

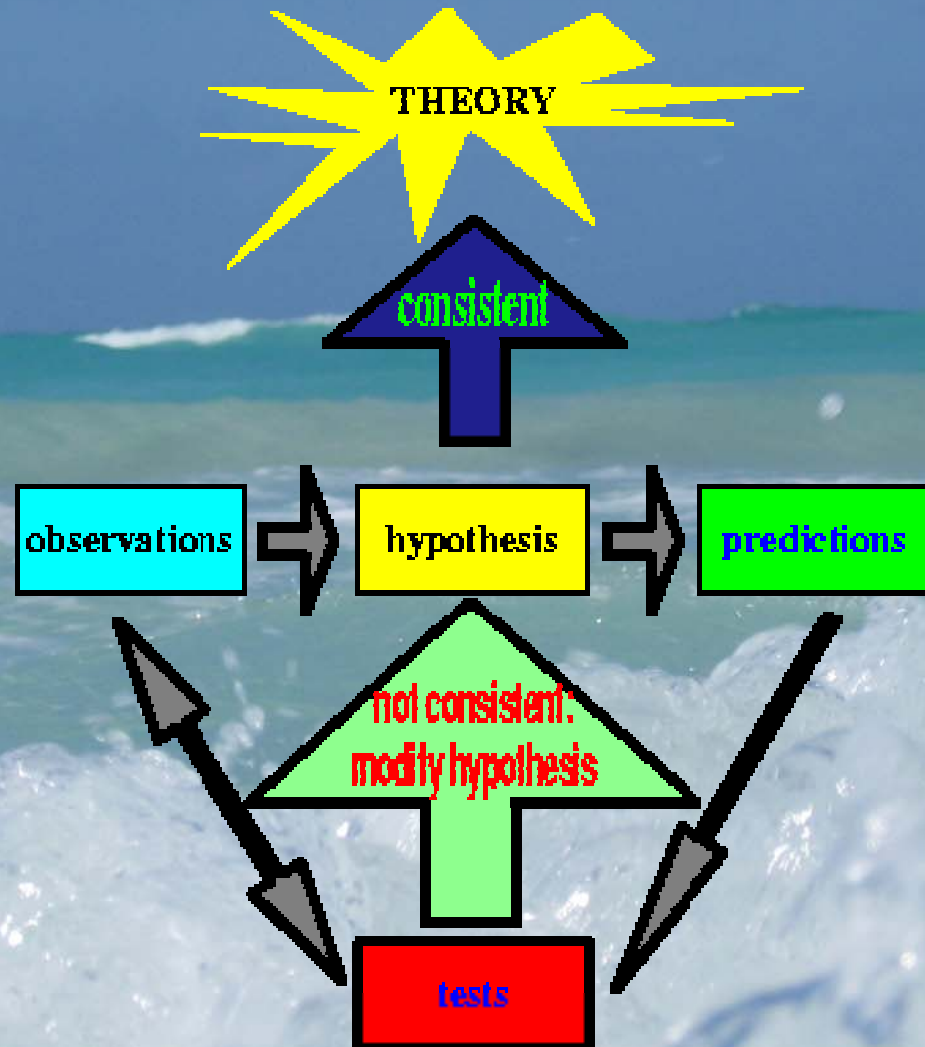
Scientific Method

Otter Bowl Diversity Event,
December 2, 2006

Scientific Method

- Scientific method is process scientists collectively and over time use to construct an accurate (reliable and consistent) representation of the world
- A way to search for truth in how the natural world works
- A process for experimentation used to answer questions and explore observations
- “Science is a way of thinking much more than it is a body of knowledge”- Carl Sagan
- “...science consists in grouping facts together so that general laws or conclusions may be drawn from them.”
Charles Darwin

Steps of Scientific Method



Observations

- Good scientist notices/observes world around them and makes observations
- Looking for patterns
- Darwin, Newton, Galileo kept notes about their environment

Observations

Spontaneous Generation

- In past people based beliefs on observations
 - i.e. spontaneous generation, the theory that living organisms come from non-living things
- Frogs are born from floods in Nile River in Egypt
- Mold in barns creates mice
- Rotting meat creates mice or flies
- Life force in air that would turn food bad
- Recipes
 - Buried bull will make bees
 - Dirty rags in a barrel of grain will make mice

Hypothesis

- Educated guess- explain observations seen
- Examples:
 - Rotting meat produces flies
 - Bacteria in the air makes soup go bad
- Make as many hypotheses as possible
- Try to base on past experiences
- Must be testable by experimentation and deductive reasoning
- Can be proven incorrect, but never prove correct with 100% certainty
 - Student examples

Predictions/Question

- Is the expected result if hypothesis and assumptions are true and your experiment can prove that
- Created to explain what is seen in observation
- Uses inductive reasoning from specific observations i.e. observed cells in animals x, y, z so all animals have cells
- Must have a simple/concrete answer that can be obtained from an experiment
- Examples
 - Where do the flies at the butcher shop come from?
 - Is there a life force in the air that causes bacteria to form?
 - How many students came to class?

