THE SCIENTIFIC WORLD VIEW

1. The Universe Is Understandable.
2. The Universe Is a Vast Single System In Which the Basic Rules Are Everywhere the Same.
3. Scientific Ideas Are Subject To Change.
4. Scientific Knowledge Is Durable.
5. Science Cannot Provide Complete Answers to All Questions.

Thinking Like a Scientist

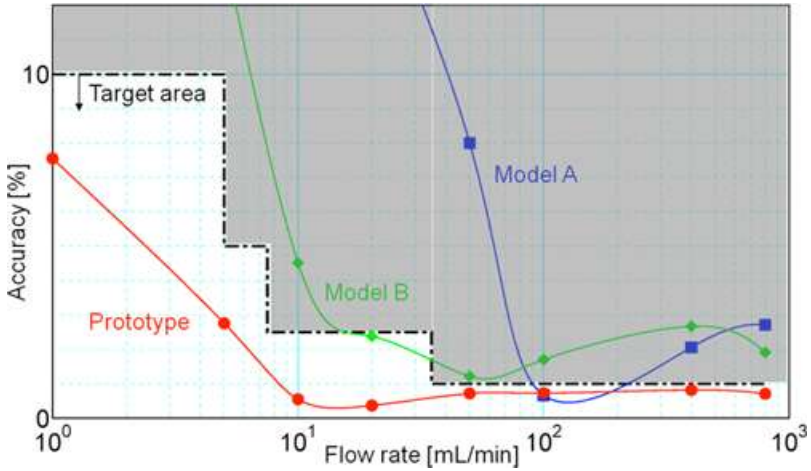
- Seek to **answer questions** about the natural world.
- Use the **Scientific Method** to test hypothesis.
- Provide accurate, reliable answers to questions/problems.
- What is the **evidence?** How strong is the evidence?

What Science Is and Is Not

- **Science is an organized way of using evidence and testing to learn about the natural world.**
- The goal of science is to investigate and understand the natural world, to explain events in the natural world, and to use those explanations to make useful predictions.
- Supernatural explanations are not testable, thus not scientific

Science Demands Evidence

- The validity of scientific claims is settled by referring to observations of phenomena
- Therefore, scientists concentrate on getting accurate data



The Scientific Method:

1. Make Observations (think of a question)
2. Formulate a Hypothesis
3. Design your Experiment: variables, controls
4. Conduct the Experiment: collect data
5. Analyze Data: trees, statistical support, graphics
6. Draw conclusions
7. Communicate the results

Hypothesis

- A hypothesis is a proposed scientific explanation for a set of observations.
- Scientists generate hypotheses using prior knowledge, or what they already know; logical inference; and informed, creative imagination.
- Scientific hypotheses must be proposed in a way that enables them to be tested.
- Some hypotheses would be ruled out. Others might be supported and eventually confirmed

