

## 1-2 How Scientists Work

### How do scientists test hypotheses?

Whenever possible, a hypothesis should be tested by an experiment in which only one variable is changed at a time. All other variables should be kept unchanged, or controlled.

### Designing an Experiment

The process of testing a hypothesis includes:

- Asking a question
- Forming a hypothesis
- Setting up a controlled experiment
- Recording and analyzing results
- Drawing a conclusion

### Asking a Question

Many years ago, people wanted to know how living things came into existence. They asked: How do organisms come into being?

### Forming a Hypothesis



One early hypothesis was **spontaneous generation**, or the idea that life could come from nonliving matter. For example, most people thought that maggots spontaneously appeared on meat.

In 1668, Redi proposed a different hypothesis: that maggots came from eggs that flies laid on meat.

### Setting Up a Controlled Experiment

The variable that is deliberately changed is called the manipulated variable.

The variable that is observed and that changes in response to the manipulated variable is called the responding variable.

Redi's Experiment on Spontaneous Generation	
<b>OBSERVATIONS:</b> Flies land on meat that is left uncovered. Later, maggots appear on the meat.	
<b>HYPOTHESIS:</b> Flies produce maggots.	
<b>PROCEDURE</b>	
<b>Controlled Variables:</b> jars, type of meat, location, temperature, time	
<b>Manipulated Variable:</b> gauze covering that keeps flies away from meat	
<b>Responding Variable:</b> whether maggots appear	
<b>CONCLUSION:</b> Maggots form only when flies come in contact with meat. Spontaneous generation of maggots did not occur.	

## **Recording and Analyzing Results**

Scientists keep written records of their observations, or data. The records are put into tables or charts.

From these tables, graphs are often made.

Sometimes drawings are used to record certain kinds of observations.

Today, researchers use computers to record their work.

Online storage makes it easier for researchers to review the data.

## **Drawing a Conclusion**

Scientists use the data from an experiment to evaluate a hypothesis and draw a valid conclusion.

Redi's results supported the hypothesis that maggots were produced by flies, not spontaneous generation.

## **Repeating Investigations**

Scientists repeat experiments to be sure that the results match those already obtained.

### **Needham's Test of Redi's Findings**

Needham challenged Redi's results by claiming that spontaneous generation could occur under the right conditions.

### **Needham's Test of Redi's Findings**

- Needham sealed a bottle of gravy and heated it.
- After several days, the gravy was swarming with microorganisms.
- Needham concluded that these organisms came from the gravy by spontaneous generation.

### **Pasteur's Test of Spontaneous Generation**

- Louis Pasteur conclusively disproved the hypothesis of spontaneous generation.
- Pasteur showed that all living things come from other living things.

## **The Impact of Pasteur's Work**

Pasteur saved the French wine industry, which was troubled by unexplained souring of wine.

He saved the silk industry, which was endangered by a silkworm disease.

He began to uncover the nature of infectious diseases, showing that they were the result of microorganisms.

## **When Experiments Are Not Possible**

It is not always possible to do an experiment to test a hypothesis. For example:

- Wild animals must be observed without disturbing them.
- Ethical considerations prevent some experiments.

By carefully planning alternative investigations, scientists can discover reliable patterns that add to scientific understanding.

## **How a Theory Develops**

As evidence from numerous investigations builds up, a hypothesis may become so well supported that scientists consider it a theory.

**In science, the word *theory* applies to a well-tested explanation that unifies a broad range of observations.**

No theory is considered absolute truth.

As new evidence is uncovered, a theory may be revised or replaced by a more useful explanation.