken some of the chemical bonds in cellulose, making it easier for other organisms, such as termites, to gain energy from the materials that remain.

Analyzing Data

Ocean Water and Oxygen Concentration

Purpose Students examine a table to analyze the oxygen content of ocean water at different depths. The activity is available online as an **editable** document.

Answers

1. It remains mostly stable to about 100 meters, and then drops steeply between 100 and 150 meters and again between 150 and 200 meters. It then drops slightly between 200 and 300 meters.

2. Since oxygen concentration drops steeply at the same depth at which light ceases to penetrate, light seems to be necessary for the highest possible oxygen concentration in ocean water. This is because the autotrophs who generate oxygen in the ocean need light.

DEMONSTRATE

Evaluate Student Progress

Have students work in pairs. One student in each pair should convert the sections "Primary Producers" or "Consumers" to an outline. They should use the subheads for Roman numerals I and II. Challenge students to list the supporting details under each main idea.

Remediate

If students have trouble answering question 3, refer students to **Figure 4-1** to remind them of the two ways the energy can enter the food chain.

ASSESSMENT

Lesson Quiz Assign the online quiz to assess your students' learning of content and skills after they have completed the lesson. The quiz is also available as an **editable** document, so that you can customize the questions for your class.

The Effect of Fertilizer on Algae Guided Inquiry Chapter Lab

Name ________________________________ Class____________ Date __________

Develop a Solution Lab Guided Inquiry

Chapter 4 Lab

The Effect of Fertilizer on Algae

Ask Questions

How do excess nutrients affect the growth of algae?

Introduction

As primary producers, algae form the base of the food web in the upper layers of the ocean and in freshwater lakes and ponds. The term *algae* is used to describe a range of organisms, from the large brown kelp found attached to rocks at the seashore to the tiny green algae found in fish tanks. Like other plants, green algae need nitrogen, phosphorus, and potassium in order to grow. All three nutrients must be available for the algae to thrive and reproduce.

Have you ever seen a pond with a thick, green layer of algae on its surface? This layer is a sign that the homeostasis of the ecosystem may have been disturbed by the presence of too much nitrogen or phosphorus in the water. Fertilizers and animal waste contain these nutrients, which can be transferred to bodies of water when rainfall flows downhill from farms.

In this lab, you will work with *Chlorella,* a type of algae that is commonly found in ponds and aquariums. You will select nutrient amounts and compare the growth of *Chlorella* when nutrients are limited and when nutrients are abundant.

Focus on Science Practices

Plan and Carry Out an Investigation, Collect Data, Analyze and Interpret Data

Materials per Group

- 3 test tubes
- glass-marking pencil
- test-tube rack
- 2 dropper pipettes
- algae culture
- 25-mL graduated cylinder
- spring water
- fertilizer
- 3 cotton balls
- grow light
- compound microscope
- glass slides
- glass coverslips

Name ______________________________ Class ___________ Date _________

Safety

Wear safety goggles and plastic gloves when handling live cultures, such as algae. If you are using glass test tubes or cylinders, check for cracks or chips. Handle slides gently to avoid breaking them and cutting yourself. Alert your teacher if you break a glass object. Review the rules for handling a microscope. To avoid electrical shocks, make sure that cords, plugs, and your hands are dry when using the light source. At the end of the lab, wash your hands thoroughly with soap and warm water.

Procedure

Part A

1. Use a glass-marking pencil to label one test tube Control, one test tube Fertilizer 1, and the third test tube Fertilizer 2. Place the test tubes in a test-tube rack.

2. Decide how many drops of fertilizer to put in the two Fertilizer test tubes. Select between one and six drops. Record your plan below.

Experimental Design	
	# Drops Fertilizer
Control	
Fertilizer 1	
Fertilizer 2	

3. Put on your safety goggles and plastic gloves. Use a dropper pipette to add 60 drops of algae culture to each test tube.

4. Add 19 mL of spring water to each test tube.

5. Use a second dropper pipette to add drops of fertilizer solution to the test tube labeled Fertilizer 1 and 2 according to the table in Step 2.

6. Loosely plug each test tube with a cotton ball to slow the evaporation of the water.

7. Place the test-tube rack under a grow light. Turn on the light. Position the rack so that each test tube will receive an equal amount of light.

8. Clean your work area and put away any unused materials. Wash your hands.

Part B

1. On the day after you set up your samples (Day 1), observe a small sample from the control test tube under a light microscope. Gently swirl the test tube so that the algae are mixed evenly in the water. If algae are collected in a pellet at the bottom of the test tube, then dislodge the pellet by holding your finger over the test tube and shaking the test tube vigorously, turning it upside down or back and forth as necessary. When the algae are thoroughly mixed into the water, use a new dropper pipette to transfer one drop from the test tube onto a glass slide and cover with a coverslip.

2. Examine the slide under high power. Count the number of *Chlorella* cells in the field of view. Record this number. As time allows, move the slide and count the cells in one or two additional new fields of view. Calculate the average number of cells per field.

3. Rinse the dropper pipette and repeat for the test tubes labeled Fertilizer 1 and Fertilizer 2. Use the same dropper pipette each day and a coverslip of the same thickness throughout the experiment.

4. Observe the test tubes each day for the next four days. Record your observations in the data table.

Name ______________________________ Class ____________ Date __________

Data Table						
Day	**Control counts**	**Control average**	**Fertilizer 1 counts**	**Fertilizer 1 average**	**Fertilizer 2 counts**	**Fertilizer 2 average**
1						
2						
3						
4						

Name ______________________________ Class ____________ Date __________

Analyze and Interpret Data

1. **Compare and Contrast** Summarize your observations of the three test tubes over four days.

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2. **Construct Graphs** Use graph paper to make a graph that shows the data you collected. Use the average number of cells per sample per day.

3. **Draw Conclusions** Based on the evidence you gathered in this experiment, how did the addition of fertilizer affect the growth of the algae?

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4. **Conduct an Investigation** In this investigation, you used cotton balls instead of rubber stoppers to plug the test tubes. Unlike rubber stoppers, cotton balls allow gases to move through them. Why is the movement of gases into or out of the test tubes essential for the growth of algae? *Hint:* Review the diagram of the carbon cycle in your textbook.

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5. **Draw Conclusions** Nitrogen gas (N_2) makes up 78 percent of the atmosphere. In this experiment, which source of nitrogen—the atmosphere or the fertilizer—had the greater effect on the growth of the algae? Cite the data you gathered and apply your knowledge of the nitrogen cycle to support your explanation.

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Name ________________________________ Class____________ Date __________

6. **Predict** Describe the movement and transformation of energy that you observed during the investigation. How do you predict this change in energy might affect other living things in a lake, a river, or another aquatic ecosystem? For example, how might a thick layer of algae on the surface of a pond affect producers that live on or near the bottom of the pond? How might it affect the consumers of the pond?

7. **Develop a Model** Draw a diagram and write a caption to explain the role of algae in the carbon cycle. Include the energy source for the algae, as well as the movement of carbon into or out of the algae.

Extend Your Inquiry

Design an experiment to see whether the proportion of phosphorus in a fertilizer affects the growth of *Chlorella*. Compare the fertilizer you used in this lab, which has a high proportion of nitrogen, with a high phosphorus fertilizer. Ask your teacher for instructions on preparing a stock solution of fertilizer.

Name ______________________________ Class____________ Date __________

Develop a Solution Lab Guided Inquiry

Chapter 4 Lab

The Effect of Fertilizer on Algae

Ask Questions

How do excess nutrients affect the growth of algae?

Introduction

Algae are primary producers. They form the base of the food web in the upper layers of the ocean. Algae also grow in freshwater lakes and ponds. Brown kelp found attached to rocks at the seashore and the tiny green algae found in fish tanks are both examples of algae. Like other plants, green algae need nitrogen, phosphorus, and potassium in order to grow. All three nutrients must be available for the algae to grow and reproduce.

Have you ever seen a pond with a thick, green layer of algae on its surface? This layer is a sign that too much algae has grown and disturbed the homeostasis, or balance, of the ecosystem. It is likely that there was too much nitrogen or phosphorus in the water. Fertilizers and animal waste contain these nutrients. Nutrients can be transferred to bodies of water when rainfall flows downhill from farms.

In this lab, you will work with *Chlorella,* a type of algae that is commonly found in ponds and aquariums. You will select nutrient amounts and compare the growth of *Chlorella* when nutrients are limited and when nutrients are abundant.

Build Vocabulary

Term	Definition
primary producer	first producer of energy-rich compounds that are later used by other organisms
homeostasis	stable, balanced conditions
ecosystem	all the organisms that live in a place, together with their nonliving environment
nutrient	a chemical substance that an organism needs to stay alive

Name ________________________________ Class _____________ Date ___________

Focus on Science Practices

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Safety

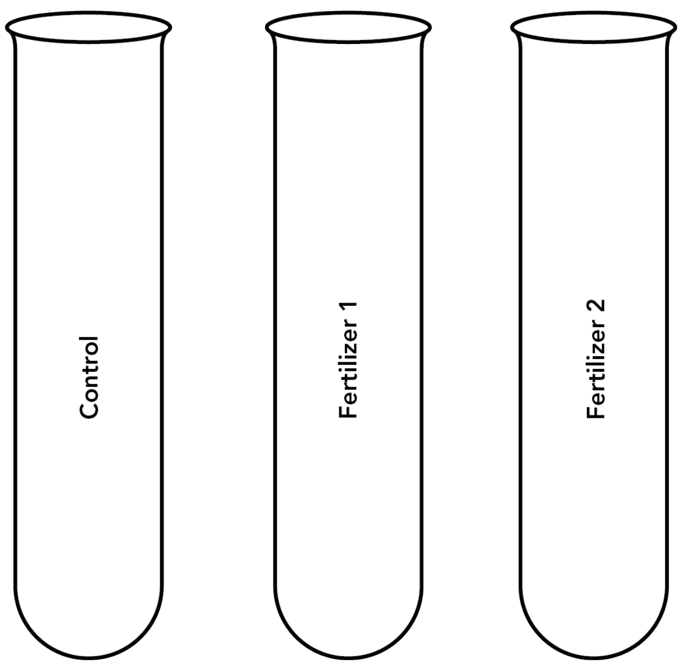
Wear safety goggles and plastic gloves when handling live cultures, such as algae. If you are using glass test tubes or cylinders, check for cracks or chips. Handle slides gently to avoid breaking them and cutting yourself. Alert your teacher if you break a glass object. Review the rules for handling a microscope. To avoid electrical shocks, make sure that cords, plugs, and your hands are dry when using the light source. At the end of the lab, wash your hands thoroughly with soap and warm water.

Procedure

Part A

1. Use a glass-marking pencil to label one test tube Control, one test tube Fertilizer 1, and the third test tube Fertilizer 2. Place the test tubes in a test-tube rack.

Label test tubes

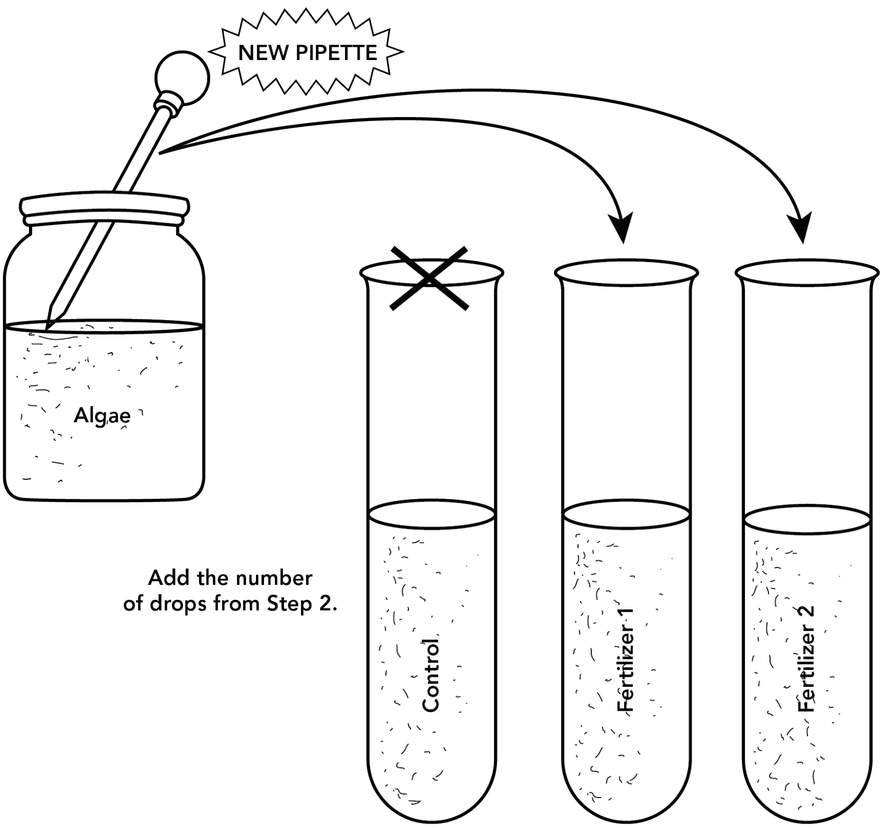


Name ________________________________ Class ____________ Date __________

2. Decide how many drops of fertilizer to put in the two Fertilizer test tubes. Select between one and six drops. Record your plan below.