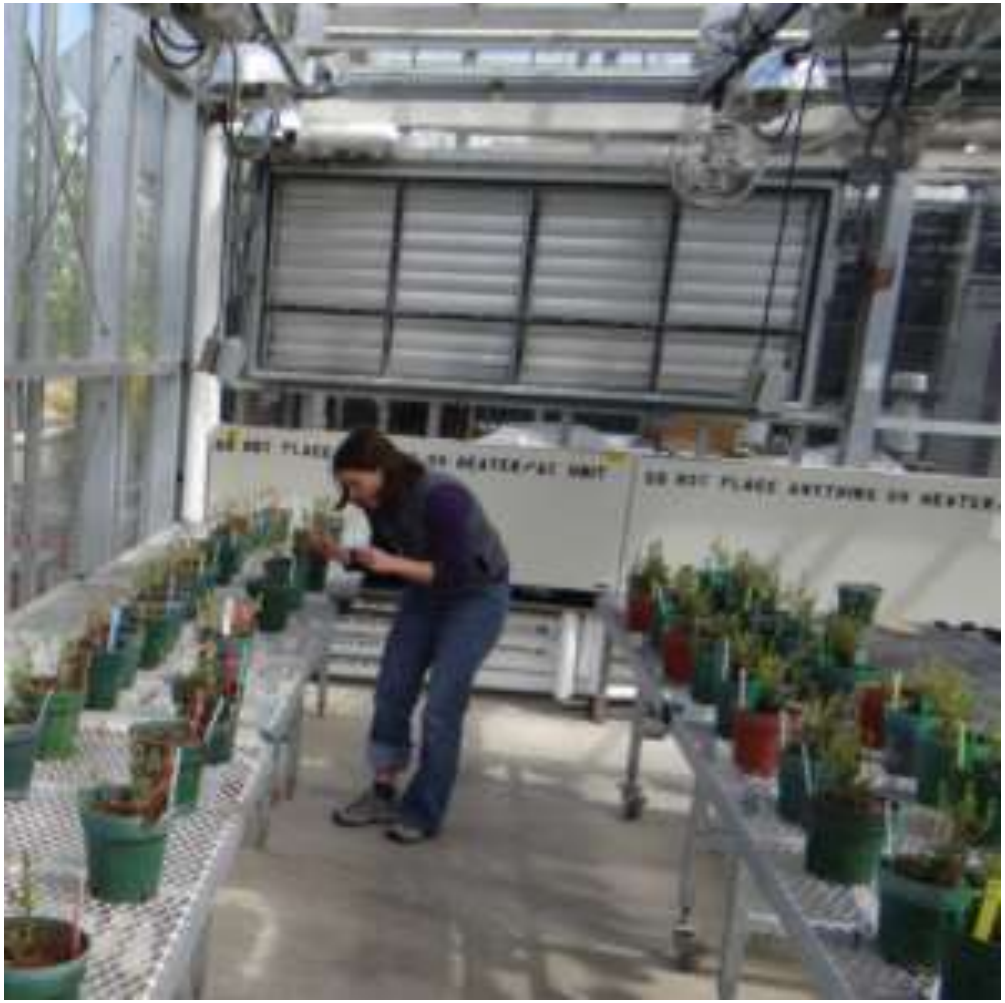
Observations

- The process of gathering information about events or processes in a careful orderly way.
- Using our senses to make observations of the natural world.

Observations

- **The information gathered from observations is called data.**
- There are **two** main categories of data: Quantitative and Qualitative.
- **Quantitative data** are expressed as numbers, obtained by counting or measuring.
- **Qualitative data** are descriptive and involve characteristics that can't usually be counted. Ex. "the scar appears old" and "the animal seems healthy and alert."

