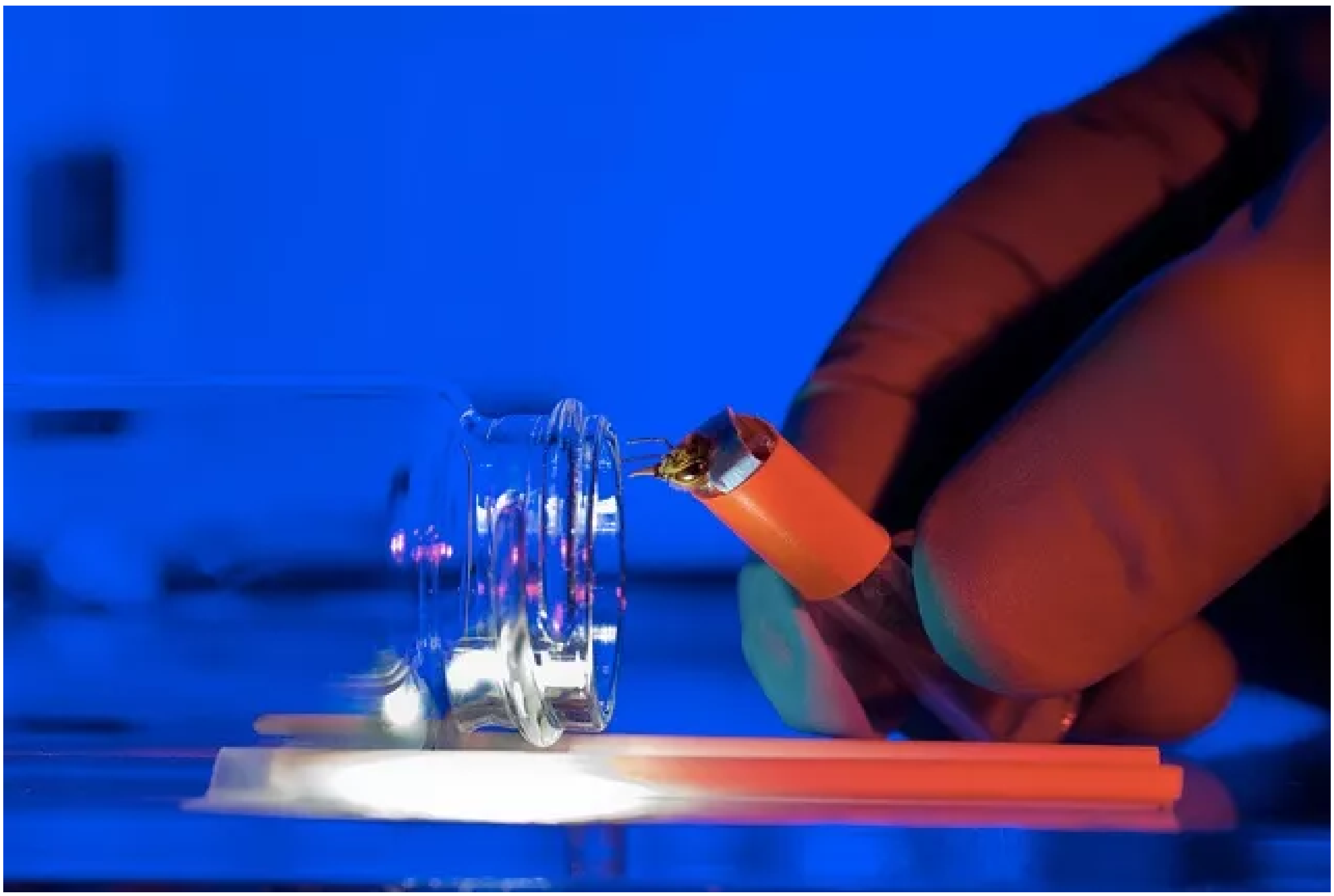
What Is Science?

By Alina Bradford - Live Science Contributor August 04, 2017



"Sniffing" bees trained for security at Los Alamos National Laboratory. (Image credit: LANL)

Science is a systematic and logical approach to discovering how things in the universe work. It is also the body of knowledge accumulated through the discoveries about all the things in the universe.

Science is based on fact, not opinion or preferences. The process of science is designed to challenge ideas through research. One important aspect of the scientific process is that it is focuses only on the natural world, according to the University of California. Anything that is considered supernatural does not fit into the definition of science.

The scientific method

When conducting research, scientists use the scientific method to collect measurable, empirical evidence in an experiment related to a hypothesis (often in the form of an if/then statement), the results aiming to support or contradict a theory.

"As a field biologist, my favorite part of the scientific method is being in the field collecting the data," Jaime Tanner, a professor of biology at Marlboro College, told Live Science. "But what really makes that fun is knowing that you are trying to answer an interesting question. So the first step in identifying questions and generating possible answers (hypotheses) is also very important and is a creative process. Then once you collect the data you analyze it to see if your hypothesis is supported or not."