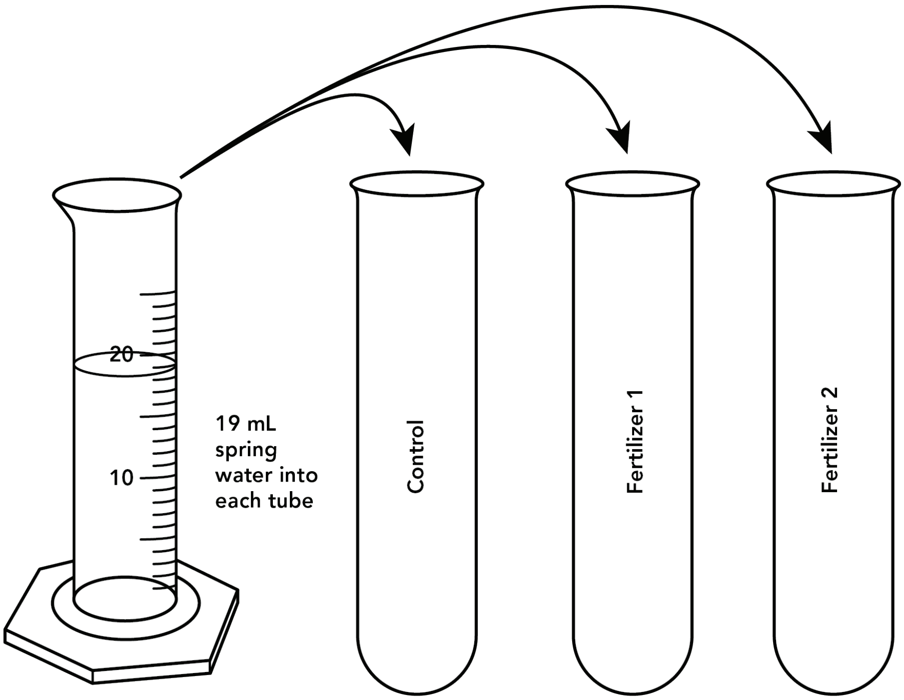
Experimental Design	
	Number of Drops Fertilizer
Control	
Fertilizer 1	
Fertilizer 2	

3. Put on your safety goggles and plastic gloves. Use a dropper pipette to add 60 drops of algae culture to each test tube.

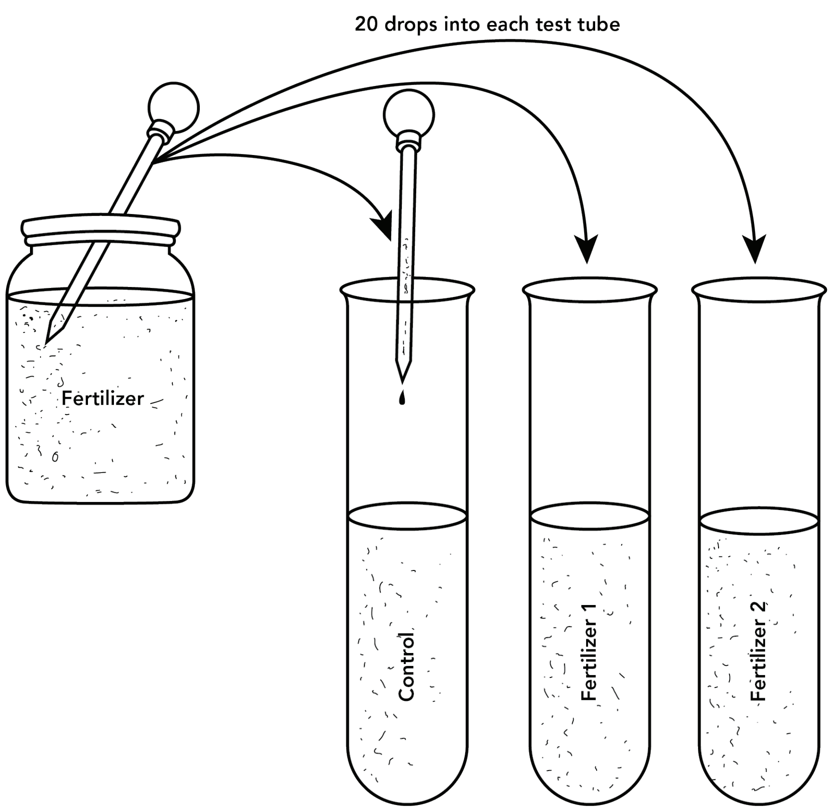


Name ________________________________ Class _____________ Date __________

4. Add 19 mL of spring water to each test tube.

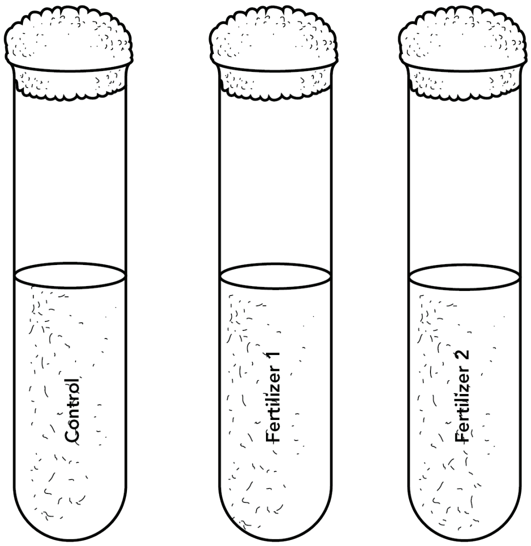


5. Use a second dropper pipette to add drops of fertilizer solution to the test tubes labeled Fertilizer 1 and 2 according to the table in Step 2.



Name ________________________________ Class____________ Date __________

6. Loosely plug each test tube with a cotton ball to slow the evaporation of the water.

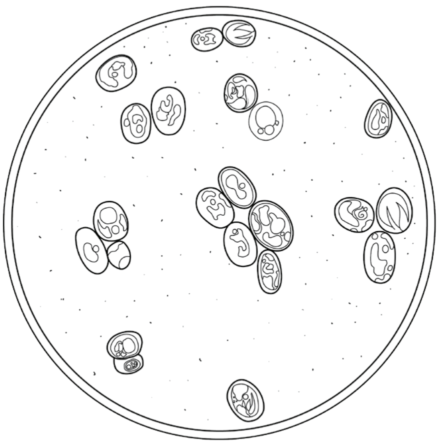


7. Place the test-tube rack under a grow light. Turn on the light. Position the rack so that each test tube will receive an equal amount of light.

Part B

1. On the day after you set up your samples (Day 1), observe a small sample from the control test tube under a light microscope. Gently swirl the test tube before you take your sample. Use a new dropper pipette to transfer one drop from the control test tube onto a glass slide and cover with a coverslip.

2. Examine the slide under high power. Count the number of *Chlorella* cells in the field of view. Record this number in the table.



Looking from the side, move the glass slide slightly. Count the number of *Chlorella* cells in this new view. Record this number and repeat one more time for a total of three views. Record the average number of cells.

3. Rinse the dropper pipette and repeat for the test tubes labeled Fertilizer 1 and Fertilizer 2. Use the same dropper pipette each day and a coverslip of the same thickness throughout the experiment.

4. Observe the test tubes each day for the next four days. Record your counts in the data table.

Name ______________________________ Class ___________ Date _________

Data Table						
Day	**Control counts**	**Control average**	**Fertilizer 1 counts**	**Fertilizer 1 average**	**Fertilizer 2 counts**	**Fertilizer 2 average**
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3						
4						

Name ______________________________ Class ___________ Date _________

Analyze and Interpret Data

1. **Compare and Contrast** Summarize your observations of the three test tubes over four days. How did the appearance of each tube change from Day 1 to Day 4? Did the appearance of one tube change more than the others?

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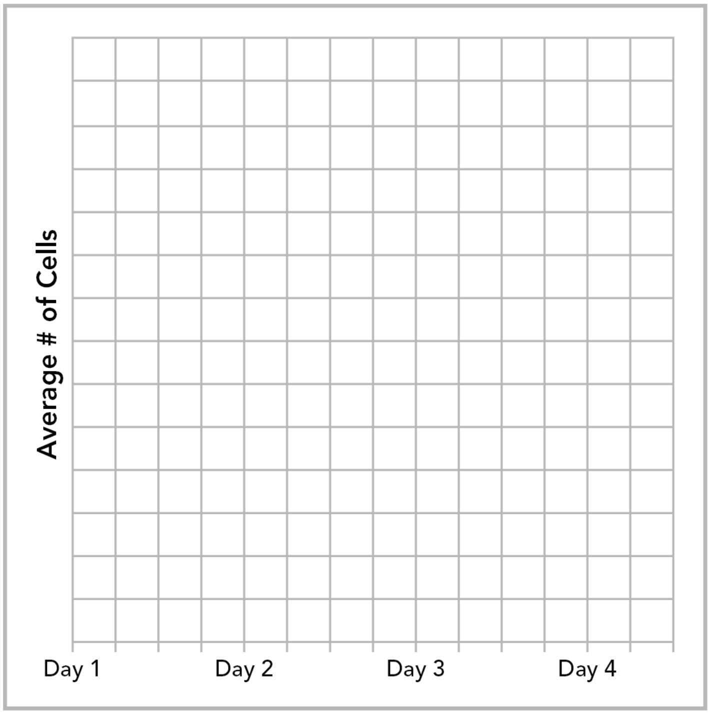
2. **Construct Graphs** Create a line graph that shows the data you collected. Draw a separate line for each sample. Show how the average number of cells in each sample changed over four days.



3. **Draw Conclusions** Based on the evidence you gathered in this experiment, how did the addition of fertilizer affect the growth of the algae?

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Name ________________________________ Class____________ Date __________

4. **Conduct an Investigation** In this investigation, you used cotton balls instead of rubber stoppers to plug the test tubes. Unlike rubber stoppers, cotton balls allow gases to move through them. Why is the movement of gases into or out of the test tubes essential for the growth of algae? *Hint:* Review the diagram of the carbon cycle in your textbook.

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5. **Draw Conclusions** Nitrogen gas (N_2) makes up 78 percent of the atmosphere. In this experiment, which source of nitrogen—the atmosphere or the fertilizer—had the greater effect on the growth of the algae? Cite the data you gathered and apply your knowledge of the nitrogen cycle to support your explanation.

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Extend Your Inquiry

Design an experiment to see whether the proportion of phosphorus in a fertilizer affects the growth of *Chlorella.* Compare the fertilizer you used in this lab, which has a high proportion of nitrogen, with a high phosphorus fertilizer. Ask your teacher for instructions on preparing a stock solution of fertilizer.

The Effect of Fertilizer on Algae Guided Inquiry Chapter Lab Teacher Support

Develop a Solution Lab Guided Inquiry

Teacher Support

Chapter 4 Lab

The Effect of Fertilizer on Algae

Students plan and carry out an investigation that tests the effects of fertilizer concentration on algae growth. They determine the concentrations of fertilizer to test, measure the amounts of algal growth, and construct a graph to analyze their data.