Experimentation



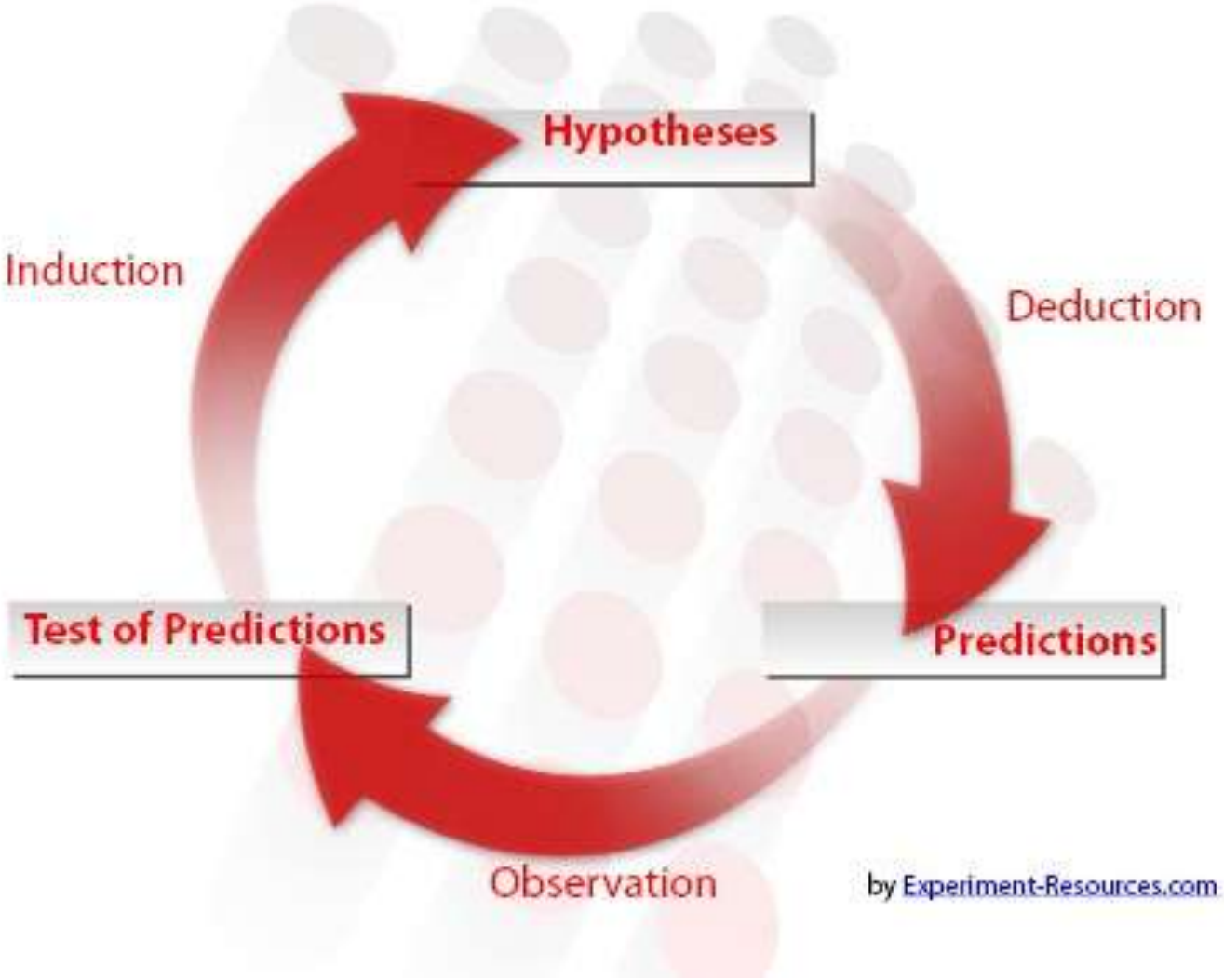
- **Designing an activity/experiment to test a hypothesis under controlled conditions. A good experiment tests only one variable at a time and a control is used.**

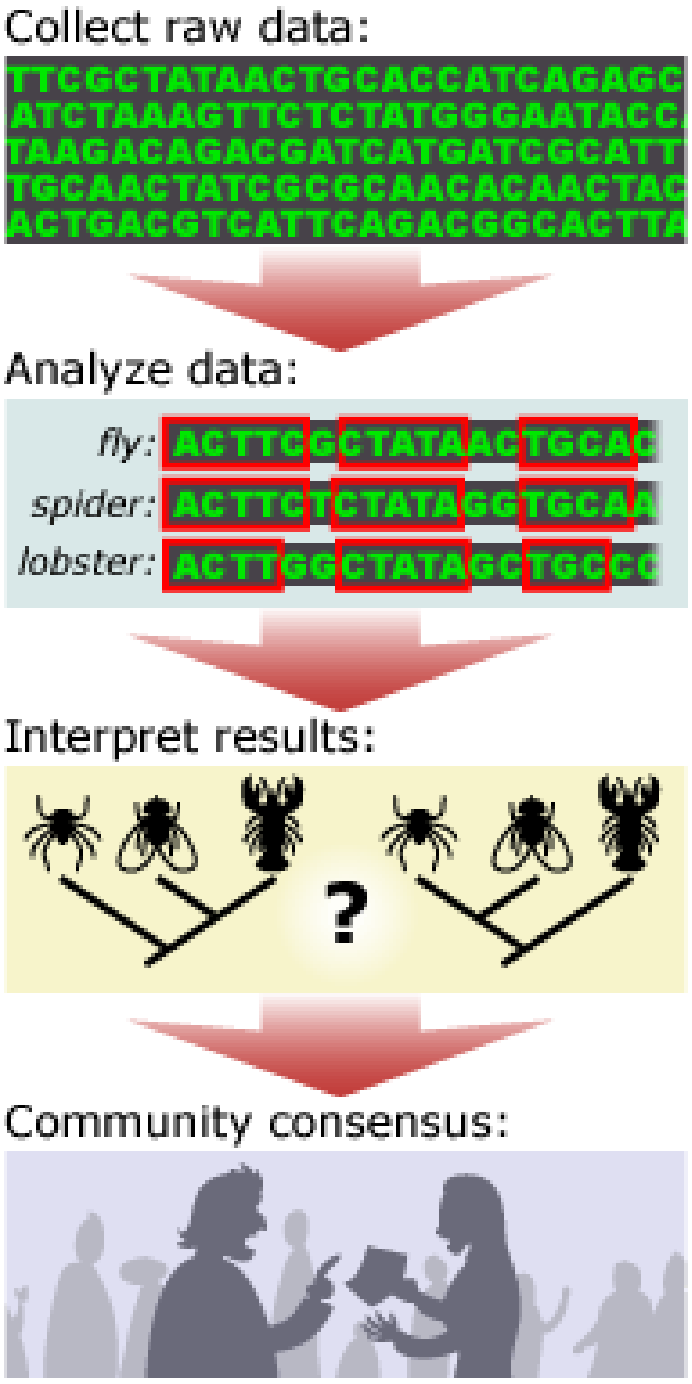
- **A good experiment can be replicated by other scientists and the same results can be obtained.**

