Hypotheses

It takes many skills to design and carry out good scientific experiments. The scientific method involves asking a good question, making a hypothesis, conducting research, identifying and controlling variables, making observations during testing, collecting data, and drawing conclusions. Using data sheets, diagrams, and graphs helps you organize and present your results. These skills help make your experiments reliable, repeatable, and meaningful.

Purpose

To write a testable hypothesis, to compare the hypothesis with the results, and to write a new hypothesis, based on the results.

Process Skills

Observe, measure, collect data, interpret data, communicate, form a hypothesis, draw conclusions

Background

When scientists conduct an **experiment**, they often follow the **scientific method**. The scientific method begins with a **research question** and a **hypothesis**. Hypotheses are statements that **predict** an outcome and provide an explanation for an experiment, based on prior knowledge and research. Hypotheses are often written using an "if . . . then . . . because" format. A hypothesis provides an answer to the research question and must be **testable**.

Scientists test a hypothesis by running experiments and making **observations**. Then they **analyze** the results, or **data**. After all these steps, they can draw a **conclusion**. The conclusion is an explanation of whether or not the results supported the hypothesis. In this activity, you will practice writing a hypothesis for a simple test using gummy candies. After the experiment, you will decide if the results supported your hypothesis. Then you will write a new hypothesis, based on your results.

Time – Part 1: 20 minutes; Part 2: 20 minutes

Grouping – Small groups

Materials
(per group)

- ❑ gummy candies in five colors: clear, yellow, orange, red, green
- ❑ 5 condiment cups
- ❑ water
- ❑ plastic spoon
- ❑ paper plate
- ❑ paper towels
- ❑ ruler with cm and mm markings
- ❑ Data Sheets 1 and 2 (one set per student)

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Procedure

In most experiments, you will focus on the science ideas you are testing. But in this experiment, you will mainly focus on the hypothesis. The important steps will be writing a hypothesis, judging whether or not your hypothesis is supported by the results of the experiment, and considering new hypotheses for future testing. The boxes below provide background information to help you write a hypothesis.

Background Research:
Three primary ingredients in gummy candy are sugar, gelatin, and food coloring.

Research Question: Will gummy candies of different colors change size if left in water for one day?

Elements of a good hypothesis: is written as a statement, makes a prediction, is testable, provides an explanation, fits with existing observations

Part 1: Write a Hypothesis and Conduct the Experiment

1. Read the information in the boxes above. With your group, discuss what you think will happen to a gummy candy if it is left in water for one day. Will the gummy candy get bigger or smaller? Will it dissolve? After deciding what you think will happen, discuss why you think it will happen.
2. Write your hypothesis. On Data Sheet 1, complete the "if . . . then . . . because" statement.
3. Measure the length of each of your gummy candies before placing them in water. Choose the longest length of each candy, which may be top to bottom or side to side. Record your measurements in the table on Data Sheet 1. [**NOTE:** Do not eat the gummy candies, as these are research subjects and will be handled by multiple people.]
4. Place one gummy candy of each color into the condiment cups. Fill each cup to the top with water.
5. After one day, carefully remove your gummy candies from their cups using a plastic spoon. Place them on a paper plate. Measure each gummy candy the same way as in Step 3, and record your measurements on Data Sheet 1. Record any additional observations at the bottom of Data Sheet 1, including whether or not you observed differences between the various colors of gummy candies.
6. Clean up your work area. Keep Data Sheet 1 as a reference to use during *Part 2: Reflection.*

Part 2: Reflection

With your group, use Data Sheet 2 to reflect on your hypothesis and consider a new hypothesis for a future experiment. Use the questions and tips in the table as a guide.

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Name_____ Date_____

Part 1: Write a Hypothesis and Conduct the Experiment

Research Question: Will gummy candies of different colors change size if left in water for one day?

Hypothesis:

If _____

then _____

because _____

Collect Data

Gummy candy color	Length before placing in water (cm)	Length after one day in water (cm)
 clear		
yellow 		
 orange		
red 		
 green		

Observations: Write about what you observed after the gummy candies were left in water for one day, including any differences you observed among the various colors.

_____

_____

_____

_____

_____

Name_____ Date_____

Part 2: Reflection

Using the information from Data Sheet 1, work with your group to complete each of the parts below.