Expected Outcome	The population of algae increases with the amount of fertilizer that the environment receives.
Group Size	Groups of 4
Safety	Before conducting the lab, review with the class the safety precautions presented on the student page. Then discuss any safety precautions that are specific to your science laboratory or classroom.

Alternate Materials

- A sunny windowsill may be used instead of a grow light. However, the number of days required to see results may vary.
- For best results, use a high-nitrogen-content fertilizer with an N-P-K rating of 24-8-16. Other fertilizers, such as those used for indoor plants, may be substituted.
- Use bottled spring water. Do not substitute with tap water or distilled water.

Advanced Preparation (30 minutes)

- Obtain a *Chlorella* culture from a science supply house.
- If using solid fertilizer, prepare a stock solution by adding one-eighth teaspoon of fertilizer to a liter of bottled spring water. If using liquid fertilizer, pour samples into small cups or beakers for student use.
- On the day of the investigation, thoroughly agitate or stir up the algae culture so that the algae are distributed evenly. Then prepare and evaluate a control test tube (Part A, Steps 3 and 4). If necessary, revise Step 3 to adjust the number of drops of algae culture that students add. The control test tube should be mostly clear, yet with algae dense enough that students can readily observe them under the microscope.

Procedure: Teaching Tips

Part A

Step 2: Ask: *How many drops of fertilizer should be placed in the Control test tube?* (zero) Remind students that a control group provides a way of comparing the effects of the variable being tested, which here is the amount of fertilizer.

Students may place up to 6 drops of fertilizer in the other two test tubes. Placing 3 drops in one test tube and 6 drops in the other test tube will provide useful results.

Step 3: To ensure that the number of algae is not a variable, students should start with approximately the same number of algae in each test tube. Make sure students avoid picking up clumps of algae with the pipette.

Step 7: If you are using a single grow light, consolidate the test tubes into a few test-tube racks. All test tubes should be approximately the same distance from the light source, and the light should be unobstructed. Try to center the test tubes under the light, because the intensity of light will decrease significantly near the edges of the bulb.

Part B

Step 1: Discuss the importance of thoroughly mixing the algae and water in the test tubes. This is necessary because the number of algae in each test tube cannot be counted, but instead is estimated by observing a representative sample.

Step 2: Review as necessary the proper techniques for preparing and observing slides under the microscope. Students should follow the procedure for taking at least one count of the algae in each test tube every day. While taking three daily counts for each test tube is ideal, the additional counts are not necessary for obtaining useful results.

Experimental Design	
	# Drops Fertilizer
Control	0
Fertilizer 1	2
Fertilizer 2	6

Data Table						
Day	**Control counts**	**Control average**	**Fertilizer 1 counts**	**Fertilizer 1 average**	**Fertilizer 2 counts**	**Fertilizer 2 average**
1	2	1.3	4	4	3	4
	1		4		3	
	1		3		6	
2	5	3.3	5	5.6	5	6.6
	2		7		7	
	3		4		8	
3	5	5	6	15	16	18.7
	6		12		20	
	4		8		20	
4	10	8.7	9	16	21	24.3
	7		14		19	
	9		11		33	

Analyze and Interpret Data: Sample Answers

1. The green color was noticeable in the test tubes with fertilizer before it was noticeable in the control. After four days, the test tube that had the most fertilizer was tinted the darkest shade of green.

2. Students' graphs should accurately represent the data they collected.

3. The data show that the addition of fertilizer increased the growth of the algae. The test tube with 6 drops of fertilizer held about 3 times the number of algae of the test tube without fertilizer.

4. The movement of gases is essential because algae make their own food using the process of photosynthesis, and the source of carbon for this process is carbon dioxide from the atmosphere. If the test tubes were sealed shut, then the carbon dioxide supply would dwindle and eventually stop the growth of algae.

5. The nitrogen from the fertilizer had a much greater effect on the growth of algae. The algae in all three test tubes could have received nitrogen from the atmosphere, so the differences in their growth were caused by the nitrogen-rich fertilizer. Only a few organisms, such as certain bacteria, are able to take in and use atmospheric nitrogen.

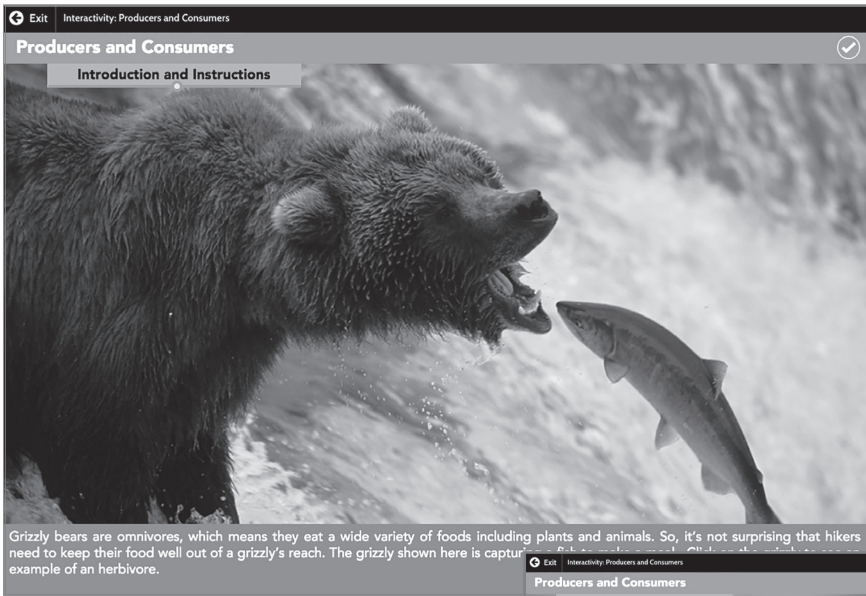
6. The algae absorbed light from the lamps, and then used photosynthesis to transform the light energy into the chemical bonds of compounds. This change in energy provides food for other living things, but producers often compete for the light. A lake covered in algae would block sunlight for producers at the lake bottom. The algae would provide food for any consumers that can eat it, as well as decomposers after the algae die. However, the algae may harm consumer populations that rely on other producers.

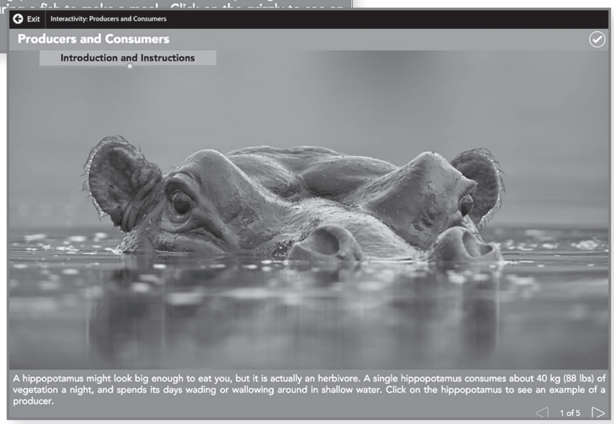
7. Students' diagrams should show algae absorbing energy from sunlight and taking in carbon dioxide from the atmosphere. The diagram or caption should describe how algae help move carbon dioxide out of the atmosphere and store carbon in the biosphere.

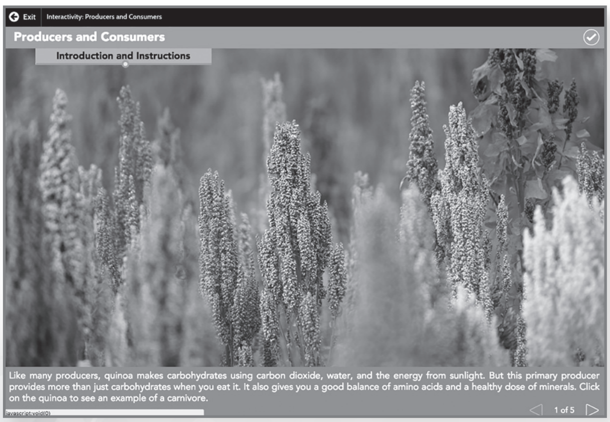
Extend Your Inquiry: Teaching Tips

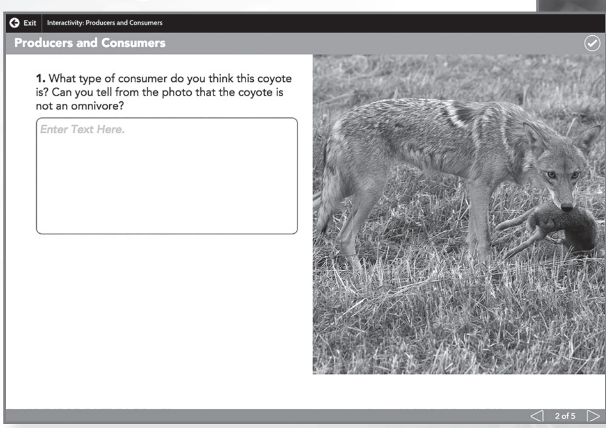
Chlorella grows best in a fertilizer that has a high nitrogen content. The algae should grow slightly less abundantly when provided with the same amount of a low-nitrogen fertilizer. To keep phosphorous and potassium levels roughly constant while reducing the nitrogen level, you may need to use a different overall quantity of a fertilizer—e.g., twice the amount of a 7-4-10 fertilizer.

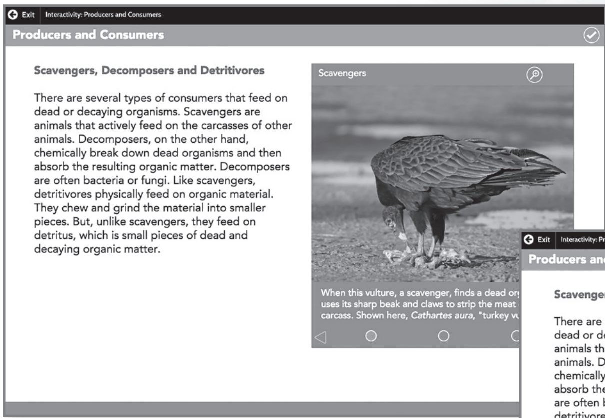
Interactivity: Producers and Consumers

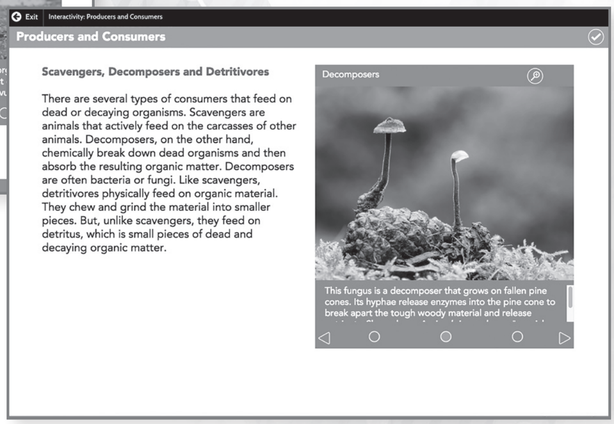


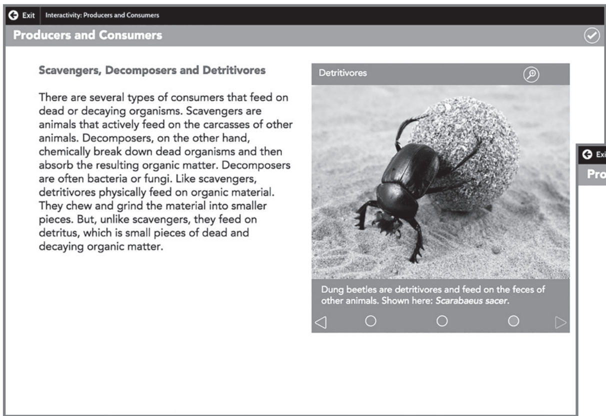







Exit
Interactivity: Producers and Consumers
Producers and Consumers
Scavengers, Decomposers and Detritivores
There are several types of consumers that feed on dead or decaying organisms. Scavengers are animals that actively feed on the carcasses of other animals. Decomposers, on the other hand, chemically break down dead organisms and then absorb the resulting organic matter. Decomposers are often bacteria or fungi. Like scavengers, detritivores physically feed on organic material. They chew and grind the material into smaller pieces. But, unlike scavengers, they feed on detritus, which is small pieces of dead and decaying organic matter.
Scavengers
When this vulture, a scavenger, finds a dead
uses its sharp beak and claws to strip the meat
carcass. Shown here, *Cathartes aura*, "turkey