THE EXPERIMENTAL METHOD

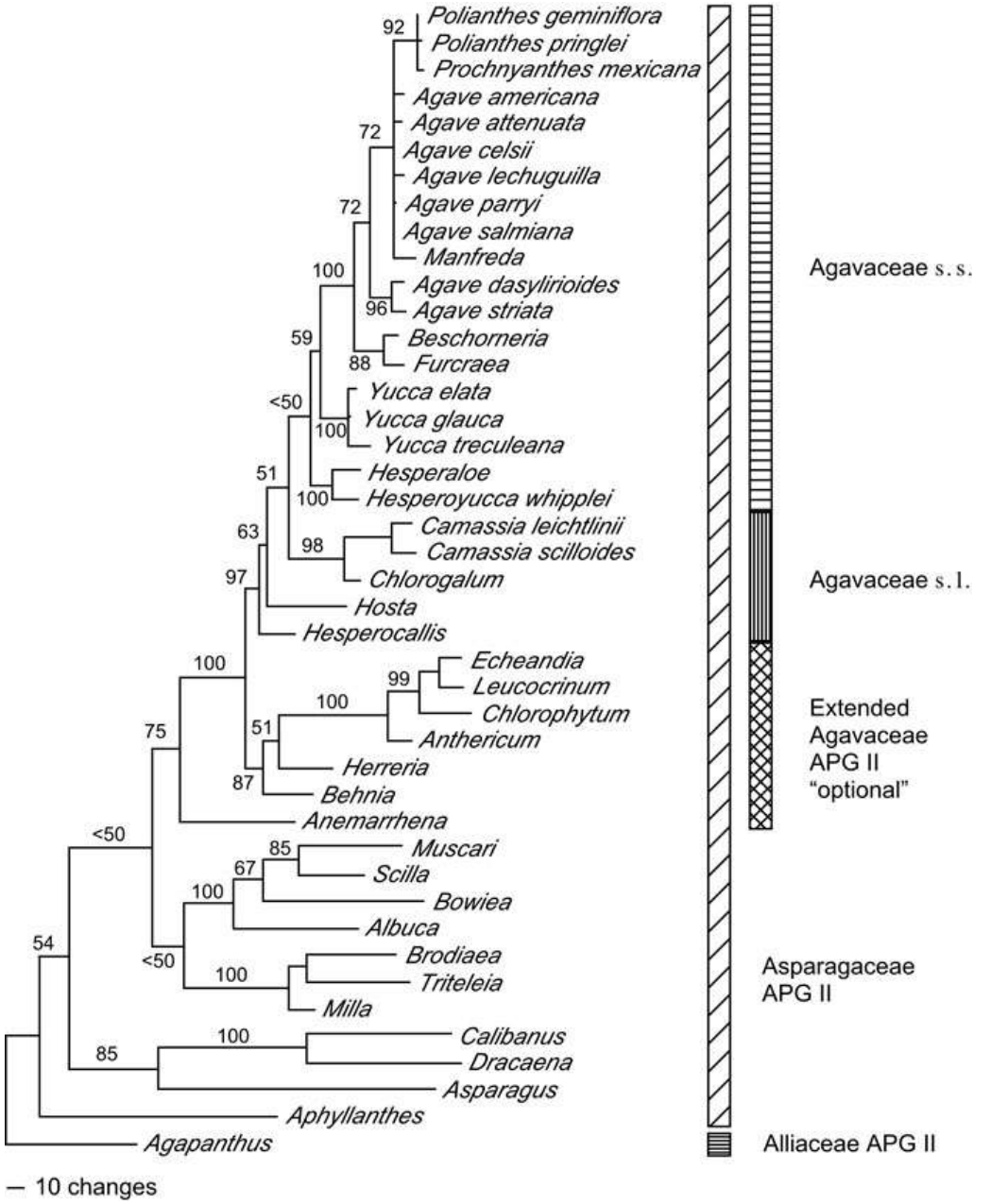
- An experiment is a study of cause and effect.
- It differs from non-experimental methods in that it involves the **deliberate manipulation of one variable**, while trying to keep all other variables constant.
- Experiments must be properly designed and include controls.

