

What Science IS

So, what IS science? It has been defined many ways, and its meaning has changed with time. Like many words, "science" has more than one proper use, and the word can also be misused. In its most fundamental sense, modern science is a **process** by which we try to **understand how the natural world works** and how it came to be that way. It is NOT a process for merely collecting "facts" about, or just describing, the natural world, although such observations do provide the raw material for scientific understanding. **Scientific knowledge** is the *inferences* that scientists draw from the data - the models for how things work.

As a process, certain **rules** must be followed, but there is NO one "scientific method", contrary to its popular treatment in textbooks. The rules of science are intended to make the process as objective as is humanly possible, and thereby produce a degree of understanding that is as close to reality as possible. One constant theme is that there is **no certainty** in science, only degrees of probability (likelihood), and potential for change. Scientific understanding can always be challenged, and even changed, with new ways of observing, and with different interpretations. The same is true of **scientific facts**. New tools and techniques have resulted in new observations, sometimes forcing revision of what had been taken as fact in the past. Therefore, unlike mathematics, and contrary to popular perception, in science **nothing** is ever **proven** (in the sense of finality or certainty that the word suggests).

Modern science is based upon several underlying assumptions:

1. The world is real. The physical universe exists, whether we can sense it or not.
2. It's possible that humans *can* accurately perceive and understand the physical universe.
3. Natural processes are sufficient to explain the natural world; non-natural processes are unnecessary.
4. Nature operates the same way everywhere in the universe, except where we have contrary evidence.

Modern science has its limitations:

1. Observations are confined to the biological limits of our senses, even with technological enhancement.
2. The mental processing of our sensory information is unconsciously influenced by previous experiences, which may result in inaccurate or biased perceptions of the world.
3. It is impossible to know if we have observed every possible aspect of a phenomenon, have thought of every possible alternative explanation, or controlled for every possible variable.
4. Scientific knowledge is necessarily contingent knowledge rather than absolute knowledge:
 - a. Scientific knowledge is based only on the available evidence which must be assessed and (and is therefore subject to more than one possible interpretation), not on indisputable "proof".
 - b. The history of science is filled with numerous examples of scientific knowledge changing over time.
5. Science must follow certain rules, such as:
 - a. Scientific explanations must be based on careful observations and the testing of hypotheses.
 - b. It must be possible to disprove a hypothesis.(with discriminating evidence)
 - c. Scientific solutions cannot be based merely upon personal opinion, popular vote, belief, or judgment.
 - d. Scientific explanations cannot include supernatural forces (these can never be disproved).
 - e. All hypotheses are not of equal value; some are better (work better) than others.
 - f. The "best" hypothesis, out of the choices, must be one that best fits all the facts.
 - g. Science is not democratic or fair. The empirical evidence and logical critical analysis rules
6. Science, as for any human endeavor, can be done poorly.
7. Science can be misused.

So, if there are so many limitations and uncertainties to science, **why is science so useful?** It turns out that the **limitations** are the **strengths** of science. From the actual use and application of the knowledge of science to real world problems, we have found that scientific knowledge is the most reliable knowledge we have about the natural world. In other words, most of the time, **it works!** Predictions based on that knowledge are usually confirmed. This has enabled much of our work in space exploration, modern medicine, agriculture and technology to be as successful as it has been, at an ever-increasing rate.