

It's in
our
hands.



The Scientific Method

Science is not just a collection of facts, but rather a method used to learn about the universe and the way it works. This method is not always applied the same way, but certain basic features can be found in most cases.

Scientific Method illustrated here using the story of the discovery of the structure of DNA

STEP
01

Based on existing knowledge, a question is asked

Before the discovery of the structure of DNA, other properties were already known, including the chemical composition and the fact that DNA stores genetic information. But no one knew how exactly a DNA molecule was structured.

STEP
02

A possible answer to the question is worked out in the form of a hypothesis

The researchers Francis Crick, James Watson, and Linus Pauling suspected that DNA has a helical structure.

STEP
03

A logical consequence of this hypothesis is formulated in such a way that it can be tested by experiment

If DNA has a helical structure, then it would produce X-shaped patterns in X-ray diffraction. This property has nothing to do with the biological matter at hand, but is a purely mathematical consequence of the helical structure.

STEP
04

The experiment is carried out

Rosalind Franklin performed X-ray diffraction on pure DNA, which resulted in an X-shaped pattern (as seen in the famous photo 51).

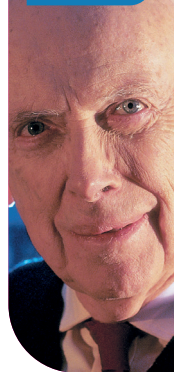
STEP
05

The results are analyzed

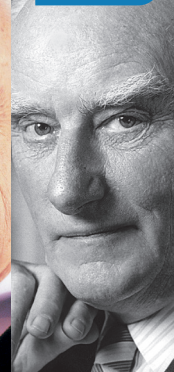
Because an X-shaped pattern was formed, Watson and Crick's assumption that DNA has a helical structure was confirmed. They then created their model.

This discovery served as the basis for further research, especially in the field of molecular genetics. Watson and Crick were awarded the Nobel Prize in Biology for it in 1962.

James D.
Watson



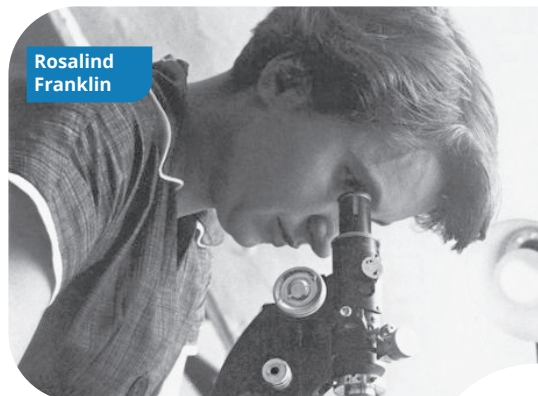
Francis
Crick



Linus
Pauling



Rosalind
Franklin





In addition to the steps listed above, other things are also important, such as:

Repeatability

A one-time result could have occurred by chance. The result is only plausible if it is confirmed by repeating the experiment and getting (approximately) the same outcome.

Peer review

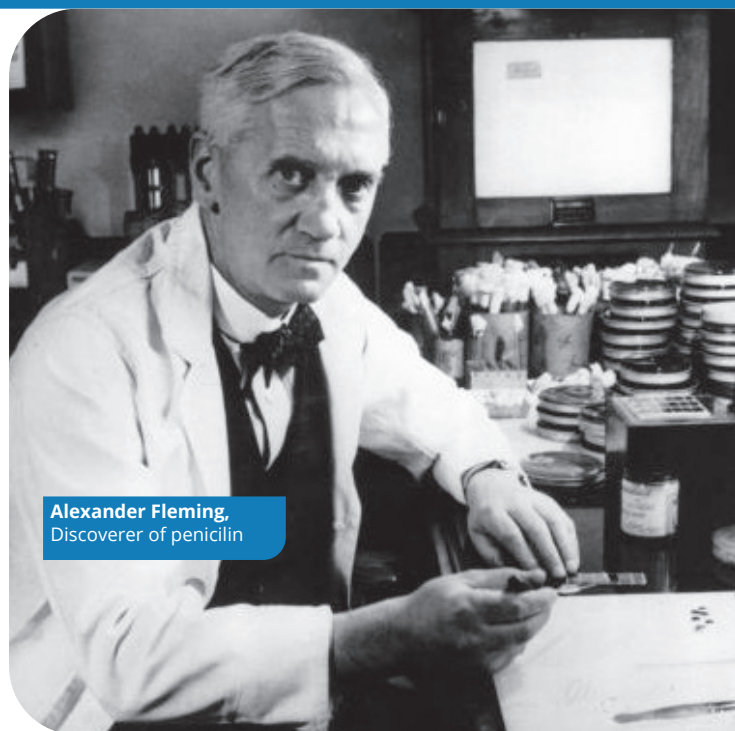
When scientists publish their results, they describe every step of their work, from the formulation of the research question to the evaluation and analysis of the results. These steps are then anonymously reviewed by other scientists. The work is only published if the necessary standards have been met, in the opinion of the reviewers.

The beauty of chance

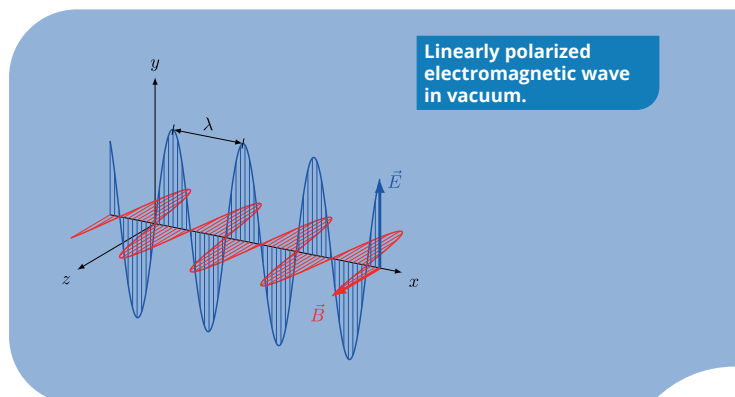
Not every scientific discovery, however, comes about through a deliberate experiment, like in this example. Some breakthroughs happen by accident – e.g., the discovery of penicillin or the invention of the microwave oven.

What happens if the experiment doesn't provide a result?

If an experiment delivers a negative outcome (if there is no result), then that can also be very important. For example: at the end of the 19th century, two scientists named Michelson and Morley conducted an experiment to prove the existence of the so-called luminiferous ether. At the time, light was thought of as a pure wave and thus needed a carrier medium, in the same way that ocean waves can exist only in water. In the case of light, the medium would be the ether. However, when Michelson and Morley carried out their experiment, they found no sign of the ether. From today's point of view, we know that this is because the ether doesn't exist. The theory was rejected among other things because of this „negative“ result which was later verified by other experiments.



Alexander Fleming,
Discoverer of penicillin



Linearly polarized
electromagnetic wave
in vacuum.