Hypothesis Testing





Bogler et al. 2006 Aliso **22**: 313–328



SCIENTIFIC LAWS AND THEORIES

- A Scientific Theory is an explanation of a set or system of related observations or events based upon proven hypotheses and verified multiple times by detached groups of unbiased researchers.

- (One scientist cannot create a theory; s/he can only create hypotheses.)

SCIENTIFIC LAWS AND THEORIES

- The biggest difference between a law and a theory is that a theory is much more complex and dynamic.
- A law governs a single action or situation, whereas a theory explains an entire group of related phenomena. (Mendel's Laws versus Darwin's Theory of Evolution by Natural Selection)
- [Note: Evolution is a Fact; Darwin's Theory is the scientifically accepted explanation for the fact(s) of evolution.]

SCIENTIFIC LAWS AND THEORIES

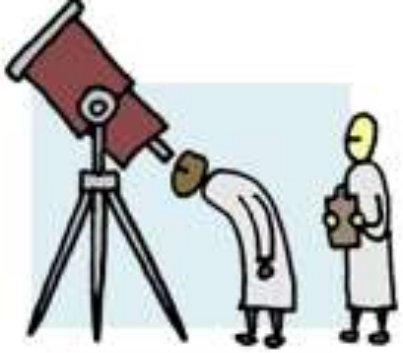
- By the time the scientific community accepts a Law or Theory, it represents the best understanding of the explanations for the elements and behaviors of a given system at that point in time.
- A Scientific Theory represents our best understanding of the "truth" about some aspect of the universe, even though it is not proven as absolute and is still understood to be subject to future revision, even to rejection.

Communicating Results

Publishing the results.

- A scientific article must tell the reader
- **what** the question to be answered is,
- **why** the question is important or relevant,
- **background** information, a
- **precise** description of how the work was done, the
- **data** that were collected, and the
- **scientist's evaluation** of what the data mean.

The peer review process



Scientists study something.

Scientists write about their results.

