

Plan Your Own Investigation 1-A

Skill Check

- ✓ Initiating and Planning
- ✓ Performing and Recording
- ✓ Analyzing and Interpreting
- ✓ Communicating

Safety Precautions



- To avoid skin irritation, use rubber gloves when handling the fertilizer.
- Follow your teacher's directions when disposing of the fertilizer.
- Clean any spills immediately, and inform your teacher.

Suggested Materials

- balance
- scoop
- 50 mL graduated cylinder
- small funnel
- five 250 mL beakers
- liquid fertilizer that contains nitrogen and phosphorus
- algae culture
- distilled water
- adhesive labels
- marker



Algae need light to grow. Put your beakers in a sunny place.

Fertilizers and Algae Growth

Fertilizers in run-off from agriculture can add extra nutrients to aquatic ecosystems. In this investigation, you will model what happens when fertilizer in run-off enters aquatic ecosystems.

Question

How does fertilizer affect algae growth?

Plan and Conduct

1. Brainstorm how you could test the effects of fertilizer on algae growth.
2. Determine what your independent variable will be. What will your dependent variable be? Will you have a control group?
3. Make a table for recording your data. How often will you make observations?
4. Ask your teacher to approve your investigation procedure, data table, and safety precautions.
5. Carry out your investigation.

Analyze and Interpret

1. What was your independent variable? What was your dependent variable?
2. Describe the changes you observed in the dependent variable, and propose an explanation.

Conclude and Communicate

3. Suppose that a large quantity of fertilizer was added to a lake ecosystem. Suggest what might happen to the populations of
 - a. producers
 - b. consumers
 - c. decomposers
4. Think about the tools, techniques, and processes that you used to gather evidence. What improvements could you make?

Extend Your Inquiry and Research Skills

5. **Research** Most fertilizers are described by three numbers, which give the ratio of nitrogen (N) to phosphorus (P) to potassium (K). Research why potassium is added to fertilizers.

Inquiry Investigation 1-B

Skill Check

Initiating and Planning

- ✓ Performing and Recording
- ✓ Analyzing and Interpreting
- ✓ Communicating

Safety Precautions



- Follow your teacher's directions for safe conduct.
- Wear appropriate safety equipment in the laboratory.
- Never taste or eat any materials in the laboratory.
- Clean any spills immediately.

Materials

- 250 mL beaker
- water
- bromothymol solution
- drinking straw
- 2 test tubes with stoppers
- test-tube rack
- 2 freshwater plant sprigs (*Elodea* or a similar species)
- black paper
- masking tape

Science Skills

Go to Science Skills Toolkit 11 for information about conducting research.



The Chemistry of Photosynthesis

You have already read that plants take in carbon dioxide from the atmosphere for the process of photosynthesis. Unfortunately, the gas exchange between a plant and the surrounding air is not something you can observe by just looking at a plant. When carbon dioxide gas dissolves in water, however, it forms a weak solution of carbonic acid. You can measure the acidity of the water using a chemical indicator, such as bromothymol blue, whose colour is dependent on acidity.

Question

How can you demonstrate that plants absorb carbon dioxide?



The contents of both test tubes are the same. What variable does the black paper control?

Procedure

1. Fill the beaker with 200 mL of water. Then add three drops of bromothymol blue. This indicator is blue when the pH of a solution is 7 or higher (basic) and yellow when the pH of a solution is less than 7 (acidic).
2. Use the drinking straw to gently blow into the solution until the indicator changes colour. CAUTION: Ensure that you blow gently and are wearing safety goggles.
3. Pour the solution into two test tubes until the test tubes are three quarters full.
4. Add a sprig of the plant to each test tube. Seal each test tube with a stopper.
5. Tape a piece of black paper around one of the test tubes so that no light can enter.
6. Place both test tubes back in the test-tube rack. Place the test-tube rack in bright sunlight for several hours.
7. Remove the paper from the test tube. Record your observations of both test tubes.

Analyze and Interpret

1. What gas did you add to the solution using the straw?
2. Why did this gas produce a colour change in the indicator?
3. Describe what colour change you observed in each test tube.
4. Explain your observations, with reference to the equation for photosynthesis in Section 1.2.

Conclude and Communicate

5. Did this investigation have a control? If so, identify the control. If not, suggest what control you would set up, and explain why.
6. How does this investigation demonstrate the stages of the carbon cycle? To answer, make a simple sketch that shows the flow of carbon you observed.