Exit
Interactivity: Producers and Consumers
Producers and Consumers
Scavengers, Decomposers and Detritivores
There are several types of consumers that feed on dead or decaying organisms. Scavengers are animals that actively feed on the carcasses of other animals. Decomposers, on the other hand, chemically break down dead organisms and then absorb the resulting organic matter. Decomposers are often bacteria or fungi. Like scavengers, detritivores physically feed on organic material. They chew and grind the material into smaller pieces. But, unlike scavengers, they feed on detritus, which is small pieces of dead and decaying organic matter.
Decomposers
This fungus is a decomposer that grows on fallen pine cones. Its hyphae release enzymes into the pine cone to break apart the tough woody material and release


Exit
Interactivity: Producers and Consumers
Producers and Consumers
Scavengers, Decomposers and Detritivores
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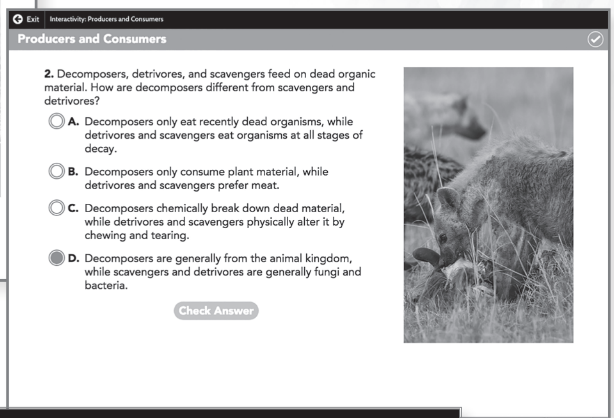
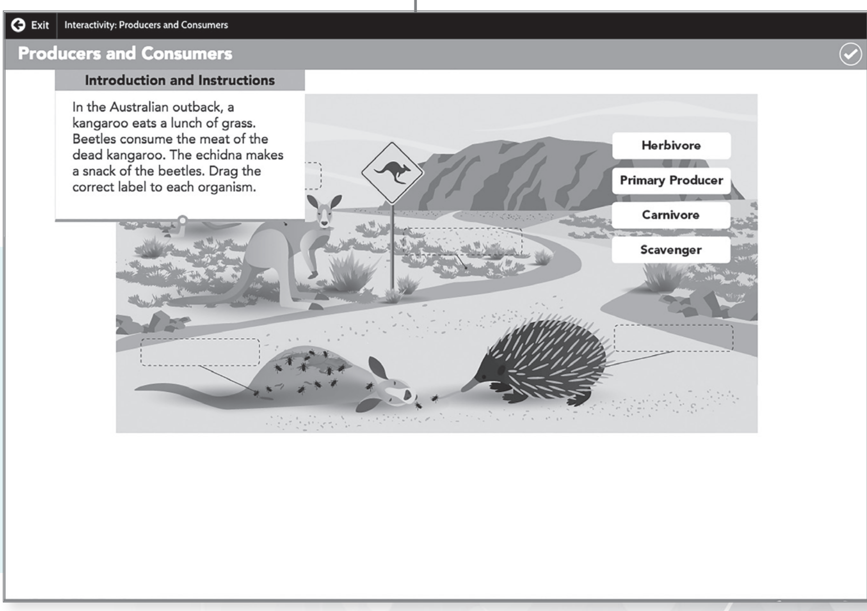
Detritivores
Dung beetles are detritivores and feed on the feces of other animals. Shown here: *Scarabaeus sacer*.


Exit
Interactivity: Producers and Consumers
Producers and Consumers
2. Decomposers, detrivores, and scavengers feed on dead organic material. How are decomposers different from scavengers and detrivores?
A. Decomposers only eat recently dead organisms, while detrivores and scavengers eat organisms at all stages of decay.
B. Decomposers only consume plant material, while detrivores and scavengers prefer meat.
C. Decomposers chemically break down dead material, while detrivores and scavengers physically alter it by chewing and tearing.
D. Decomposers are generally from the animal kingdom, while scavengers and detrivores are generally fungi and bacteria.
Check Answer


Exit
Interactivity: Producers and Consumers
Producers and Consumers
Introduction and Instructions
In the Australian outback, a kangaroo eats a lunch of grass. Beetles consume the meat of the dead kangaroo. The echidna makes a snack of the beetles. Drag the correct label to each organism.
Herbivore
Primary Producer
Carnivore
Scavenger

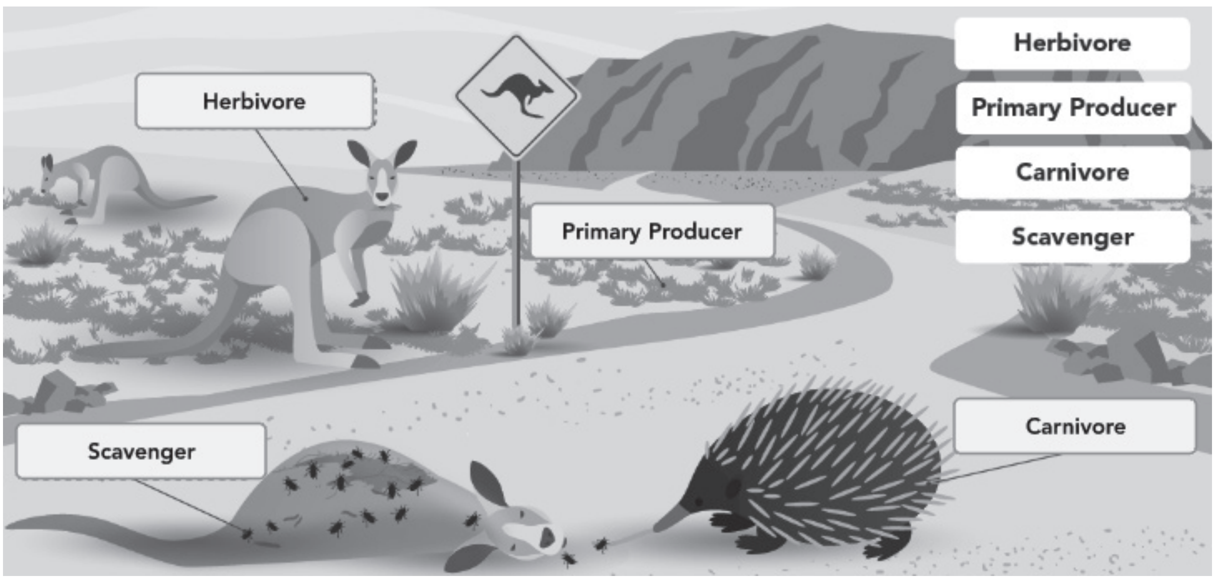
Interactivity:
Producers and Consumer Answer Key

Producers and Consumers

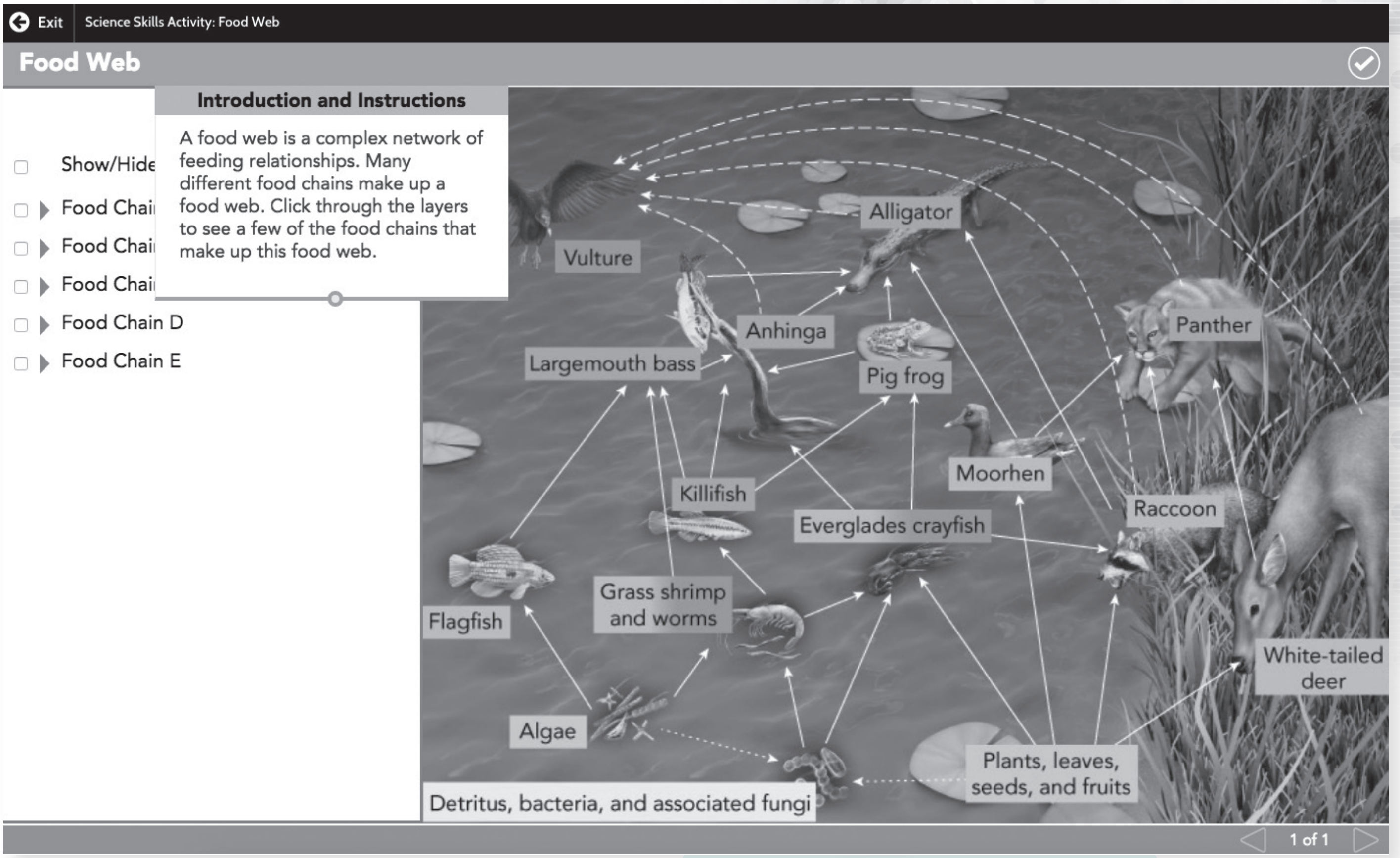
Screen 2: Answers will vary. Sample answer: I think the coyote is likely a carnivore, since it is holding a rabbit in its mouth. However, from the picture, I cannot tell if coyotes also eat plant material. So, I cannot tell for sure that it is definitely a carnivore and not an omnivore.

