

The Scientific Method and Biology

Enrich

Skill: Drawing conclusions

The Dawn of Modern Science

For as long as they have existed on Earth, humans have been curious about the world in which they live. This curiosity led to the development of science. However, you may be surprised to learn that science as we know it is relatively new.

Much of the foundation of modern science was laid by the natural philosophers of ancient Greece. They were among the first people to answer questions about the natural world using logic. However, these natural philosophers believed that logic was sufficient to find answers to questions about the world. They saw no need to prove by experiment what they already answered with logic. Today, we know that logic alone is not enough to answer questions in science.

The shift from early natural philosophy to modern experimental science gradually took place over centuries. However, modern science took a giant leap with the work of an Italian scientist named Galileo.

Galileo Galilei was born in Pisa, Italy, in 1564. At the age of 17, Galileo entered the University of Pisa to study medicine. According to legend, Galileo was sitting in a cathedral one day when he became distracted by a hanging lamp that was swinging back and forth. He began to time the swinging of the lamp against his pulse and noticed something very interesting—each swing of the lamp took exactly the same amount of time. Even when the distance of the swings decreased, the elapsed time from the beginning of one swing to the beginning of the next remained constant.

Intrigued by what he saw in the cathedral, Galileo decided to re-create the motion of the swinging lamp. He used pendulums made from weights tied to strings to conduct a series of simple experiments. He swung the pendulums in wide arcs and narrow arcs, again timing the

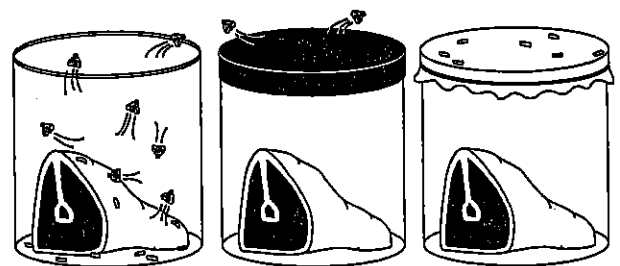
swings against his own pulse. Galileo found that for a pendulum of a given length, the number of swings per unit of time never varied, regardless of the weight of the pendulum or the distance of the swing.

Galileo had discovered an important fact about the motion of pendulums. But more importantly, he introduced a new method for investigating the natural world. Instead of reasoning his way to a conclusion like the natural philosophers of his day would have, he relied on careful measurement and calculation. He tested and proved his ideas by experiment.

Another important characteristic of Galileo's method was that his experiments were verifiable. Anyone could repeat his experiments and reproduce the same results. The ability to repeat an experiment and reproduce its results has become an essential part of the modern scientific method.

In 1668, another Italian scientist, Francesco Redi, used the scientific method to refute the long-held belief in spontaneous generation—the theory that living creatures arise from nonliving matter. Those who subscribed to this theory believed that snakes and toads arose from mud, and that maggots were produced by rotting meat.

Redi hypothesized that the maggots that appeared on rotting meat were actually the products of eggs laid by flies. However, he realized that his hypothesis had little value until it was confirmed by careful experimentation. To test his hypothesis, Redi put fresh pieces of meat



The Scientific Method and Biology
The Dawn of Modern Science (continued)

into a number of glass flasks. He carefully sealed some of the flasks and left the rest open. After a short time, maggots appeared on the meat in the open flasks but not on the meat in the sealed flasks. From the results of his experiment, Redi was able to conclude that maggots come from the eggs of flies, not rotten meat.

The scientific method begins with imagination and ends with conclusions based on experimentation. Early natural philosophers certainly had imagination, but they lacked a means of testing their conclusions objectively. The scientific method enables humans to bridge the gap between human imagination and the objective reality of the natural world.

CRITICAL THINKING

1. How was Galileo's approach to reaching conclusions about the natural world different from the approach taken by the ancient Greeks? (*Comparing*)
2. Why are verifiable experiments so important to the scientific method? (*Making inferences*)
3. Even after Redi performed his conclusive experiments, some people continued to believe in spontaneous generation. Why do you think they remained unconvinced by Redi's work? (*Making judgments*)