Extend Your Inquiry and Research Skills

7. **Inquiry** Think of another question you would like to investigate about photosynthesis. How would you design an experiment to help you find the answer?
8. **Research** Write a brief report about the contributions of one of the following scientists to our understanding of photosynthesis:
 - Jan Baptista van Helmont (1577–1644)
 - Jan Ingenhousz (1730–1799)
 - Joseph Priestley (1733–1804)
 - Jean Senebier (1742–1809)
 - Nicolas de Saussure (1767–1845)
 - Julius von Sachs (1832–1897)

Inquiry Investigation 1-C

Skill Check

- ✓ Initiating and Planning
- ✓ Performing and Recording
- ✓ Analyzing and Interpreting
- ✓ Communicating

Safety Precautions



- You will be working with liquids of different acidities. Avoid getting these liquids on your skin and clothing.
- If you spill a liquid on your skin or clothing, rinse with plenty of water.
- Inform your teacher of any spills, and follow his or her directions for safe clean-up.

Materials

- 5 small plastic or paper cups
- pencil
- marker
- tray
- potting soil
- seeds (such as beans, radish, or Brassica)
- 50 mL graduated cylinder
- 5 stoppered Erlenmeyer flasks, containing solutions with pH levels of 3, 4, 5, 6, and 7
- ruler
- grow light (optional)

Math Skills

Go to Math Skills Toolkit 3 for information about constructing graphs.



Soil-water Acidity and Plant Growth

Certain types of air pollution can make rainwater more acidic. Rainwater is absorbed into the ground and the soil, and then taken up by plants. In this investigation, you will compare plant growth in soils that have absorbed water of different acidity levels. Remember that the lower the pH, the higher the acidity is.

Question

How does the acidity of rainwater influence the fertility of soil?

Hypothesis

Make a hypothesis about how the plants will respond to increasing levels of acidity in the soil and water.



How are plants affected by acid rain?

Procedure

1. With a pencil tip, poke a hole in the bottom of each cup for drainage.
2. Label each cup with your name(s) and the level of pH (pH 3, pH 4, pH 5, pH 6, pH 7, respectively).
3. Place the cups on the tray.
4. Add soil to each cup until the cup is three quarters full.
5. Place a bean, or another seed, about 3 cm below the surface of the soil in each cup. Cover the seed with soil.
6. Using the graduated cylinder, water the seed in each numbered cup with 10 mL of water from the Erlenmeyer flask with the matching pH number. Be sure to rinse the graduated cylinder after you water each seed.

7. Place the tray in the sunlight or under a grow light, if possible.
8. Water each seed daily with 10 mL of water if the tray is in the sunlight or under a grow light. Otherwise, use 5 mL of water per day. Pour the water directly into the soil, not on any leaves.
9. Make a table like the one shown below. Give your table a title.

Day	Water pH	Plant Height (cm)	Number of Leaves	Leaf Colour
Day 1	pH 3			
	pH 4			
	pH 5			
	pH 6			
	pH 7			
Day 2	pH 3			
	pH 4			
	pH 5			
	pH 6			
	pH 7			

10. Make and record your observations about the height of each plant, the number of leaves, and the leaf colour every day for two weeks.

Analyze and Interpret

1. Construct and plot a graph for each plant with “Time (days)” on the x -axis and “Plant Height (cm)” on the y -axis.
2. Which pH level supported the greatest rate of growth? Which pH level produced the least growth?

Conclude and Communicate

3. Based on your analysis, write a general statement about the effect of rainwater pH on the soils in which plants are growing.
4. Was your hypothesis supported by your results? Explain why or why not.

Extend Your Inquiry and Research Skills

5. **Inquiry** How acidic is the rain in your area? Design an investigation in which you use pH paper and clean containers to test the rainwater in your area and compare it with rainwater in other parts of the province.
6. **Inquiry** The effects of acid precipitation on soil pH vary with the type of underlying bedrock. Design an investigation to identify the types of rock that are good at neutralizing acidic conditions.

Plan Your Own Investigation 1-D

Skill Check

- ✓ Initiating and Planning
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Safety Precautions



- To avoid skin irritation, use rubber gloves when handling the fertilizer.
- Follow your teacher's directions when disposing of fertilizers.
- Clean any spills immediately, and inform your teacher.