Screen 4: C

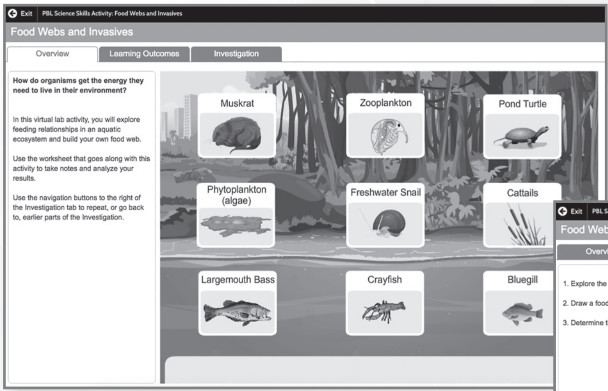
Screen 5:

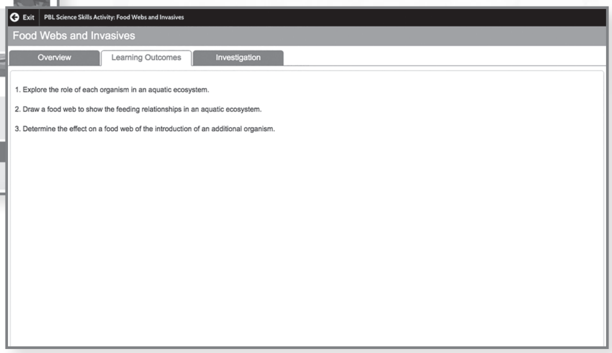


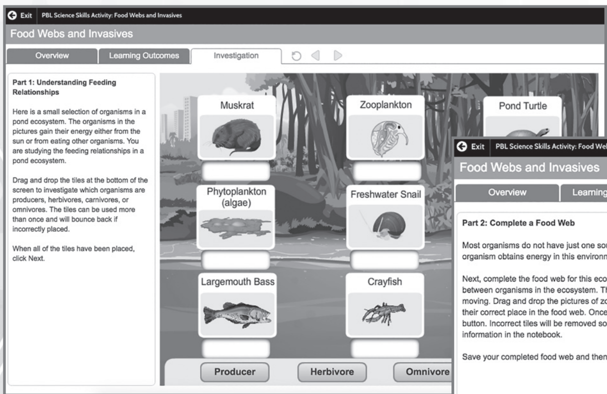
Interactivity: Food Web

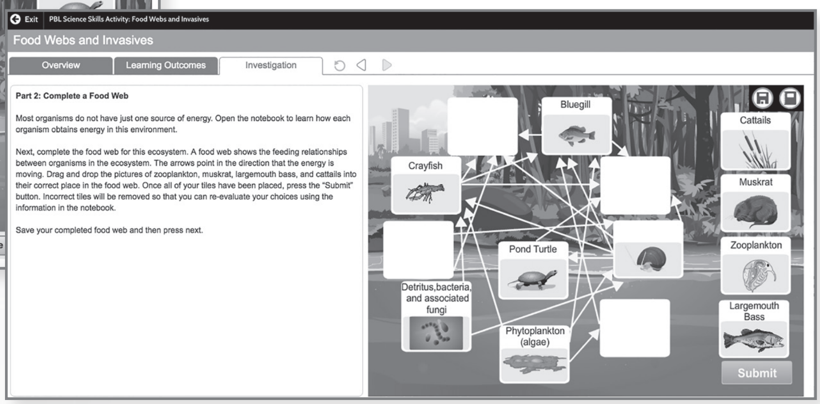


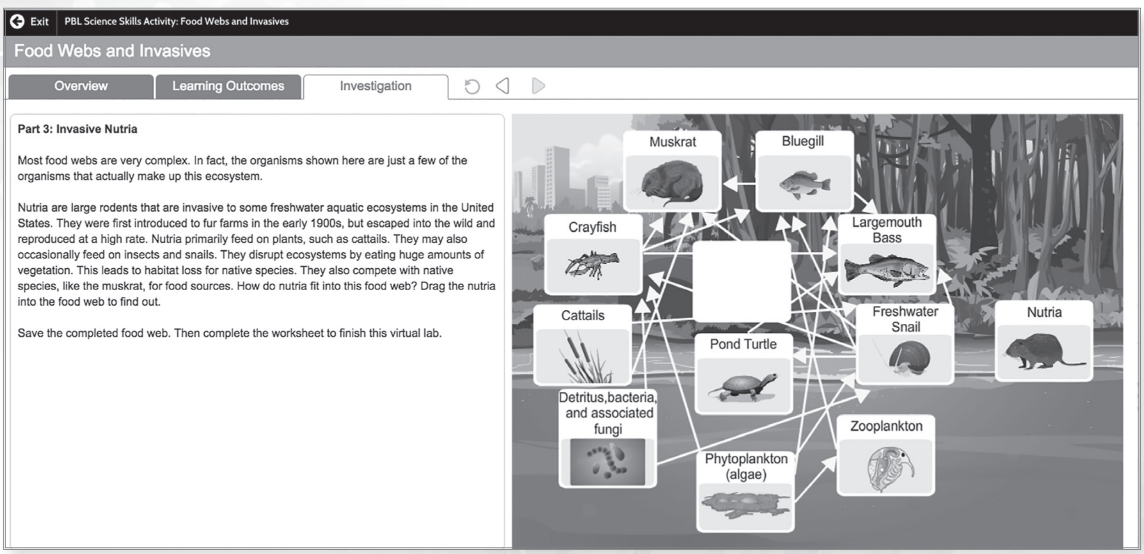
Problem-Based Learning Interactivity: Food Web and Invasives











Food Webs and Invasives

How do invasive species affect an ecosystem?

Timing Chapter 4, Lesson 2

RECORD OBSERVATIONS AND DATA

Part 1

1. Which organisms in this ecosystem are producers, herbivores, carnivores, and omnivores? Record your answers in the table.

Producers	
Herbivores	
Carnivores	
Omnivores	

Part 2

The notebook in the Interactivity and the data table below both describe how each organism obtains energy in this environment. Use the table to help you complete the food web.

Organism	Type	Feeds On/Energy Source
Algae or other Phytoplankton	Producers	Uses sunlight to carry out photosynthesis
Bluegill	Omnivore	Zooplankton, algae, animals such as snails and crayfish
Cattail	Producer	Uses sunlight to carry out photosynthesis
Crayfish	Omnivore/ Detritivore	Algae, animals such as snails, detritus
Freshwater Snail	Herbivore/ Detritivore	Plants such as cattails, algae, detritus
Largemouth Bass	Carnivore	Animals such as crayfish, snails, bluegill, turtles
Muskrat	Omnivore	Plants such as cattails, animals such as bluegill, crayfish, and snails
Western Pond Turtle	Omnivore	Animals such as snails, and carrion
Zooplankton	Herbivore	Phytoplankton
Bacteria and fungi	Decomposers	Breaks down other organisms and releases nutrients

2. Save an image of the completed food web for Part 2. Print it and attach it to this worksheet or use the space provided to draw the food web for this pond ecosystem.

Part 3

3. Save an image of the food web with the addition of the nutria, print it, and attach it to this worksheet. If you drew the food web in the space provided, add the nutria to your drawing and show what it feeds on.

ANALYZE AND CONCLUDE

Refer to the completed food web from Part 2 to answer the following question.

4. **Construct an Explanation** List any organisms that appear in more than one trophic level. How is it that an organism can be in more than one trophic level in an ecosystem? Include an example in your explanation.

Refer to the completed food web from Part 3 to answer the following question.

5. **Develop Models** Draw two food chains from the food web that involve the nutria.

6. **Analyze** How can the introduction of nutria affect a pond ecosystem food web?

CONNECT TO THE UNIT PROBLEM

7. Think about the invasive species you chose to research in the Problem Launch. What is the role of this species in your local food web? Is it a producer? herbivore? carnivore? Find out about a few other species in your local ecosystem. Populate the chart by listing your invasive species in the first row, its food or energy source and its role in the ecosystem. Then fill out rows for four other populations in your local ecosystem.

Population	Food or Energy Source	Role

8. How might your invasive species be affecting the native species in your local food web? What resources might it be using in order to thrive?

Problem-Based Learning Interactivity: Food Web and Invasives Answer Key

Food Webs and Invasives

How do invasive species affect an ecosystem?

Timing Chapter 4, Lesson 2

RECORD OBSERVATIONS AND DATA

Part 1

1. Which organisms in this ecosystem are producers, herbivores, carnivores, and omnivores? Record your answers in the table.

Producers	cattails, phytoplankton
Herbivores	zooplankton
Carnivores	large mouth bass
Omnivores	muskrat, fresh water snail, pond turtle, crayfish, bluegill

Part 2

The notebook in the Interactivity and the data table below both describe how each organism obtains energy in this environment. Use the table to help you complete the food web.

Organism	Type	Feeds On/Energy Source
Algae or other Phytoplankton	Producers	Uses sunlight to carry out photosynthesis
Bluegill	Omnivore	Zooplankton, algae, animals such as snails and crayfish
Cattail	Producer	Uses sunlight to carry out photosynthesis
Crayfish	Omnivore/ Detritivore	Algae, animals such as snails, detritus
Freshwater Snail	Herbivore/ Detritivore	Plants such as cattails, algae, detritus
Largemouth Bass	Carnivore	Animals such as crayfish, snails, bluegill, turtles
Muskrat	Omnivore	Plants such as cattails, animals such as bluegill, crayfish, and snails
Western Pond Turtle	Omnivore	Animals such as snails, and carrion
Zooplankton	Herbivore	Phytoplankton
Bacteria and fungi	Decomposers	Breaks down other organisms and releases nutrients

2. Save an image of the completed food web for Part 2. Print it and attach it to this worksheet or use the space provided to draw the food web for this pond ecosystem.

Part 3

3. Save an image of the food web with the addition of the nutria, print it, and attach it to this worksheet. If you drew the food web in the space provided, add the nutria to your drawing and show what it feeds on.

ANALYZE AND CONCLUDE

Refer to the completed food web from Part 2 to answer the following question.

4. **Construct an Explanation** How is it that an organism can be in more than one trophic level in an ecosystem? Include an example in your explanation.

An organism may be a part of more than one trophic level when it eats a variety of foods, such as plants and animals. The muskrat is a first-level consumer when eats cattails, and a second-level consumer when it eats crayfish.

Refer to the completed food web from Part 3 to answer the following question.

5. **Develop Models** Draw two food chains from the food web that involve the nutria.

Students should identify two of the following food chains; cattails → nutria; phytoplankton → freshwater snail → nutria; cattails → freshwater snail → nutria; bacteria and associated fungi → freshwater snail → nutria

6. **Analyze** How can the introduction of nutria affect a pond ecosystem food web?

Sample answer: Even though nutria consume insects and snails occasionally, they affect the food web primarily by eating huge amounts of vegetation. This leads to habitat loss for native species. They also compete with the muskrat for food.

CONNECT TO THE UNIT PROBLEM

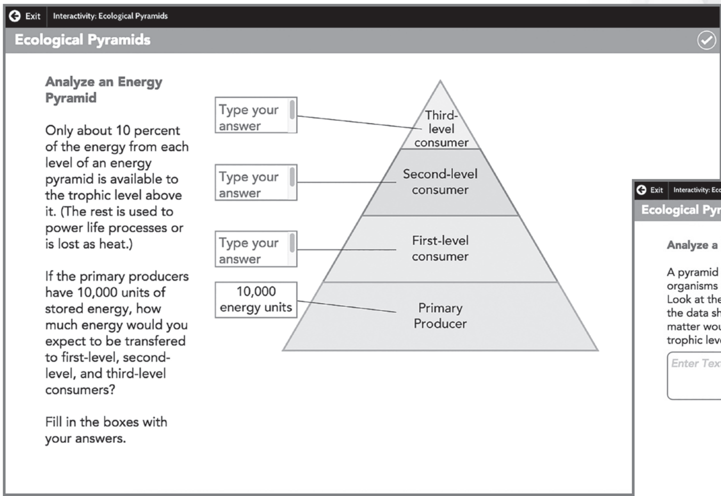
7. Think about the invasive species you chose to research in the Problem Launch. What is the role of this species in your local food web? Is it a producer? herbivore? carnivore? Find out about a few other species in your local ecosystem. Populate the chart by listing your invasive species in the first row, its food or energy source and its role in the ecosystem. Then fill out rows for four other populations in your local ecosystem. Sample answers provided.