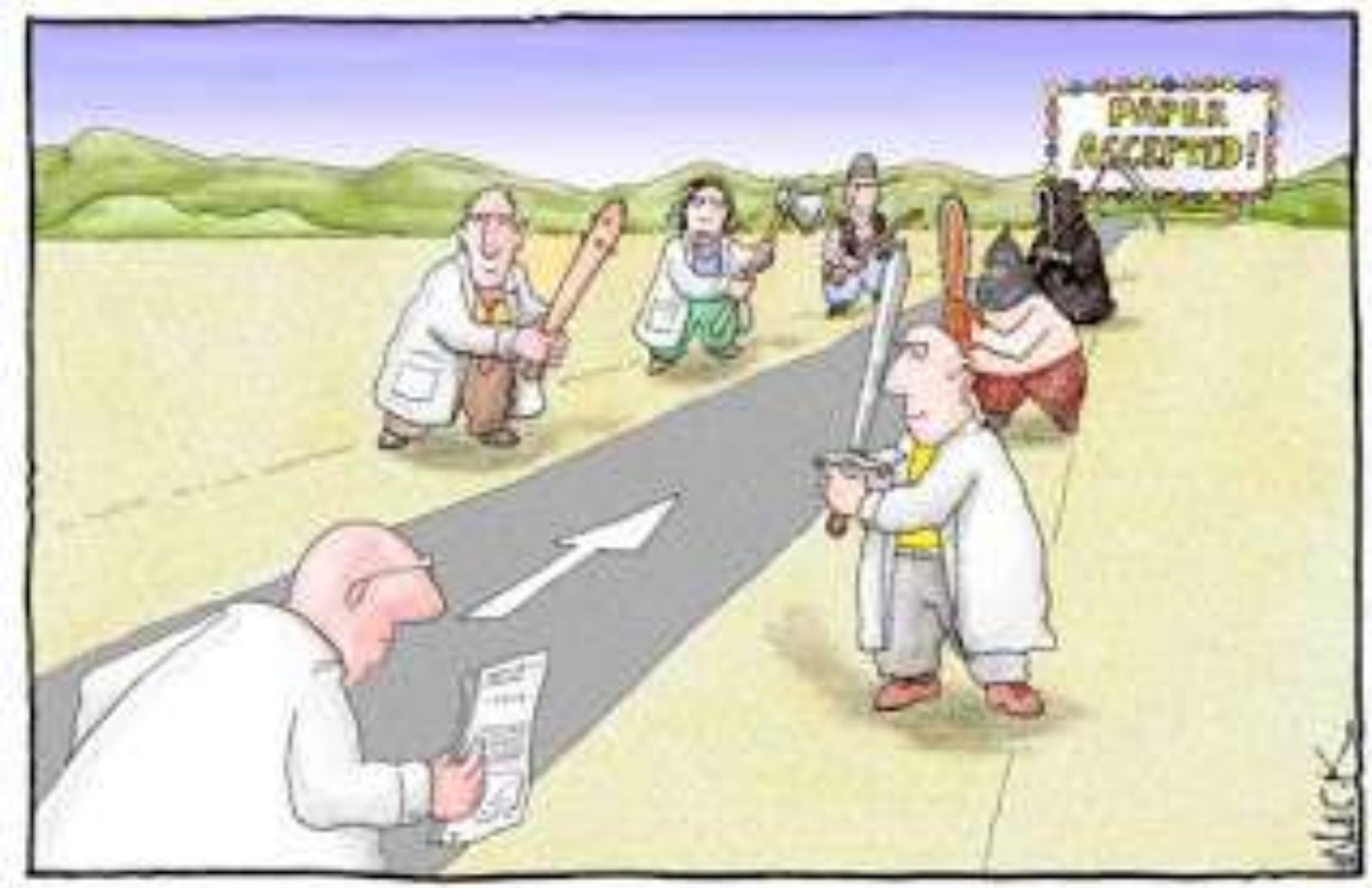
Journal editor receives an article and sends it out for peer review.

Peer reviewers read the article and provide feedback to the editor.

Editor may send reviewer comments to the scientists who may then revise and resubmit the article for further review. If an article does not maintain sufficiently high scientific standards, it may be rejected at this point.

If an article finally meets editorial and peer standards it is published in a journal.