Suggested Materials

- green pea seeds
- large cups
- soil
- garden trowel
- marker
- water
- fertilizer that contains nitrogen
- soil test kits for nitrogen



Fertilizer is beneficial to plants, but how much is too much?

Can a Plant Have Too Much Fertilizer?

A fertilizer can include a human-made chemical or compost from animals and other organic wastes. If a small amount of fertilizer produces healthy plants with a lot of tomatoes, will a lot of fertilizer produce larger plants with more or larger tomatoes? Can a plant have too much fertilizer? In this investigation, you will monitor the effects of fertilizer and the nitrogen content of soil on the growth of plants.

Hypothesis

Make a hypothesis about how the pea plants will respond to different amounts of fertilizer.

Plan and Conduct

1. Brainstorm how you could test the effects of fertilizer on plant growth. Write a question to focus your investigation.
2. Determine what your independent variable will be. What will your dependent variable be? Will you have a control group? How will you measure the effects of the fertilizer?
3. Make a table for recording your data. How often will you make observations?
4. Ask your teacher to approve your investigation procedure, data table, and safety precautions.
5. Carry out your investigation.

Analyze and Interpret

1. From your observations, write a general statement about the effects of fertilizer on pea plant growth.

Conclude and Communicate

2. Why is it important to know how much fertilizer to add to a garden or an agricultural field?
3. Suppose that a large quantity of fertilizer was added to an agricultural field. How might the run-off affect trees in a nearby forest?

Extend Your Inquiry and Research Skills

4. **Inquiry** Design an experiment to test how the addition of compost to the soil affects plant growth. How could you test the effectiveness of compost made from different sources, such as animal manure, grass clippings and leaves, and leftover food?

Chapter 1 Summary

1.1 Sustainability

Key Concepts

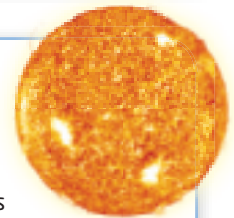
- Sustainable ecosystems endure, and they sustain the organisms that live within them.
- Matter, including nutrients such as nitrogen, are constantly moving through Earth's spheres.
- Human activities that increase the influx of nutrients into a terrestrial or aquatic ecosystem can upset the nutrient balance in the ecosystem.
- Decisions and actions that are taken to protect the health of ecosystems may involve international agreements and court decisions.



1.2 The Biosphere and Energy

Key Concepts

- The biosphere relies on a constant stream of solar energy.
- Chlorophyll in primary producers converts solar energy to chemical energy through photosynthesis.
- Most of the stored energy in one trophic level does not move to the next trophic level.
- Bioaccumulation and biomagnification can result in unhealthy levels of pollutants in organisms.



1.3 Extracting Energy from Biomass

Key Concepts

- Organisms use cellular respiration and fermentation to extract the energy stored in the glucose produced by photosynthesis.
- Burning fossil fuels has dramatically increased the concentration of carbon dioxide, a greenhouse gas, in the atmosphere.
- Acid precipitation is caused by burning fossil fuels. It can have negative effects on terrestrial and aquatic ecosystems.
- Increased awareness and improved technology have led to a decrease in acid precipitation since the 1980s.



Chapter 1 Review

Make Your Own Summary

Summarize the key concepts of this chapter using a graphic organizer. The Chapter Summary on the previous page will help you identify the key concepts. Refer to Study Toolkit 4 on pages 566-567 to help you decide which graphic organizer to use.

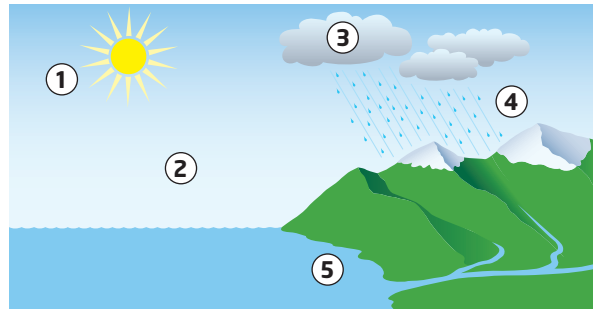
Reviewing Key Terms

1. The regions of Earth where living organisms exist is called the . (1.1)
2. is a process in which nutrient levels in aquatic ecosystems increase, leading to an increase in the populations of primary producers. (1.1)
3. An includes all the interacting parts of a biological community and its environment. (1.1)
4. The chemical reaction that changes solar energy into chemical energy is . (1.2)
5. A category of living things that is defined by how they gain energy is called a . (1.2)
6. is a process that derives energy from organic molecules in the presence of oxygen (1.3)
7. The warming of Earth caused by greenhouse gases trapping some of the energy that would otherwise leave Earth is called the . (1.3)

