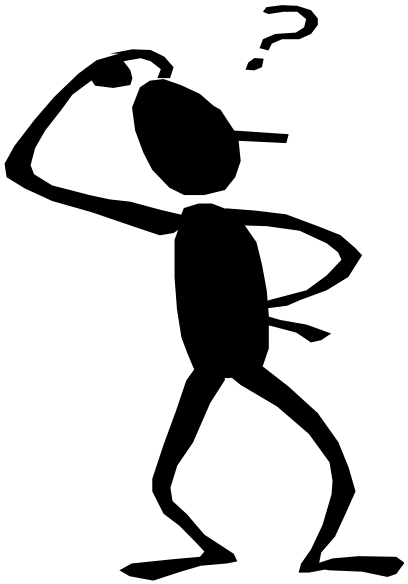
SCSh:1,2,3
The Scientific Method

The series of steps used to gather information and solve a problem

Science is…

- An organized way of using evidence to learn about the ***natural world***
- The goal of science is to investigate and understand nature, to explain events in nature, & use events to make predictions



Step 1: State the Problem

- A problem is the result of observations

- Observe nature - ask **Why** and **How** nature works the way it does

- Develop inferences: logical conclusions based on observations *(How do you think it works?)*

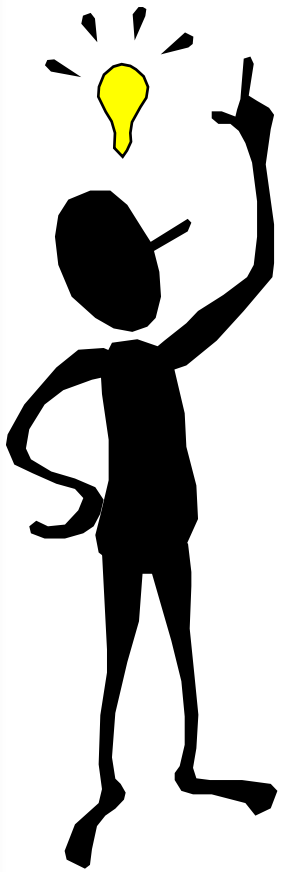
Mr. Grubbs Question:

- Mr. Grubs lived near an empty lot where boys often played baseball. One day, he heard a crash and the clinking of broken glass. Upon entering the living room, he found a broken window. He went to the door. As he opened the door & looked out, he saw John running past the house carrying a baseball bat.
- Based on the above description:
  - List 5 Observations
  - List 2 Inferences

Research

- Gather information about your problem to create logical answers to your question

Step 2: Hypothesis



- A **testable** explanation of your question/set of observations
  - Generates Predictions—the expected outcome of a test assuming the hypothesis is correct
  - Written in If, then format
  - Example: ***if*** a plant gets nitrogen, ***then*** it will grow taller than a plant without nitrogen.

