

How do scientists actually do science?

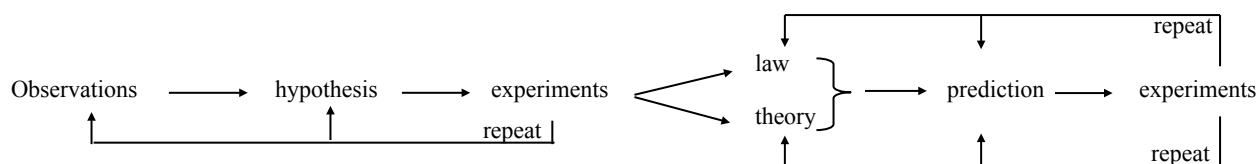
Really there is no such thing as "the" scientific method." Science uses many methods. Scientific thinking is a process for processing and understanding information and solving problems. It can be useful in all aspects of life. It is important that you are familiar with the vocabulary.

It is important to realize that while we hope that our experiments work out in class, more often than not, experiments do not work and just as much science is learned from these results.

Although the list below appears sequential, often the method of doing science is usually quite circular as demonstrated by the flow chart below.

- Observations – Information collected by watching and paying close attention to details.
- Hypothesis – A testable statement, question, idea or explanation.
- Experiments – Tests that search for new information.
- Law – A concise summary statement or mathematical equation that summarizes a broad set of observations.
- Theory – An explanation or interpretation of a broad set of observations, with considerable evidence and facts to support it.

Flow Chart:



Avoid the use of the word prove or true

It is best to avoid using the word “prove or proof”. While it is completely possible to *disprove* a hypothesis, when the data does not support the ideas, however, when lab results seem to “prove” a hypothesis, the results really only serve to verify the hypothesis. The reality is, that to *prove* something, every possible test would have to be applied, and that of course is not possible. Rather it is best to say that the lab results “indicate, verify, demonstrate, or give support to” whatever hypothesis, law or theory you are proposing. Thus, theories can never be proven to be absolutely correct.

The human side of science

Keep in mind that scientists are human. They have prejudices; they misinterpret data; they become emotionally attached to their theories and lose their objectivity, and they play politics. The principles and ideas presented in this course (as with most courses) leave little time to discuss the doubts, conflicts, clashes of personalities, and revolutions of perception that have led to the present ideas. It is important to be aware that although the ideas are presented so concisely and neatly on websites and in textbooks, this does not mean that actual scientific progress is so smooth, certain, and predictable. Some of the ideas you are learning took centuries to develop and involved a large number of scientists, many of whom devoted their lives to their study. Some of whom even lost their lives because of their study. Science is affected by profit motives, budgets, fads, wars, and religious beliefs. Galileo, for example, was forced to recant his laws of falling bodies because of Catholic persecution, and LaVoisier, the father of modern chemistry, was beheaded because of his political affiliations. The progress of science is often slowed more by the frailties of humans and their institutions than by the limitations of their scientific measuring devices. Today we gain our view of the natural world by standing on the shoulders of the men and women scientists that came before us. Take advantage of this view, but do not lose your imagination. Dare to think, question, and revel in the fascination of it all.