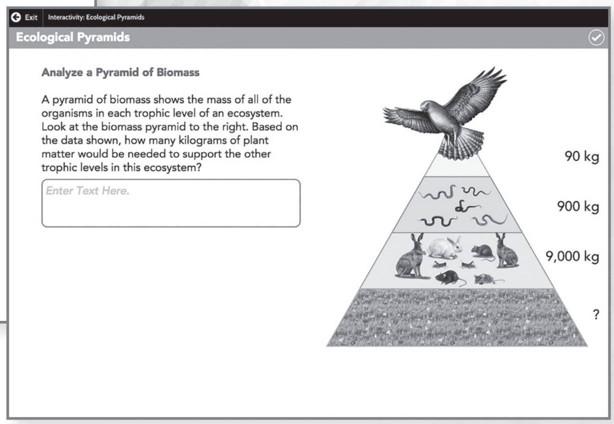
Population	Food or Energy Source	Role
Eurasian Milfoil	Sunlight	Producer
Bulrushes	Sunlight	Producer
Trout	Insects (larval stage to adult)	Carnivore
Wood duck	Duckweed, water lilies, other plants and plant parts (including fruits and nuts), insects	Omnivore
Moose	Plants (including water lilies and cattails)	Herbivore

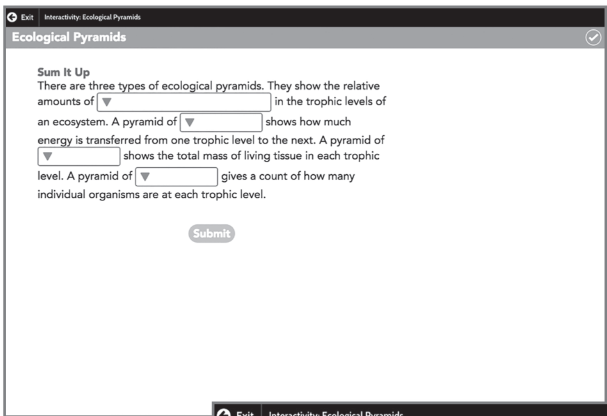
8. How might your invasive species be affecting the native species in your local food web? What resources might it be using in order to thrive?

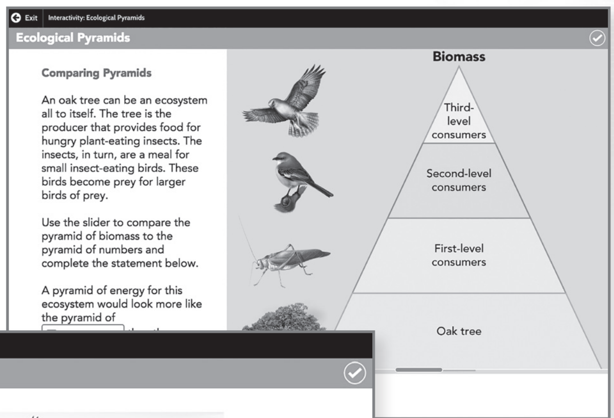
Sample answer: Eurasian milfoil is a producer that is not a significant food source for any native consumer. It uses resources such as space and sunlight and can crowd out native producers. Reducing populations of native producers may result in reduced food sources for consumers that feed on native producers.

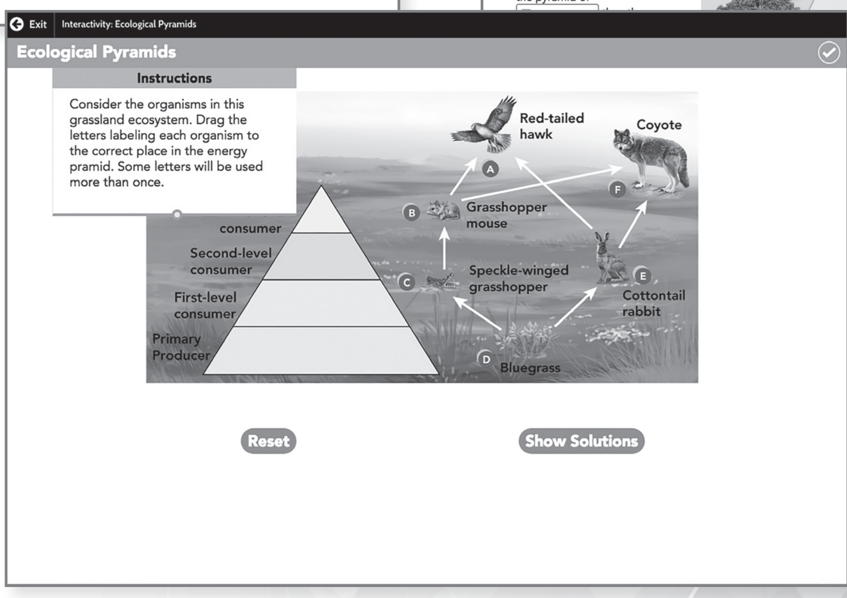
Interactivity: Ecological Pyramids







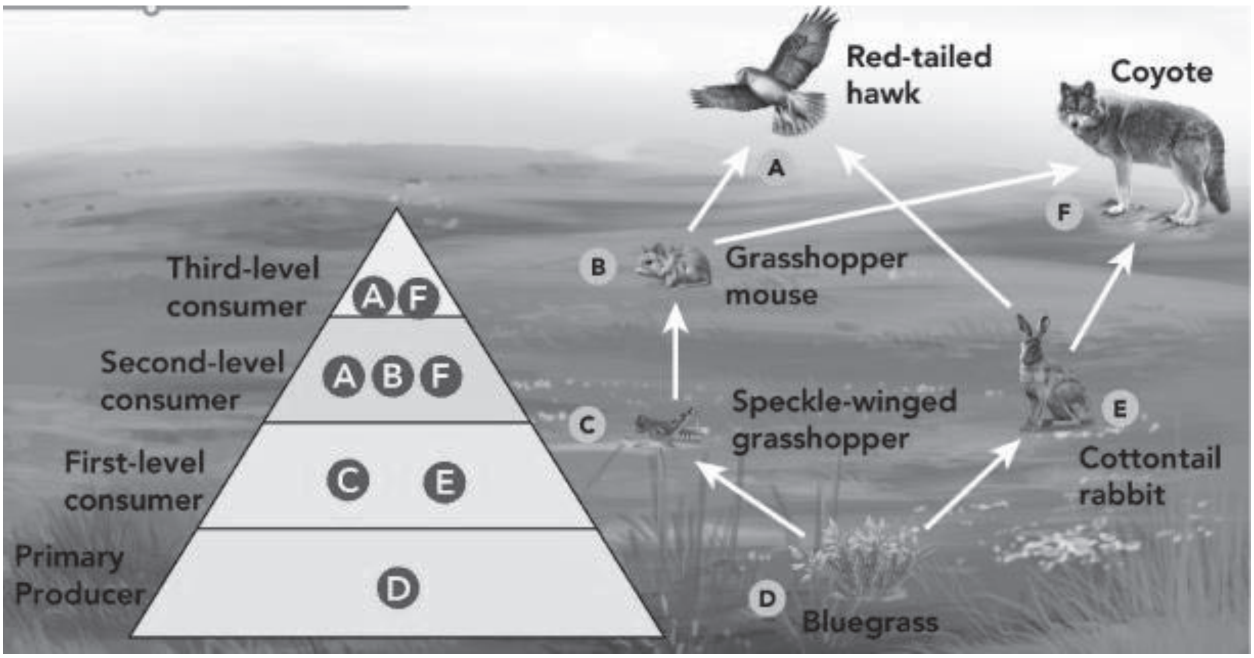




Interactivity:
Ecological Pyramids Answer key

Ecological Pyramids

Screen 1: Bluegrass (D) is a primary producer. The cottontail rabbit (E) and speckle-winged grasshopper (C) are first-level consumers. The grasshopper mouse (B), coyote (F), and red-tailed hawk (A) are second-level consumers. The coyote (F) and red-tailed hawk (A) are also third-level consumers.



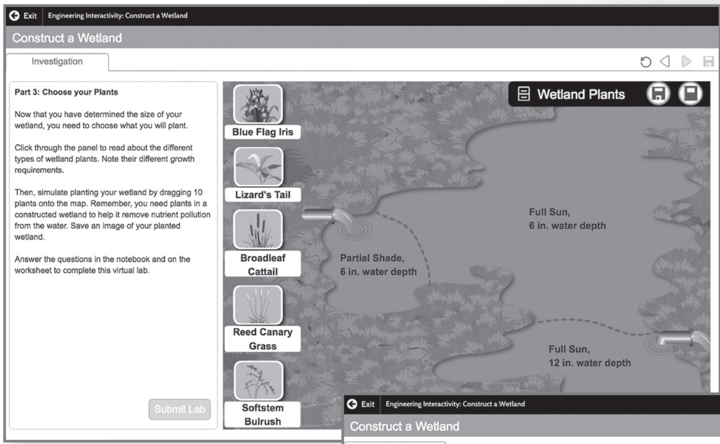
Screen 2: First level consumers: 1000 energy units; Second level consumers: 100 energy units; Third level consumers: 10 energy units

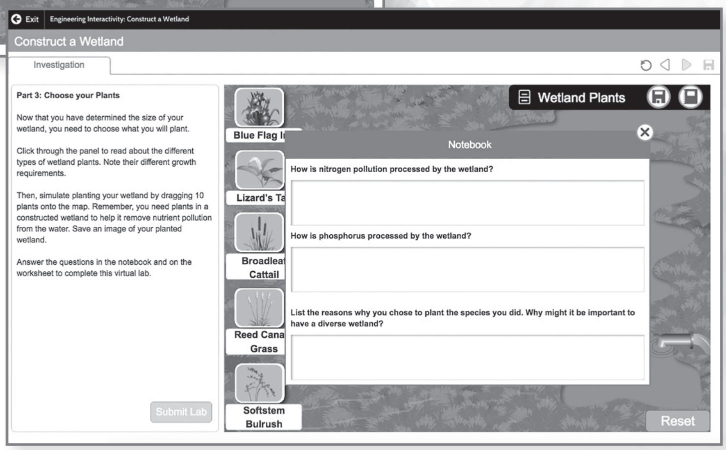
Screen 3: Answers will vary. Sample answer: 90,000 kg

