

Science

I. What is Science?

A way of analyzing your surroundings to make useful predictions based on logic & experimental testing of ideas (hypotheses).

A. One possible event sequence:

1. Observe environment
2. Propose an explanation/correlation/hypothesis/model related to observation (#1, above) **that can be tested experimentally**. This means the explanation-model **must be able to make predictions** about experimental outcomes.
3. Perform an experiment to test the explanation/model in #2.

4. If the prediction made in 2 above was
 - a) accurate, that supports (**not proves!**) the validity of the explanation-model.
 - b) inaccurate, the explanation-model must be modified or discarded.

5. Repeat #1-4 from above, as interest dictates.

6. When a hypothesis/model has been shown over time & many experiments to have strong predictive value, and essentially contradictions by experimental results, the hypothesis/model may graduate to the status of a theory.

Important:

In science, a **theory** (d) is the highest level of development of an idea. It is supported by *many* experimental results. If someone tells you that the kinetic molecular theory or any other theory is weak because it is “just a theory” they show that they:

1) do not understand the meaning of the word *theory* in science,

or

2) hope you do not understand the meaning of the word *theory*.

B. Important!!! If new data conflict with a hypothesis, model, theory, *etc.*, then the hypothesis, etc. must be changed. *I.e.*, scientists cannot ignore results.

II. Science and society

A. Science has done much to improve the human condition. Progress in medicine is ample proof of this. See below. That said:

1. Historically there have been conflicts between scientists and power centers in other parts of society.
2. While science focuses on physical matters, these physical matters may have significant philosophical implications. (Ex: The earth is not the center of the universe.)

B. Which brings us to science/logic vs. *ill*-logic.
(George Washington might say *dead*-logic.
Discomfort? Tough Twinkies! The actions of
Galen, Rush, and others indicate that we must
deal with this.)

1. Science deals w/ physical world (examined by
experimentation)

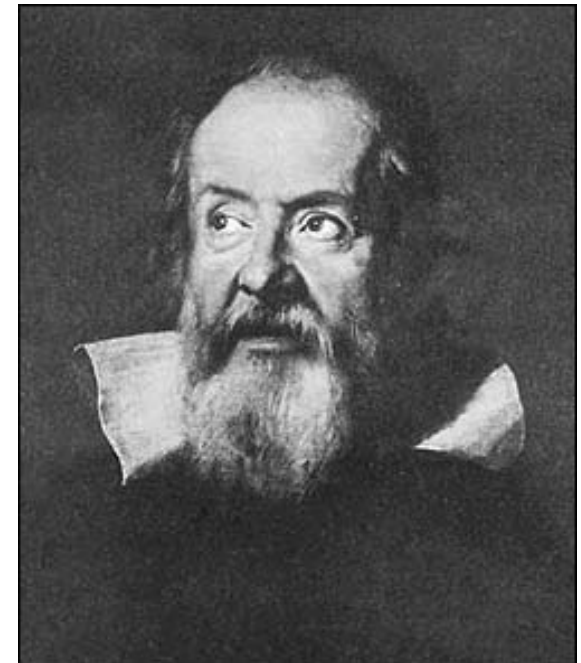
2. *Science cannot deal with supernatural
matters.* (Think about the word “supernatural”
for a second. You will see why that is so.)

3. Historically conflicts have arisen between experimental & non-logic based approaches (turf battles?). (*i.e.*, Predictions about the physical world developed in a supernatural or spiritual context.) Example: Heliocentrism (d), Galileo, and the Roman Catholic Church. (A 350 year old apology is better than no apology at all!)

Image: Google Images

See Wikipedia:

http://en.wikipedia.org/wiki/Galileo_affair)



4. On the other hand, some folks (occasionally scientists) have claimed that they can use science to prove or disprove issues that are supernatural or religious. **Supernatural** issues cannot be proven or disproved by methods that depend **natural** phenomena and experiments.

C. Your religion is none of my business, and it's nobody else's either (see USA *Constitution*).

However, important: Does it matter whether we use science to make decisions?

1. When an action will be taken, yes.
2. Where no actions are to be taken, ??? (but philosophical consistency?)

Example: Do you plan to take any actions based on how old the earth is?

3. Does the practice of medicine involve taking any actions? Can you think of an example?

III. Medicine & Science

Historically (roughly pre~1800's), medicine did not use scientific methods. To see what medicine was like before it relied on the scientific method: Buckwalter, J.A., *Journal of Bone and Joint Surgery 82-A (12): 1782-1803 (2000)*. Available via Upstate library. Let's look at

A. Galen, important physician in ancient (~180 AD) Greece:

1) “theory” of humors Note massive misuse of the word “theory” here.

a) black bile (earth)

b) yellow bile (fire)

c) blood (air)

d) phelgm (water)

Balance between these four humors controlled health.

