Plan Your Own Investigation 1-A

Skill Check

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

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?

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.

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**

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?

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 12** for information about conducting research.

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

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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.

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.

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

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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.

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 trawl
- marker
- water
- fertilizer that contains nitrogen
- soil test kits for nitrogen

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

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?