Screen 4: biomass; numbers

Screen 6: energy or matter; energy ; biomass; numbers

Engineering Interactivity: Construct a Wetland


Exit
Engineering Interactivity: Construct a Wetland
Construct a Wetland
Investigation
Part 3: Choose your Plants
Now that you have determined the size of your wetland, you need to choose what you will plant.
Click through the panel to read about the different types of wetland plants. Note their different growth requirements.
Then, simulate planting your wetland by dragging 10 plants onto the map. Remember, you need plants in a constructed wetland to help it remove nutrient pollution from the water. Save an image of your planted wetland.
Answer the questions in the notebook and on the worksheet to complete this virtual lab.
Submit Lab
Blue Flag Iris
Lizard's Tail
Broadleaf Cattail
Reed Canary Grass
Softstem Bulrush
Wetland Plants
Full Sun,
6 in. water depth
Partial Shade,
6 in. water depth
Full Sun,
12 in. water depth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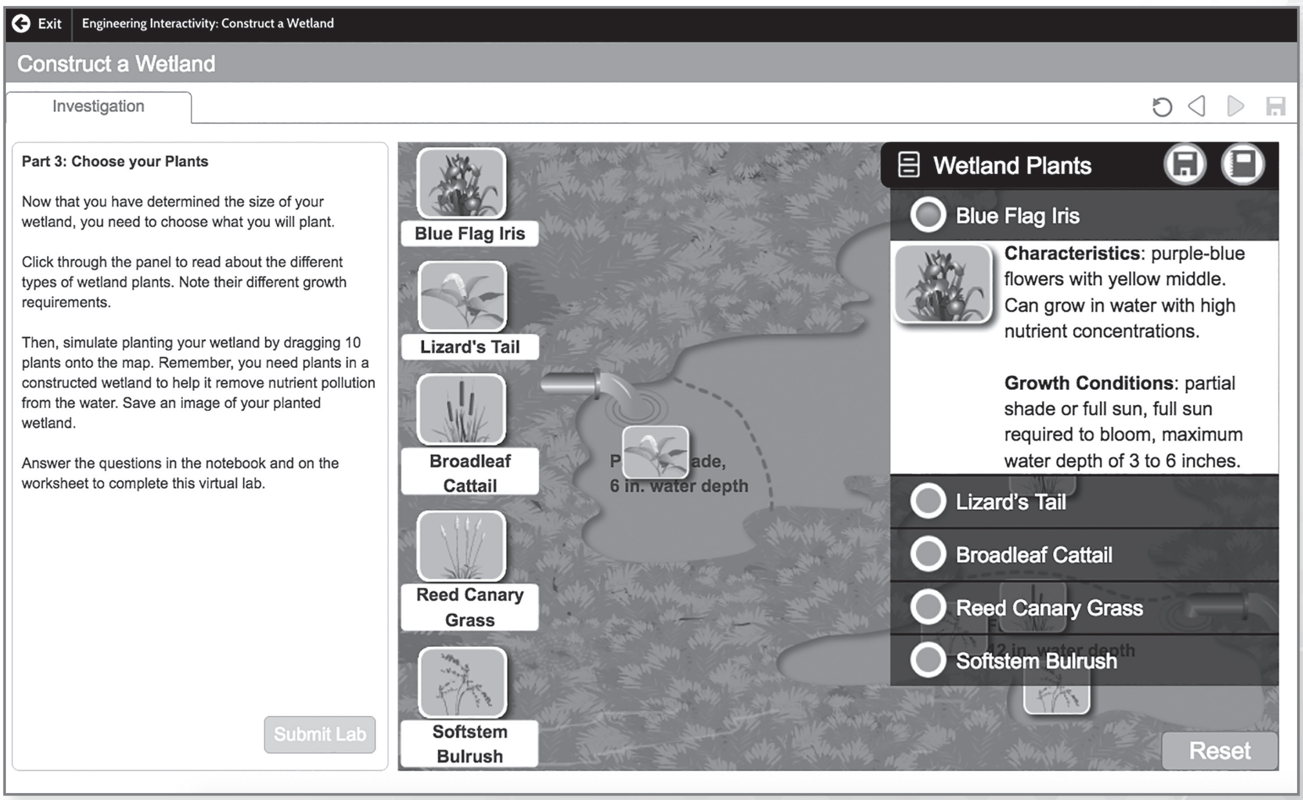
Then, simulate planting your wetland by dragging 10 plants onto the map. Remember, you need plants in a constructed wetland to help it remove nutrient pollution from the water. Save an image of your planted wetland.
Answer the questions in the notebook and on the worksheet to complete this virtual lab.
Submit Lab
Wetland Plants
Notebook
How is nitrogen pollution processed by the wetland?
How is phosphorus processed by the wetland?
List the reasons why you chose to plant the species you did. Why might it be important to have a diverse wetland?
Softstem Bulrush
Reset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Engineering Interactivity: Construct a Wetland
Construct a Wetland
Investigation
Part 3: Choose your Plants
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Click through the panel to read about the different types of wetland plants. Note their different growth requirements.
Then, simulate planting your wetland by dragging 10 plants onto the map. Remember, you need plants in a constructed wetland to help it remove nutrient pollution from the water. Save an image of your planted wetland.
Answer the questions in the notebook and on the worksheet to complete this virtual lab.
Submit Lab
Blue Flag Iris
Lizard's Tail
Broadleaf Cattail
Reed Canary Grass
Softstem Bulrush
Wetland Plants
Blue Flag Iris
Characteristics: purple-blue flowers with yellow middle. Can grow in water with high nutrient concentrations.
Growth Conditions: partial shade or full sun, full sun required to bloom, maximum water depth of 3 to 6 inches.
Lizard's Tail
Broadleaf Cattail
Reed Canary Grass
Softstem Bulrush
6 in. water depth
Reset

Name ______________________________ Class ______ Date ________

Construct a Wetland

This activity can be found in your digital course.

What is necessary for a successful wetland?

Record Data and Observations

Part 1

1. The purpose of a wetland is to decrease the impact of farm animal waste and nitrogen- and phosphorus-rich fertilizers on the nutrient cycles in water ecosystems. When constructing a wetland, what factors should farmers consider?

Part 2

2. While maintaining the required minimum of each animal, determine the maximum number of cows your farm can support within the 1-acre wetland limit. Then determine the maximum for pigs and chickens. Record how many kilograms of nitrogen are produced and the minimum size of the wetland needed. Complete the table for your farm with the number of animals you selected.

Number of Animals			Total Nitrogen (kg)	Minimum Wetland Size (acres)
Cows	Pigs	Chickens		
	5	250		
1		250		
1	5			

Name ______________________________ Class ______ Date __________

Part 3

3. List how many of each type of plant you planted in your wetland. Did you plant all five types? Why or why not?

4. Determine the best location within the wetland to plant the Blue Flag Iris. Use the information you know about this wetland plant to support your answer.

Analyze and Conclude

5. **Revise Information** Now that you have completed this activity, think about your answer to Question 1 of this worksheet. Are there other factors farmers should consider when constructing a wetland based on the information you have learned?

Engineering Interactivity: Construct a Wetland Answer Key

Construct a Wetland

This activity can be found in your digital course.

What is necessary for a successful wetland?

Record Data and Observations

Part 1

1. The purpose of a wetland is to decrease the impact of farm animal waste and nitrogen- and phosphorus-rich fertilizers on the nutrient cycles in water ecosystems. When constructing a wetland, what factors should farmers consider?

Sample answer: Farmers should consider how much farm animal waste and fertilizer runoff occurs within a given timeframe. They may also consider ways to pre-treat the water and how to dispose of large solids and plastics.

Part 2

2. While maintaining the required minimum of each animal, determine the maximum number of cows your farm can support within the 1-acre wetland limit. Then determine the maximum for pigs and chickens. Record how many kilograms of nitrogen are produced and the minimum size of the wetland needed. Complete the table for your farm with the number of animals you selected.

Number of Animals			Total Nitrogen (kg)	Minimum Wetland Size (acres)
Cows	Pigs	Chickens		
16	**5**	**250**	3.67	0.9175
1	70	**250**	3.982	0.9955
1	**5**	2000	3.624	0.906

Answers will vary for individual student's farms.

Part 3

3. List how many of each type of plant you planted in your wetland. Did you plant all five types? Why or why not?

Sample answer: I planted 2 blue flag irises, 3 lizard's tails, 2 broadleaf cattails, 2 reed canary grasses, and 1 softstem bulrush. I planted a variety of vegetation because different wetland plants grow better in different depths of water, and with different amounts of sunlight. My wetland has areas with different water depths and sun exposure, so I planted them with plants that grow well in these areas.

4. Determine the best location within the wetland to plant the Blue Flag Iris. Use the information you know about this wetland plant to support your answer.

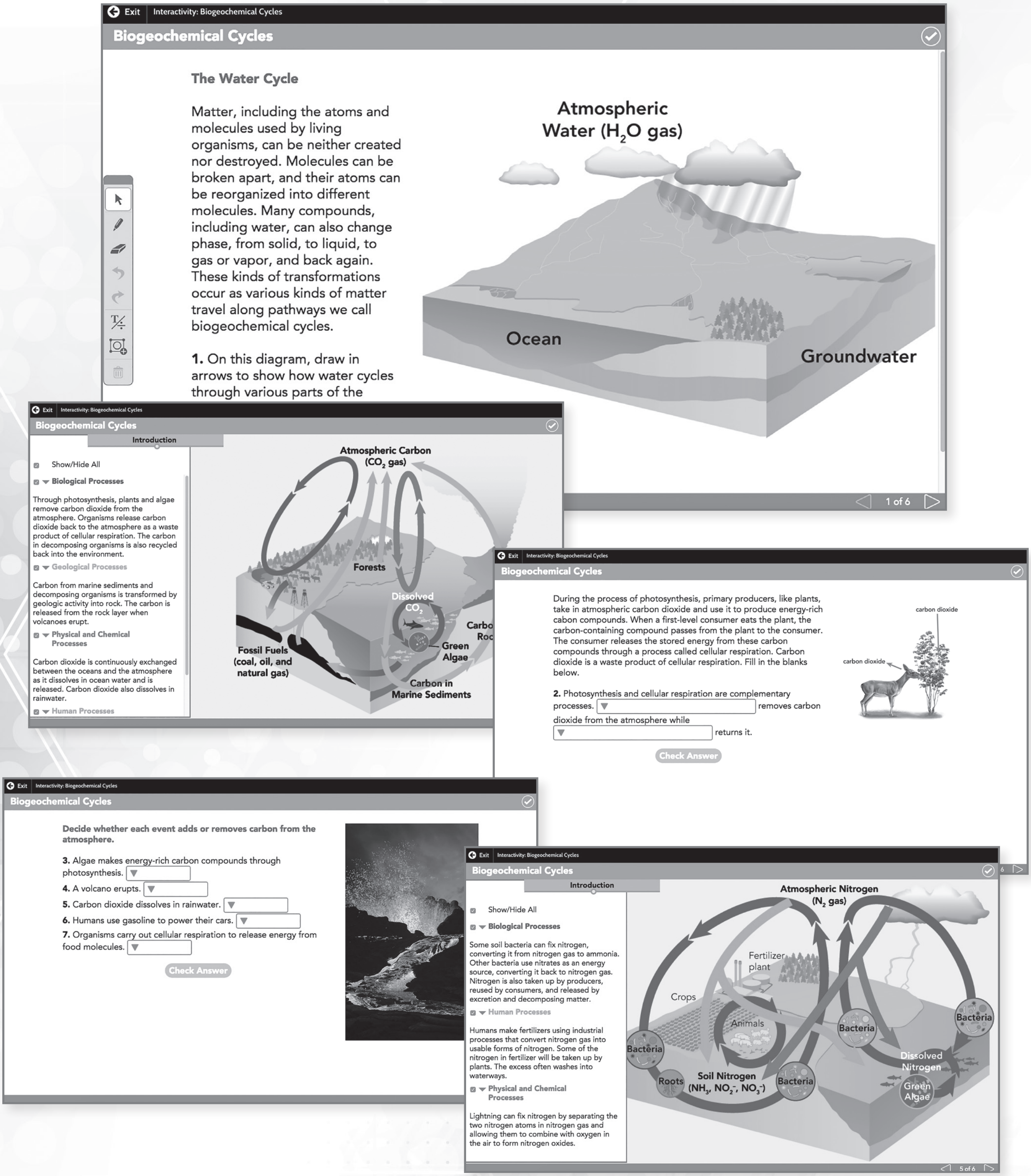
Sample answer: Blue Flag Iris grows in relatively shallow water (3 to 6 inches) and can grow in either full sunlight or partial shade. But, it needs full sun to bloom, so I would plant it in the area with full sun and a 6 in water depth.

Analyze and Conclude

5. **Revise Information** Now that you have completed this activity, think about your answer to Question 1 of this worksheet. Are there other factors farmers should consider when constructing a wetland based on the information you have learned?

Sample answer: Farmers should consider how the animals they raise affects the wetland they construct. The number of animals the farmer raises affects the size of the wetland needed to convert excess nitrogen. The farmer should also carefully consider what type of wetland plants to plant. Plants that grow aggressively might outcompete plants that are more effective for removing nitrogen.

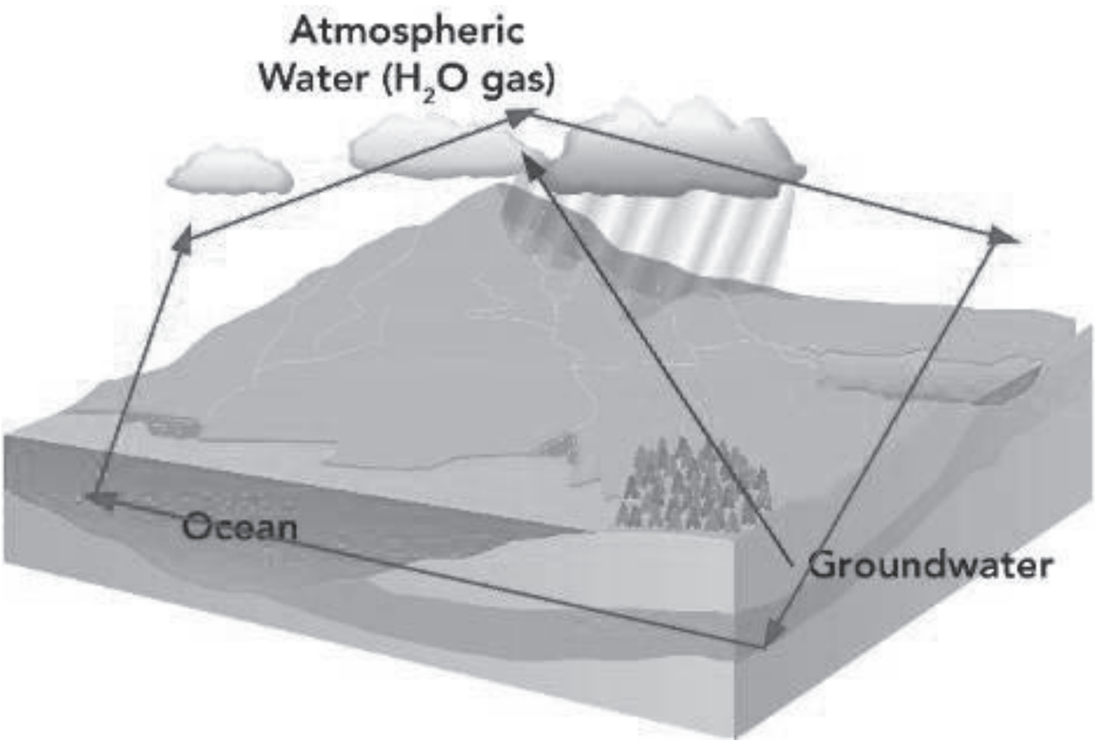
Interactivity: Biogeochemical Cycles



Interactivity: Biogeochemical Cycles Answer Key

Biogeochemical Cycles

Screen 1 #1: Answers will vary. Sample answer:



Screen 3 #2: photosynthesis; cellular respiration

Screen 4 #3: Removes **#4:** Adds **#5:** Removes **#6:** Adds **#7:** Adds

Screen 6 #1: fertilizer**.** **#2:** bacteria. **#3:** atmosphere.