2. Ask questions about the observations and gather information.
3. Form a hypothesis — a tentative description of what's been observed, and make predictions based on that hypothesis.
4. Test the hypothesis and predictions in an experiment that can be reproduced.
5. Analyze the data and draw conclusions; accept or reject the hypothesis or modify the hypothesis if necessary.
6. Reproduce the experiment until there are no discrepancies between observations and theory. "Replication of methods and results is my favorite step in the scientific method," Moshe Pritsker, a former post-doctoral researcher at Harvard Medical School and CEO of JoVE, told Live Science. "The reproducibility of published experiments is the foundation of science. No reproducibility – no science."

Some key underpinnings to the scientific method:

- The hypothesis must be testable and falsifiable, according to North Carolina State University. Falsifiable means that there must be a possible negative answer to the hypothesis.
- Research must involve deductive reasoning and inductive reasoning. Deductive reasoning is the process of using true premises to reach a logical true conclusion while inductive reasoning takes the opposite approach.
- An experiment should include a dependent variable (which does not change) and an independent variable (which does change).
- An experiment should include an experimental group and a control group. The control group is what the experimental group is compared against.

Scientific theories and laws

The scientific method and science in general can be frustrating. A theory is almost never proven, though a few theories do become scientific laws. One example would be the laws of conservation of energy, which is the first law of thermodynamics. Dr. Linda Boland, a neurobiologist and chairperson of the biology department at the University of Richmond, Virginia, told Live Science that this is her favorite scientific law. "This is one that guides much of my research on cellular electrical activity and it states that energy cannot be created nor destroyed, only changed in form. This law continually reminds me of the many forms of energy," she said.

A law just describes an observed phenomenon, but it doesn't explain why the phenomenon exists or what causes it. "In science, laws are a starting place," said Peter Coppinger, an associate professor of biology and biomedical engineering at the Rose-Hulman Institute of Technology. "From there, scientists can then ask the questions, 'Why and how?'"

Laws are generally considered to be without ex
discrepancies. This does not mean theories are
typically across multiple disciplines by separate
no relationship to science. To most people a the
told Live Science.

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A brief history of science

The earliest evidence of science can be found in prehistoric times, such as the discovery of fire, invention of the wheel and development of writing. Early tablets contain numerals and information about the solar system. Science became decidedly more scientific over time, however.

1200s: Robert Grosseteste developed the framework for the proper methods of modern scientific experimentation, according to the Stanford Encyclopedia of Philosophy. His works included the principle that an inquiry must be based on measurable evidence that is confirmed through testing.

1400s: Leonardo da Vinci began his notebooks in pursuit of evidence that the human body is microcosmic. The artist, scientist and mathematician also gathered information about optics and hydrodynamics.

1500s: Nicolaus Copernicus advanced the understanding of the solar system with his discovery of heliocentrism. This is a model in which Earth and the other planets revolve around the sun, which is the center of the solar system.

1600s: Johannes Kepler built upon those observations with his laws of planetary motion. Galileo Gallilei improved on a new invention, the telescope, and used it to study the sun and planets. The 1600s also saw advancements in the study of physics as Isaac Newton developed his laws of motion.

1700s: Benjamin Franklin discovered that lightning is electrical. He also contributed to the study of oceanography and meteorology. The understanding of chemistry also evolved during this century as Antoine Lavoisier, dubbed the father of modern chemistry, developed the law of conservation of mass.

1800s: Milestones included Alessandro Volta's discoveries regarding electrochemical series, which led to the invention of the battery. John Dalton also introduced atomic theory, which stated that all matter is composed of atoms that combine to form molecules. The basis of modern study of genetics advanced as Gregor Mendel unveiled his laws of inheritance. Later in the century, Wilhelm Conrad Röntgen discovered X-rays, while George Ohm's law provided the basis for understanding how to harness electrical charges.

1900s: The discoveries of Albert Einstein, who is best known for his theory of relativity, dominated the beginning of the 20th century. Einstein's theory of relativity is actually two separate theories. His special theory of relativity, which he outlined in a 1905 paper, "The Electrodynamics of Moving Bodies," concluded that time must change according to the speed of a moving object relative to the frame of reference of an observer. His second theory of general relativity, which he published as "The Foundation of the General Theory of Relativity," advanced the idea that matter causes space to curve.

Medicine forever changed with the development of the polio vaccine in 1952 by Jonas Salk. The following year, James D. Watson and Francis Crick discovered the structure of DNA, which is a double helix formed by base pairs attached to a sugar-phosphate backbone, according to the United States National Library of Medicine.

Additional resources

- University of California, Berkley: What is Science
- University of Georgia: What is Science?
- PBS: Nature and Process of Science
- Indiana University: Teaching the Nature of Science
- University of Waikato: Scientific Hypothesis, Theories and Laws

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