Methods of Science

•Facts are observations agreed upon by all or nearly all observers.

•Observation vs. Inference

*an observation is something we can see or measure an inference is a generalized idea based on observations.

•A hypothesis is a tentative, testable statement based on inferences.

•A controlled experiment is used to test hypotheses. It is designed such that the independent (or manipulated) variable is changed in order to observe its effects on the dependent (or responding) variable.

Generally scientific tests look at two variables:

•**Independent** (manipulated) **variable**; varying this causes a change in the dependent variable.

•**Dependent** (responding) **variable**

•Since usually any number of factors can affect the dependent variable, scientists like to run controlled experiments.

•These are exact duplicate of the original experiment, except the independent variable is changed to some set value.

i.e.- drug *vs*. sugar pill

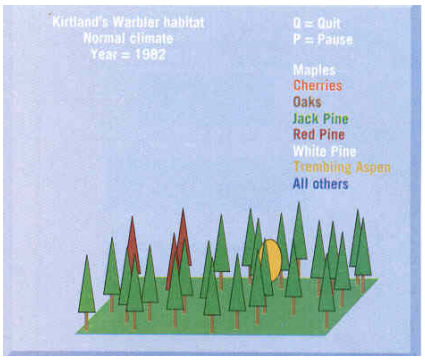
•This way it can be established that the original independent variable had the effect on the dependent one.

-The results of a scientific test is a collection of data.
a. numerical= quantitative
b. nonnumerical= qualitative

As data supports more hypotheses, models are constructed

a. actual working
b. pictorial
c. mental
d. computer
e. laboratory

•Computer simulations are becoming increasingly important in Biology.



•Models that offer broad, fundamental explanations of many observations are called THEORIES.

So… the scientific method is:

1. make observations and questions about them.
2. develop a tentative answer to the question- a hypothesis.
3. design a controlled experiment to test the hypothesis.
4. collect data
5. interpret data
6. draw conclusions
7. compare conclusions with hypotheses for support.
8. if supported conduct further tests or if refuted create a new hypothesis.

Misunderstandings About Science

Theory in Science & Language

Theory:

•**Science:** grand scheme to explain many observations.

•**Everyday**: guess, hypothesis, prediction, notion, belief.

Science & Technology

Science: a search for understanding about the natural world.

Technology: the control of the natural world for the benefit of humans.

•Science often leads to technological advancements.

•Technology often leads to scientific discoveries.
i.e.- telescope

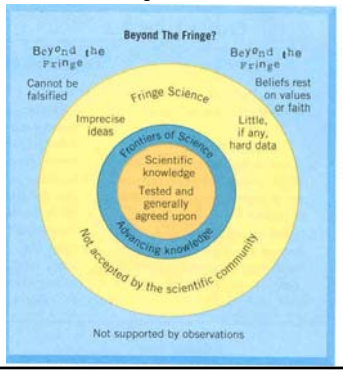
Science & Objectivity

•A myth about science is that scientists are always able to maintain their objectivity (keep their values out of work).

•Objectivity is a goal of good sciences, but unrealistic.

Psuedoscience

•Some people still insist on believing in discarded science or pseudoscience.



Media Coverage

•Most reports of science in the popular media deal with fringe & pseudoscience.

Measurements & Uncertainty

•All measurements are approximations. The degree of exactness depends upon the measuring instruments and the skill of the measurers.

•Measurement uncertainties and errors that occur during experiments are known as "experimental errors".

a. systematic errors- are repeated errors due to badly calibrated equipment,etc.

b. random errors- errors that just crop up. (i.e.-oops I dropped the flask).

•This scientific uncertainty can be reduced by instrument improvement and requiring a standard procedure.

Accuracy vs. Precision

Accuracy- a function of agreement w/an accepted value

Precision- measure of exactness.