Labster Virtual Labs

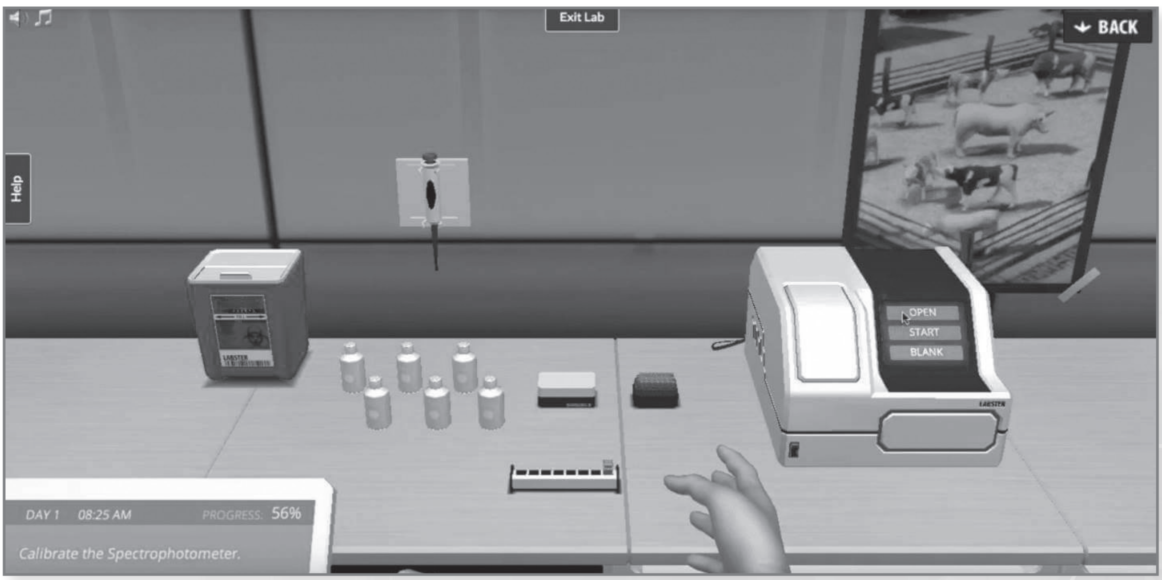
In the Eutrophication lab, students take the role as an environmental investigator whose mission is to solve a massive fish kill mystery.

Help the suffering fish

In the Marine Biology lab, students discovered that the fish were dying of suffocation, and now they want to know more about what caused the low dissolved oxygen levels.
In the Eutrophication lab, students will use microscopy to analyze the biological matter in the water and spectrophotometry to study dissolved nitrogen levels. This will give them the data they need to conclude their investigation.

Analyze water samples

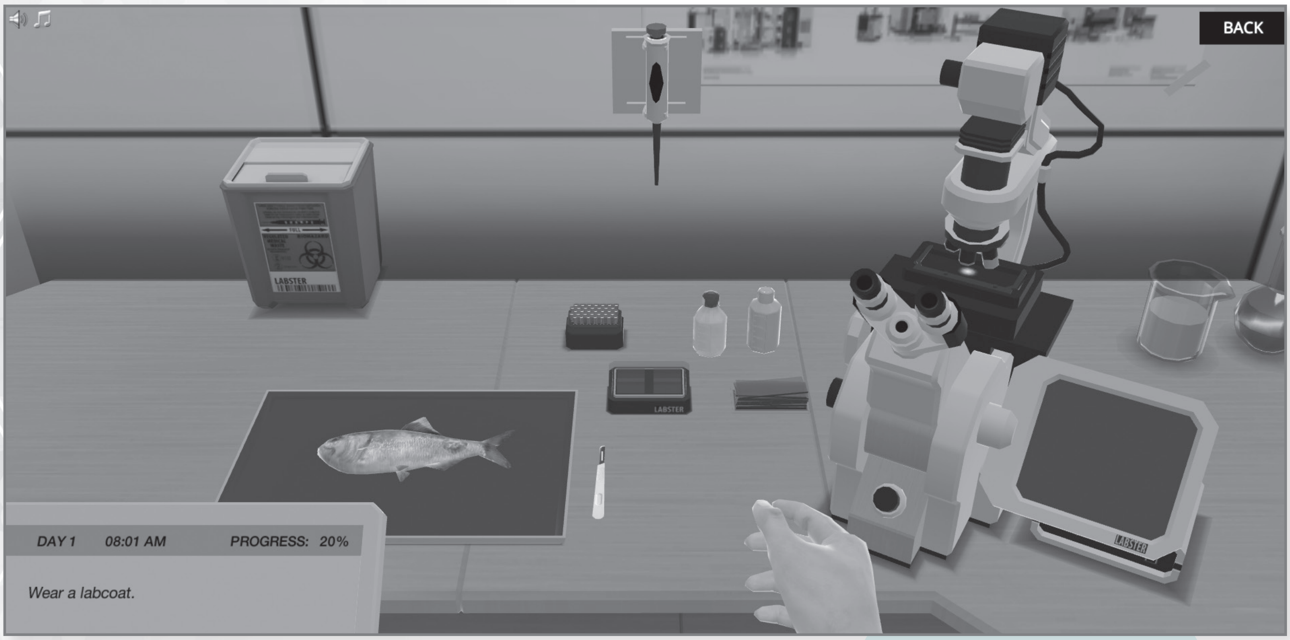
In the Marine Biology Lab students discovered that the low oxygen in the water was causing the fish to suffocate. Looking for more data, they will now analyze the water sample using the microscope. In this way students can study the biological matter in the water to find out if the algae could have something to do with the low oxygen levels.

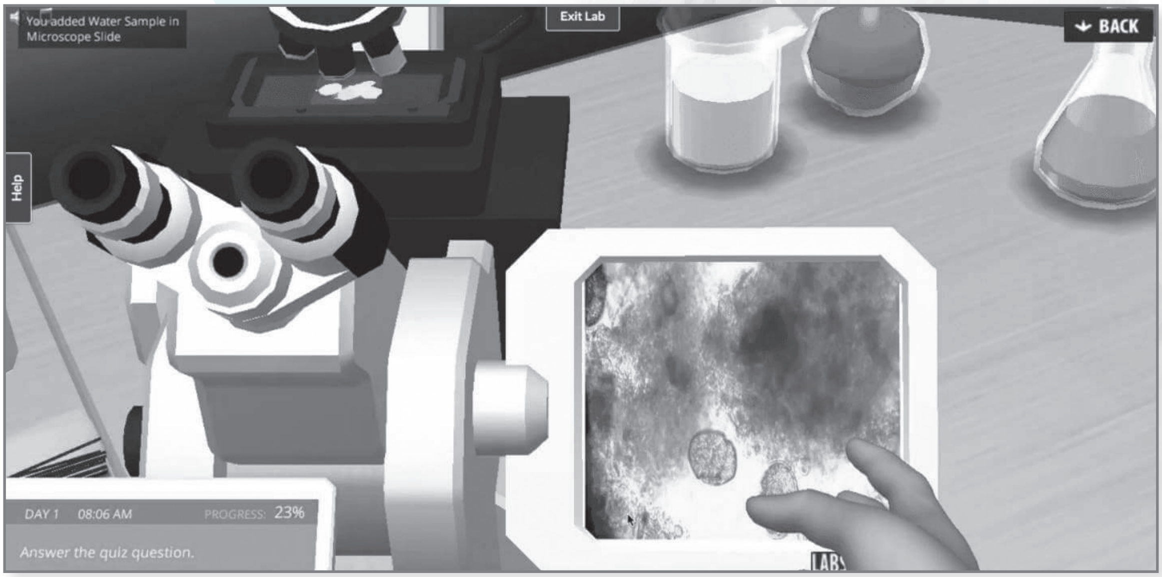


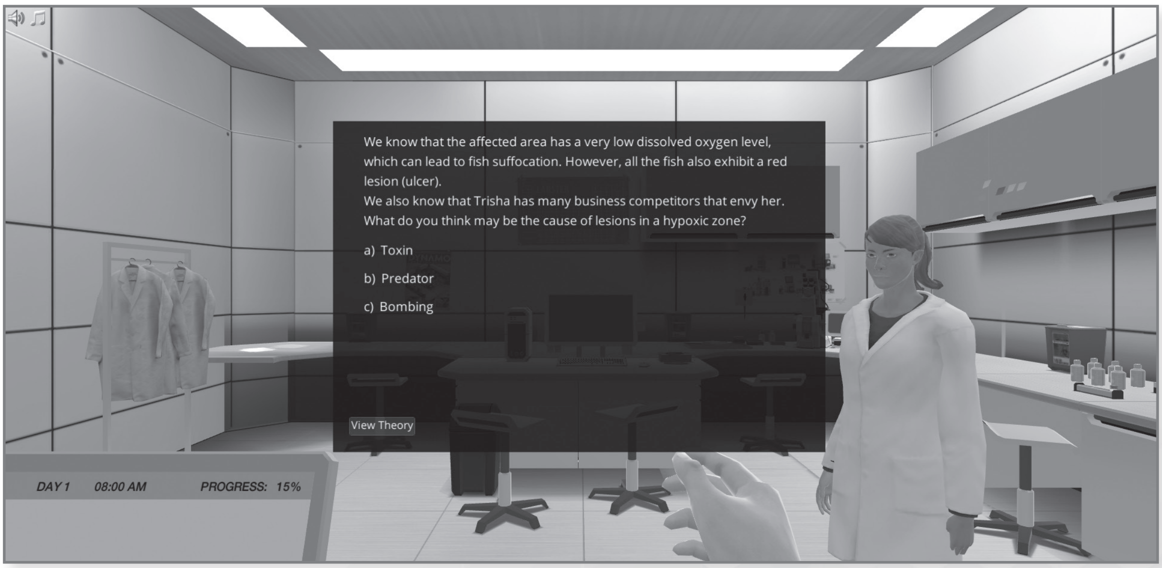
Determine the source of the algal bloom

In the Eutrophication lab, students will learn about the nitrogen cycle and how human activity can influence it. They will analyze nitrogen content in the water sample using spectrophotometry. An interactive map will help them determine the source of the excessive nitrogen run-off that caused the harmful algal bloom.

Will your students be able to solve the fish kill mystery?




You added Water Sample in Microscope Slide
Exit Lab
BACK
Help
DAY 1 08:06 AM PROGRESS: 23%
Answer the quiz question.


We know that the affected area has a very low dissolved oxygen level, which can lead to fish suffocation. However, all the fish also exhibit a red lesion (ulcer).
We also know that Trisha has many business competitors that envy her.
What do you think may be the cause of lesions in a hypoxic zone?
a) Toxin
b) Predator
c) Bombing
View Theory
DAY 1 08:00 AM PROGRESS: 15%

Miller & Levine Biology

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Promote Understanding

Inspire Learning

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- Student Edition eText
- Digital Explorer's Journal Problem-Based Learning Workbook
- Biology Foundations: Reading and Study Guide Workbook
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