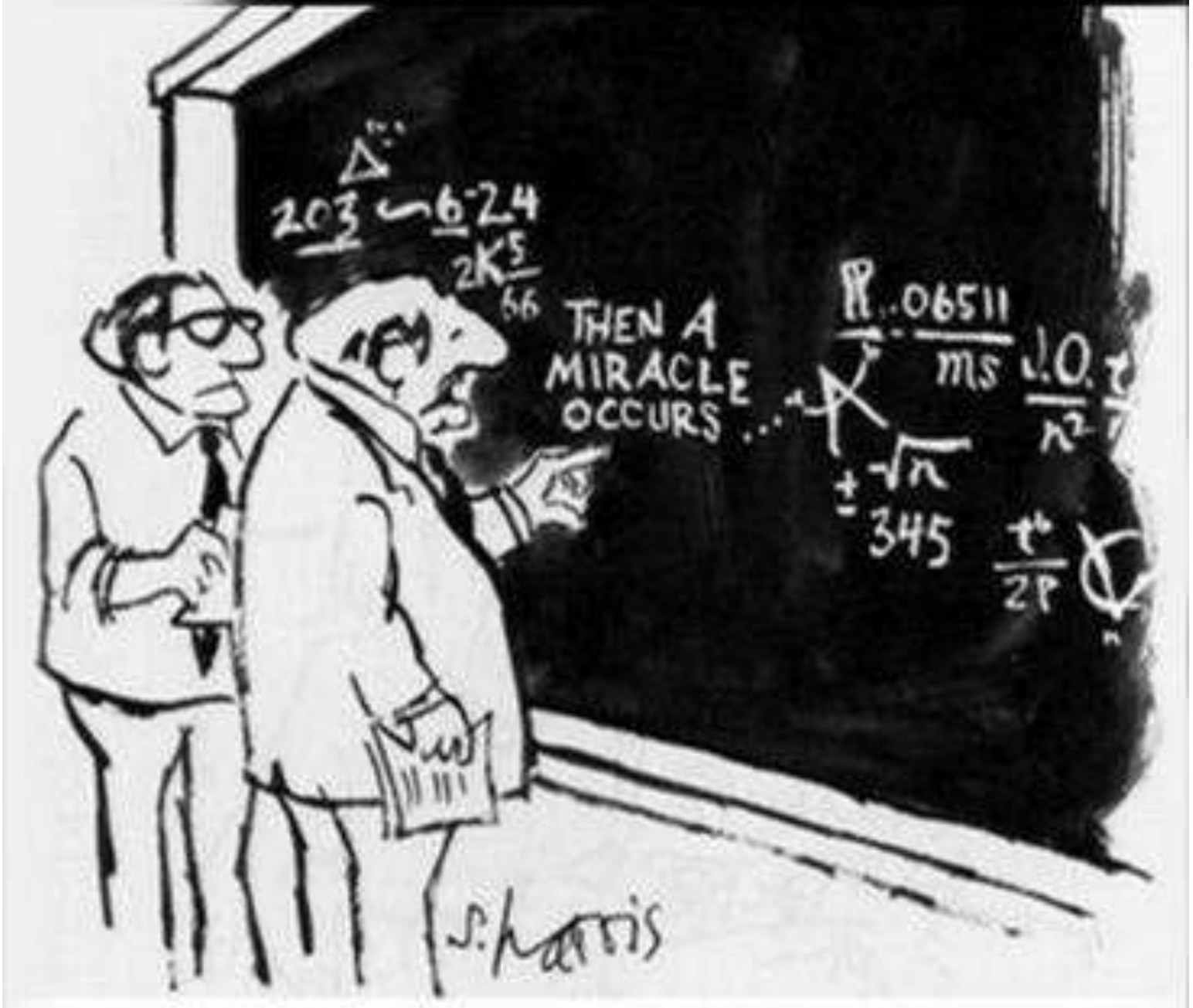
Peer review Process



Most scientists regarded the new streamlined peer-review process as 'quite an improvement.'

Evaluating scientific messages in publications:

- Where does the information come from?
- Are the views of the scientific community accurately portrayed?
- Is the scientific community's confidence in the ideas accurately portrayed?
- Is a controversy misrepresented or blown out of proportion?
- Where can I get more information?
- How strong is the evidence?
- Are the citations current and representative



"I think you should be more explicit here in step two."

End