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1.1 What Is Science?

Lesson Objectives

- State the goals of science.
- Describe the steps used in scientific methodology.

Lesson Summary

What Science Is and Is Not

Science is an organized way of gathering and analyzing evidence about the natural world. The goals of science are to provide natural explanations for events in the natural world and to use those explanations to make useful predictions. Science is different from other human works in the following ways:

- Science deals only with the natural world.
- Scientists collect and organize information about the natural world in an orderly way.
- Scientists propose explanations that are based on evidence, not belief.
- They test those explanations with more evidence.

Scientific Methodology: The Heart of Science

Methodology for scientific investigation involves:

- Making an **observation**. Observation involves the act of noticing and describing events or processes in a careful, orderly way. Scientists use their observations to make inferences. An **inference** is a logical interpretation based on what scientists already know.
- Suggesting hypotheses. A **hypothesis** is a scientific explanation for a set of observations that can be tested in ways that support or reject it.
- Testing the hypothesis. Testing a hypothesis often involves designing an experiment. Whenever possible, a hypothesis should be tested by a **controlled experiment**—an experiment in which only one variable (the **independent variable**, or manipulated variable) is changed. The variable that can change in response to the independent variable is called the **dependent variable**, or responding variable. The **control group** is exposed to the same conditions as the experimental group except for one independent variable.
- Collecting, recording, and analyzing **data**, or information gathered during the experiment.
- Drawing conclusions based on data.

What Science Is and Is Not

1. What is science?

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2. What are the goals of science?

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Scientific Methodology: The Heart of Science

Questions 3–10 refer to spontaneous generation, the idea that life can arise from nonliving matter. Spontaneous generation was accepted by many in the scientific community up until the mid-nineteenth century. A series of simple experiments tested the validity of this idea.

3. Evidence used to support spontaneous generation was the observation that foods over time become covered in maggots or fungal and bacterial growth. The inference behind spontaneous generation is that there is no "parent" organism. Write this inference as a hypothesis using an if–then sentence that suggests a way of testing it.

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4. In 1668, Francesco Redi proposed a different hypothesis to explain the specific example of maggots that appear on spoiled food. He had observed that maggots appear on meat a few days after flies have been seen on the food. He inferred that the flies had left behind eggs too small to see. Redi's experiment is shown below. What conclusion can you draw from Redi's experiment?

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_____

5. In the late 1700s, Lazzaro Spallanzani designed a different experiment to show that life did not arise spontaneously from food. He inferred that some foods spoil because of growing populations of microorganisms. Fill in the information requested below.

Independent variable:

_____

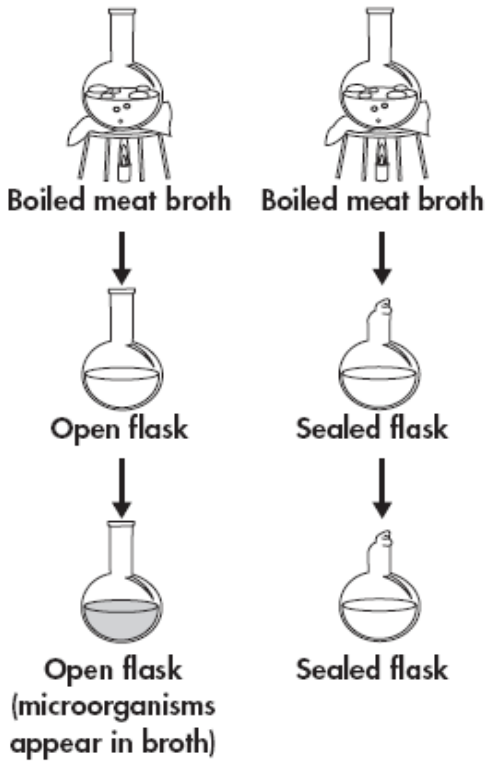
Dependent variable:

_____

Controlled variables (identify three):

_____

_____



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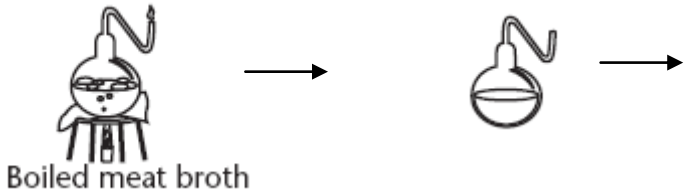
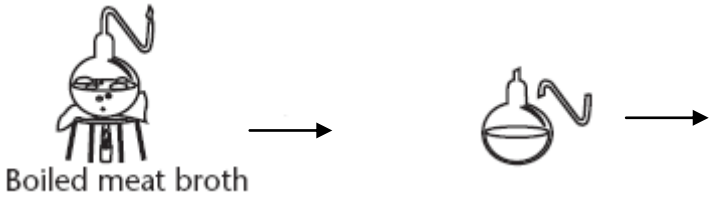
6. THINK VISUALLY Critics of Spallanzini said that he showed only that organisms cannot live without air. In 1859 Louis Pasteur designed an experiment to address that criticism, an experiment that reproduced Spallanzani's results.

Draw in the third and final steps in the experiment. Use an arrow to show the path of travel of the microorganisms. Shade the broth in the flask(s) in which microorganisms grew.





7. How did Pasteur solve Spallanzani's problem of limiting exposure to air?

_____

_____

8. What purpose did boiling the meat broth serve in both the Spallanzani and Pasteur experiments?

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_____

9. How do the Redi, Spallanzani, and Pasteur experiments disprove the hypothesis you wrote in Question 3?

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10. Today, we use a process of heating liquids to prevent spoiling by bacteria and other microorganisms, pioneered by one of the three scientists mentioned above. What is that process called and for what food it is used?

_____

Apply the Big idea

11. What facts did Redi's, Spallanzani's, and Pasteur's experiments establish? What broader scientific understanding about life did the experiments explore? How does the example of these experiments demonstrate science as a way of knowing?

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