Tests

- Scientist performs an experiment to test hypothesis
- Experiment must be controlled with control group and experimental group(s). Only 1 variable is tested, everything else is exactly alike.
- Examples:
 - Wide mouth jars with a piece of meat were subjected to variations of openness and one was sealed. In sealed jar no flies were seen.
 - Broth was boiled in different flasks to sterilize it. All flasks were open except control. All open containers had bacteria
- Must do multiple replications
- Your results must be reproducible by other scientists and as your methods

After Testing

- If disprove the hypothesis, back to the observations, hypothesis, predictions and tests
- Keep on going through this process until you can't disprove the hypothesis
- Each time you come to conclusions from the experiment
- When you can't disprove the hypothesis you have a **THEORY**

Theory or Paradigm

- Is a generalization based on observations and experiments- it is VERY well tested and at this point can not be unproven
- Basis for predicting future events.
- Examples
 - Gravity
 - Evolution
 - Big Bang Theory
 - Plate Tectonics

Example

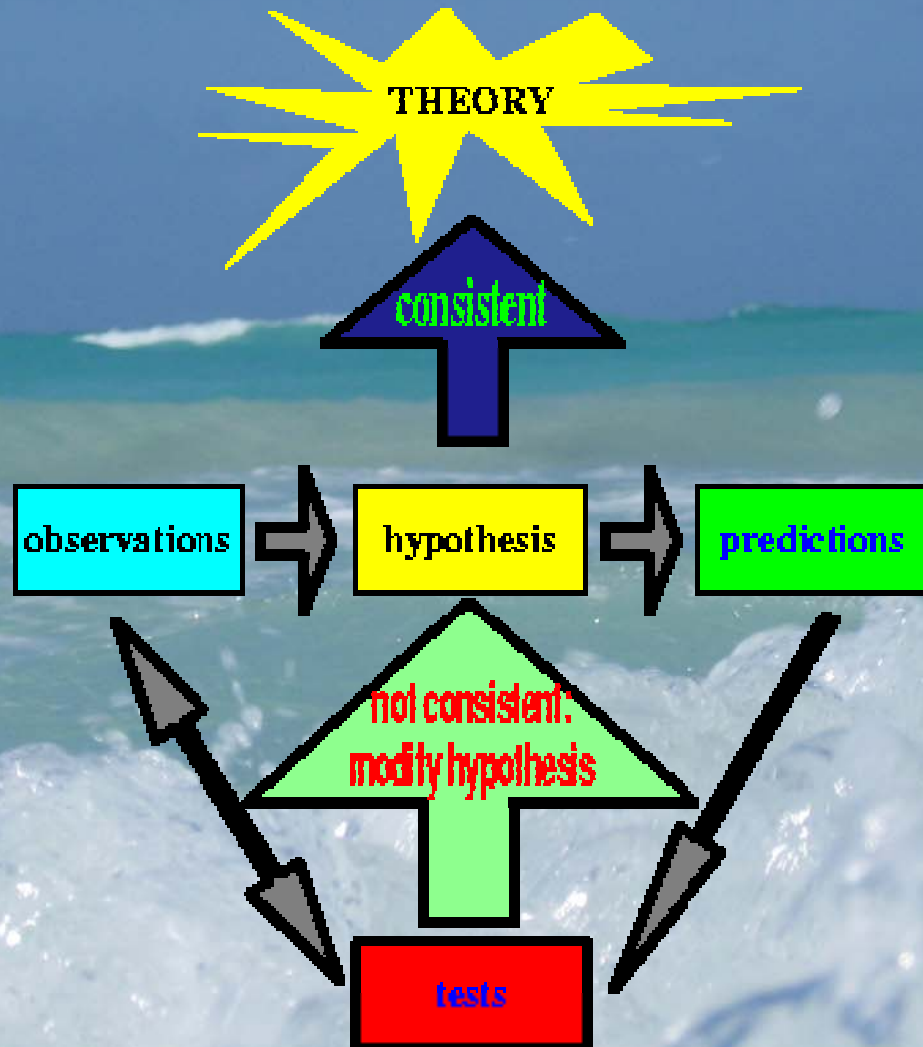
- **Observation:** Plant by window will begin to lean/grow towards window
- **Predictions/Question:** Why does the plant grow towards the window?

Hypothesis, predictions, testing

Acidification of the Oceans

- Ocean gradually becoming more acidic (pH levels decreasing)
- Increased CO_2 in the atmosphere dissolving into the ocean because of balance of CO_2 in ocean and atmosphere
- If true, acidification may cause corals to die and effect the world's ocean and ecosystems

Scientific Method



Scientific Method as it relates to Acidification of the Oceans

- Summary of issue
- Observations
- Hypothesis
- Predictions
- Testing
- Conclusions/Theory