2) anatomical studies

- a) Dissections done largely on animals (laws at the time!)
- b) blood flowed tidally (back and forth) from liver
- c) but he did advance the field in some areas

3) Recommended treat hemorrhage by bleeding!

Bleeding!!!!!!!!!!!!

Could Galen have recommended this if he had done even a simple scientific experiment to test the effect of bleeding on his patients?

4) Galen's problem was that he assumed his treatment was working instead of testing to find out if it was working.

B. George Washington: treatment received prior to his death (in 1799) for a sore throat and fever was “bleeding, blistering, leaches, enemas, and emetics.” Wallenborg: bleeding vol = 5 pints.

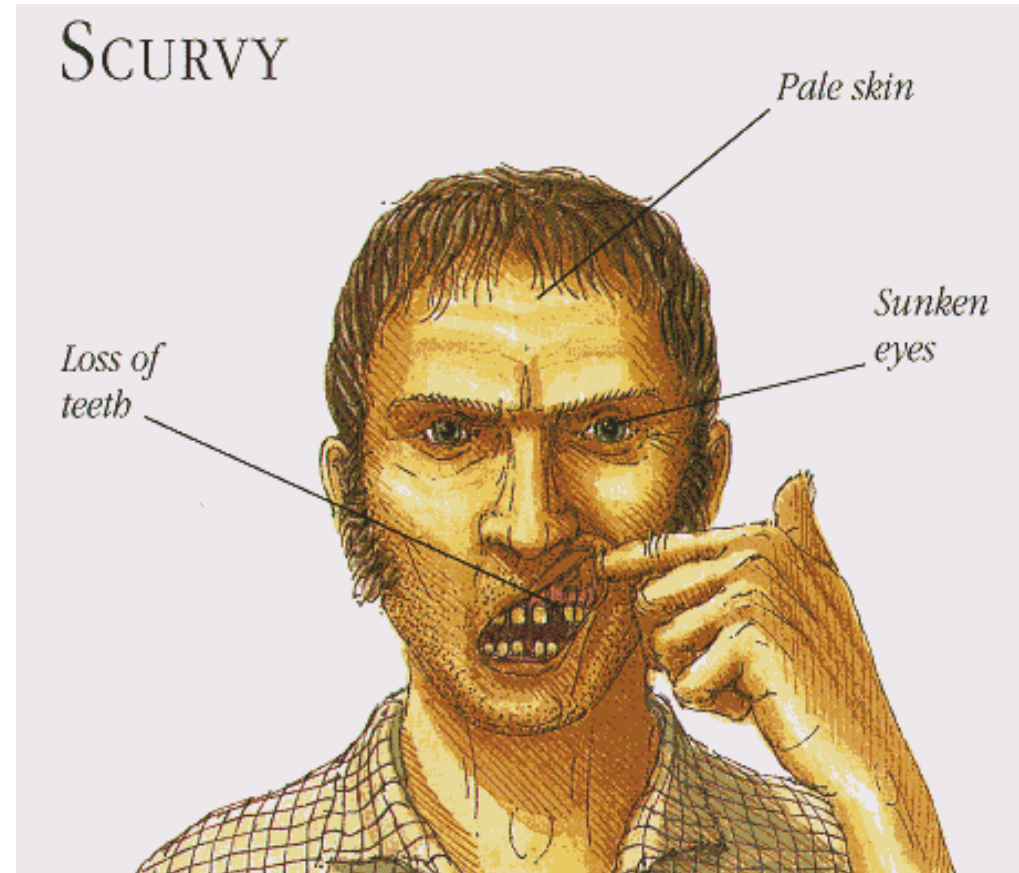
(<http://gwpapers.virginia.edu/articles/wallenborn.html>)

C. James Lind: scurvy, citrus fruit, and the **first clinical trial** w/ controls (1747) on our planet!!!

1) Lind: a surgeon in the British Royal Navy

2) It was well known that specific health problems (scurvy was one) were associated with long naval voyages.

from Google Images



3) Lind hypothesized that sailors were developing scurvy because of an inadequate diet. (Seems easy in hindsight, but there were many other possible hypotheses.)

4) Lind's experiment to test of his hypothesis:

a) 12 sailors diagnosed with scurvy in experiment (trial)

b) 2 sailors each in 6 different groups (5 control groups)

i) 1 quart of cider/day

ii) 25 drops vitriol/day (vitriol?)

iii) two spoonfuls vinegar 3 times/day

iv) 1 teaspoon of plant root *etc.*, extract/day

v) half-pint sea water/day

vi) 1 lemon & 2 oranges/day

Result: Six days later the sailors in groups i-v showed no improvement, while the sailors in group vi) were healthy enough to start caring for the sailors in groups i-v)!!!

That's why science is handy!

What questions could you ask yourself after this lecture?