Knowledge and Understanding **K/U**

8. Explain the meaning of the word “ecosystem.”
9. Sustainable ecosystems “endure and support.” Clarify what this means.
10. Explain why keeping aquatic ecosystems sustainable is important to organisms that live in terrestrial ecosystems.
11. What organisms are considered primary producers? What important function do they perform in the biosphere?

12. Copy the following diagram into your notebook. Use arrows to indicate the direction of the movement of water in the diagram. Then identify and explain the process that occurs at each numbered step.



13. What is one possible cause of the increase in carbon dioxide in the atmosphere since the mid-19th century?
14. Explain the connection between fossil fuels and photosynthesis.
15. Identify the key difference between cellular respiration and fermentation.
16. Greenhouse gases are in Earth’s atmosphere.
 - a. List three examples of greenhouse gases.
 - b. How have greenhouse gases affected the biosphere?
17. Countries around the world are monitoring carbon dioxide emissions.
 - a. What is the Kyoto Protocol?
 - b. How can countries reduce the amount of carbon dioxide that they are releasing into the atmosphere?

Thinking and Investigation **T/I**

18. Research information about a local landfill site. Find the answers to the following questions:
 - a. Is methane extracted at this landfill site?
 - b. Is this landfill site working on a plan to conform with the Ontario legislation to collect methane gas?
 - c. Does this landfill site have a plan to use the collected methane?

- d. Although the methane can be simply burned off, the Ontario legislation requires landfills to collect methane. Why?
19. Make a list of the ways in which you use fossils fuels (directly or indirectly) in a typical day. Consider which two events or activities would be easiest for you to change to reduce your consumption of fossil fuels.
20. Canada has made progress in reducing its emissions of sulfur dioxide and nitrogen oxides, the two substances that acidify precipitation. What are some contributions that individuals can make to reduce these emissions?

Communication C

21. **BIG IDEAS** Ecosystems are dynamic and have the ability to respond to change, within limits, while maintaining their ecological balance. Draw a diagram to show what happens to excess nitrogen in an ecosystem. Label the pathway of nitrogen from its gas form in the atmosphere, to the lithosphere, and back to the atmosphere again. Identify clearly on your diagram some human factors that could alter the balance in this pathway. Show and explain, why, within limits, excess nitrogen does not upset the balance of that ecosystem.
22. **BIG IDEAS** People have the responsibility to regulate their impact on the sustainability of ecosystems in order to preserve them for future generations. Write an e-mail to a friend, explaining why it is important for governments to protect areas of existing forest.
23. Suppose that you are a science teacher. Your class of Grade 5 students is studying trophic levels. Prepare an explanation that will help the students identify the trophic level of each organism in the following food chain in an aquatic ecosystem:
Zooplankton are microscopic animals that eat phytoplankton. Zooplankton are eaten by crabs. Sea otters eat crabs.

24. Draw a diagram that represents the position and interaction of Earth's four spheres (lithosphere, hydrosphere, atmosphere, and biosphere).
25. Copy the following table into your notebook. Complete the table to compare photosynthesis and cellular respiration.

Reaction	Photosynthesis	Cellular respiration
Organism in Which Reaction Occurs		
Reactants		
Products		
Is Energy Absorbed or Released?		

26. In the past, one response to concerns about industrial pollution was to build taller smokestacks, so that pollution from the burning fossil fuels was released higher into the atmosphere. Write two or three sentences that make an argument against building taller smokestacks at industrial sites as a long-term solution to pollution.
27. Write a short paragraph that explains the difference between the greenhouse effect and the enhanced greenhouse effect.

Application A

28. Describe a sample scenario to explain how an animal living hundreds of kilometres from an area sprayed with DDT might get DDT in its body.
29. DDT is stored in the body fat of organisms and remains toxic for many years. Explain why these two characteristics are undesirable in a pesticide. What characteristics would you want in a pesticide to make it less harmful to non-pest organisms?
30. If you eat a plate of rice with vegetables for lunch, at what trophic level are you? If you eat a hamburger for lunch, at what trophic level are you? Explain.