Summary of experiment: What is the answer to the research question? Explain.
Compare results to hypothesis: Did the results support the hypothesis? Explain why or why not. (Review the hypothesis and compare it to the results.)
New research question: List one idea for a future experiment related to this one that you would like to try.
New hypothesis: Using the "if . . . then . . . because" format, make a new hypothesis for the new question you just wrote.

Name_____ Date_____

Critical Thinking

1. What is a hypothesis?

2. Why is it important to include a "because" statement when making a hypothesis?

3. Do the results of an experiment have to match the hypothesis? Why or why not?

4. Why is it useful to know how to make hypotheses? Think about careers that require this skill.

Hypotheses

TEACHING TIPS

This process activity will help students learn how to write a hypothesis using the "if . . . then . . . because" format. After formulating a good research question, writing a hypothesis is the next step in the scientific method. A hypothesis is a testable statement that predicts the outcome of an experiment and provides an explanation for why the prediction is expected. It is based on background research and prior knowledge. In this activity, students will write a hypothesis, conduct an experiment, and compare their results with their hypothesis. They will also write a research question for future study and compose a hypothesis to go with it. In the process, students may come to understand the importance of making a hypothesis as an essential step in scientific research.

SET-UP AND PROCEDURES

- Throughout the activity, keep students focused on the skill of making and reflecting on a hypothesis, even though the subject of dissolving candies may be interesting to them.
- Review with students the components of a good hypothesis. Have students read the *Quick Read What Is a Hypothesis?* found in the Hypotheses unit.
- To ensure that Part 2 will be successful and valuable, review students' hypotheses from Part 1 before allowing groups to proceed to testing. Be sure their hypotheses contain the elements of a good hypothesis described in the Procedure section.
- While scientists do not always use the "if . . . then . . . because" format, using this structure will help students understand the two key components of a hypothesis.
- It is not necessary to collect data exactly 24 hours later. However, waiting for more than one day will likely cause the gummy candies to absorb so much water that they will break apart on contact, making measurement almost impossible.
- Consider assigning jobs for each student within a cooperative group prior to the activity. Examples include getter, measurer, reporter, and cleaner.

MATERIALS

- Use room temperature or cold water. Using hot water in the cups will significantly alter the results of the experiment and cause the gummy candies to dissolve.
- If condiment cups are not available, paper cups can be used instead.
- Have plenty of towels on hand in case of spills.
- If the classroom does not have a sink, have a large tub available for students to pour their water into during cleanup.

- It is handy to have a small, labeled tub that students from each group can place their condiment cups into overnight. This makes for a quicker setup the next day and helps contain spills.
- Rulers may get sticky when taking measurements. Plastic rulers are recommended.

EXTENSIONS AND VARIATIONS

- *Variation:* Allow students to repeat the experiment, this time comparing sugar-free versus regular gummy candies. Remind students to vary their hypothesis, based on the new variable.
- *Writing:* Have students create a Venn diagram comparing the similarities and differences between making a hypothesis in science and making a prediction in a story.
- *Guest:* Invite a research scientist to talk with the class about some of the experiments he or she has done and the importance of making hypotheses in those experiments.
- *Art:* Ask students to draw and cut out a large, colored paper question mark and then glue it to blank poster board. Using colored pencils or markers, have students write their new research question (from Data Sheet 2) on the question mark and their new hypothesis around the outside of the question mark. Provide other art materials, such as stickers, glitter, paint, and scrap magazines, so students can decorate their posters. Display posters around the classroom and consider using them for inquiry science opportunities.
- *Critical Thinking:* Provide students with two or three possible hypotheses from a mock experiment, only one of which can be supported by the eventual results. Discuss with the class the difference between "wrong" and "not supported." Ask students whether there is ever a time when a hypothesis could be wrong. (Hypotheses are never considered wrong, they are either supported or not supported by the results.)
- *ELL/ESL:* Create a word wall. Include content vocabulary such as *experiment, scientific method, research question, hypothesis, observation, data, results, conclusion,* and *summary.* Also include vocabulary relevant to the lesson, such as *gelatin, dissolve,* and *gummy candy.* For more vocabulary resources, visit Vocabulary A–Z.com.

- *Technology:* Invite groups to take digital pictures during their experiment. Then allow students to create a digital slide show that presents their hypothesis, summarizes their experiment, and compares the results of the experiment with the initial hypothesis—much as a scientist might do.
- *Home Connection:* Challenge students to conduct an experiment at home, with a focus on the hypothesis. Ask them to write a hypothesis and compare it with their results. Allow students to share their hypotheses and results with the class.

ANSWER KEY

EXPERIMENT Science Skills—Hypotheses Data Sheet 1

Name_____ Date_____

Part 1: Write a Hypothesis and Conduct the Experiment

Research Question: Will gummy candies of different colors change size if left in water for one day?

Hypothesis: *Hypotheses will vary. Be sure students understand how to use the "if . . . then . . . because" format. Also check to make sure that their "because" statement makes sense. See example below.*

If I leave a gummy candy in water for one day

then it will shrink

because the water will make it dissolve.

Collect Data

Gummy candy color	Length before placing in water (cm)	Length after one day in water (cm)
 clear	*If popular bear gummy candies are used, they will be about 2.5 cm (1 in.) long before soaking. If a different type of gummy candy is used, measure the candies before the experiment to be able to evaluate students' measurements.*	*If popular bear gummy candies are used, they will be 3 to 4 cm (1–1½ in.) long after they have soaked in water for 1 day. If a different type of gummy candy is used, try the experiment beforehand to be able to evaluate students' measurements.*
 yellow		
 orange		
 red		
 green		

Observations: Write about what you observed after the gummy candies were left in water for one day, including any differences you observed among the various colors.

Answers will vary. Students may note that the gummy candies grew larger, fell apart easily, felt slimy, and were less brightly colored. The measurement results from this experiment are likely to be consistent for all the colored gummy candies. Rarely, one of the candies may absorb more water than the others. If this happens, discuss possible reasons with the class. For example, perhaps there was a difference in the amount of gelatin that was added in the factory, or perhaps there was a temperature variation in the water that was first used in the cups.

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ANSWER KEY

Answers will vary, depending on the results of the experiment and how well students followed procedures. Examples are provided.

EXPERIMENT Science Skills—Hypotheses Data Sheet 2

Name_____ Date_____

Part 2: Reflection

Using the information from Data Sheet 1, work with your group to complete each of the parts below.

Summary of experiment: What is the answer to the research question? Explain.

All of the gummy candies got larger when left in water for one day.

Compare results to hypothesis: Did the results support the hypothesis? Explain why or why not. (Review the hypothesis and compare it to the results.)

Answers will vary, depending on the hypothesis each student made. The best way for answers to be written is using the following format:

My hypothesis was not supported. The gummy candy absorbed the water and grew larger.

or

My hypothesis was supported. The gummy candies absorbed the water and grew larger.

New research question: List one idea for a future experiment related to this one that you would like to try.

Answers will vary but should relate in some way to the gummy candy experiment. Some possibilities include testing using different types of candy, different amounts of time, or different water temperatures.

New hypothesis: Using the "if . . . then . . . because" format, make a new hypothesis for the new question you just wrote.

Answers will vary but should follow the "if . . . then . . . because" format. Be sure the "because" makes sense and is related to the results of the new experiment that students described above.

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ANSWER KEY AND EXPLANATIONS

Critical Thinking

1. What is a hypothesis?

Answers will vary but should include the following essential ideas:

Hypotheses predict the results of experiment, based on prior knowledge and research. Hypotheses are often written using an "if . . . then . . . because" format. Hypotheses provide a predicted answer to the research question and must be testable.

2. Why is it important to include a "because" when making a hypothesis?

Hypotheses are written using "if . . . then" to explain what is being done in the experiment and what the predicted outcome will be. The "because" statement is essential because it provides reasoning for the prediction, based on prior knowledge and research. The "because" statement makes the hypothesis an educated prediction rather than a wild guess.

3. Do the results of an experiment have to match the hypothesis? Why or why not?

No. While hypotheses are logical, educated guesses based on prior knowledge, they will not always be supported by the results of a research experiment. An unsupported hypothesis provides as much information as a hypothesis that is supported by the results of an experiment. Both types of hypotheses lead to answers and to new research questions that can be used in future experiments. In authentic scientific research, it is important to be open to all possible outcomes and to never skew results in order to support a hypothesis.

4. Why is it useful to know how to make hypotheses? Think about careers that require this skill.

Hypotheses are useful because they predict possible outcomes of experiments before they are conducted and require reflection on those outcomes once the experiments are complete. Hypotheses require background research and foresight. Most careers require the ability to create questions, formulate hypotheses, follow procedures, gather results, and draw conclusions. For example, teachers, nurses, and police investigators often follow these steps to solve problems. But careers in science, technology, and math may require more rigorous adherence to the scientific method.