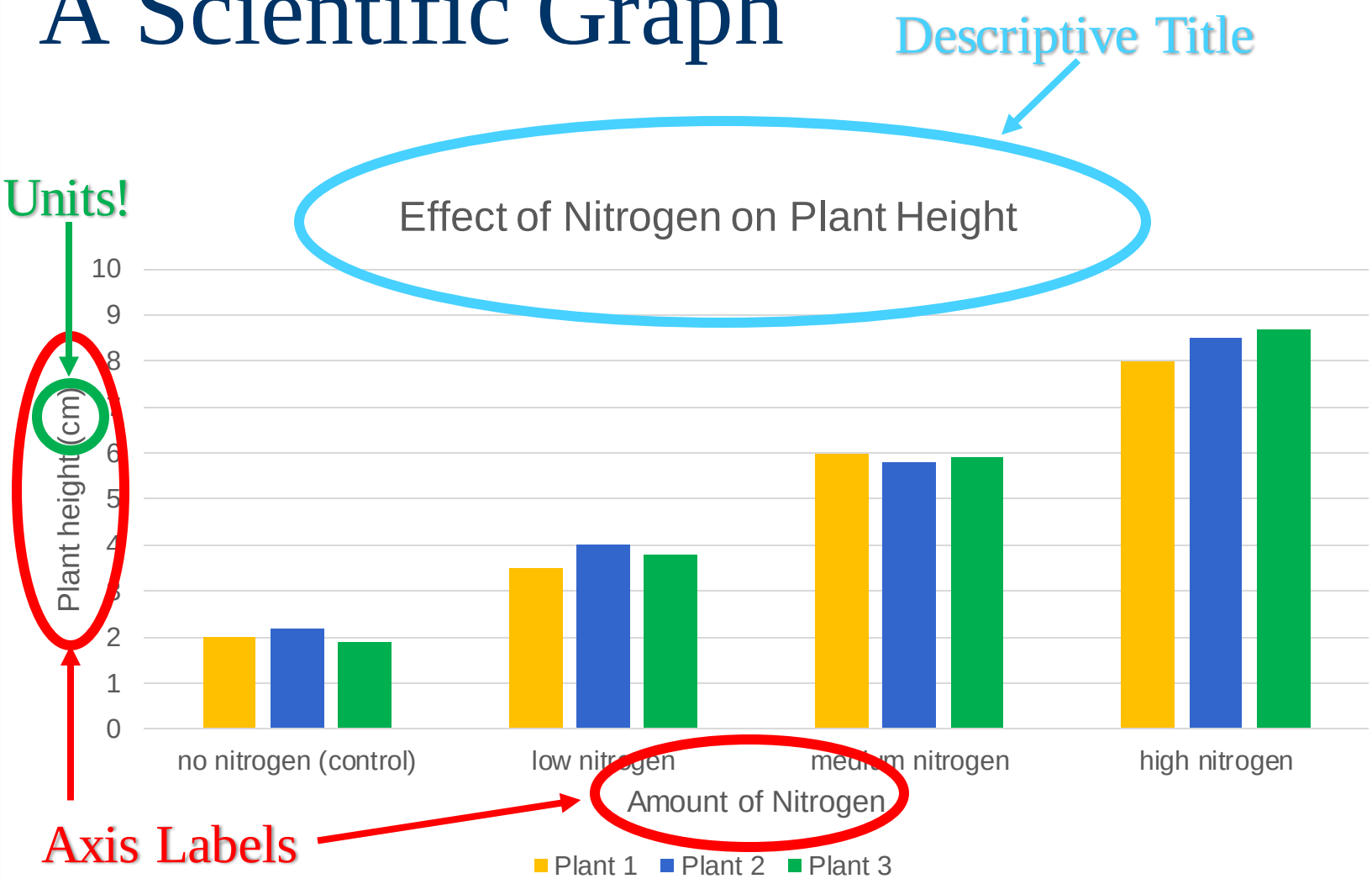
Step 3. Experiment

- **<u>Control group-</u>** Does NOT receive the independent variable (IV)
- **Experimental group**—Does receive the IV
  - **<u>I</u>ndependent variable (Manipulated variable)** —This is the factor that I change: *<u>I</u> can change it*
  - **Dependent variable (Responding variable)**—response to IV

- Graphing Variables:
  - **D**ependent, **R**esponding on **Y** axis (DRY)
  - **M**anipulated, **I**ndependent on **X** axis (MIX)

- Variables can be identified in a hypothesis:
  - If a plant has nitrogen, then it will grow taller than a plant that does not have nitrogen.
  - If…Nitrogen (IV); Then…Grow Taller (DV)

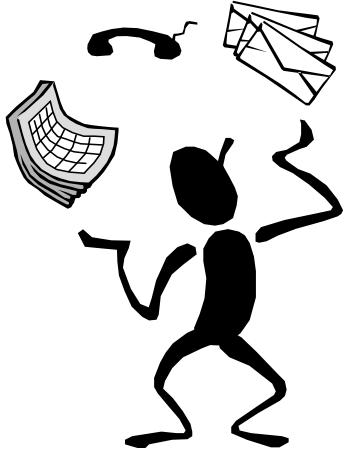
A Scientific Graph



Constants

- Constants things that remain the same—constant—in both the control and the experimental groups
  - Plant Example:
    - Always use the same type of soil
    - Always use the same amount of water and light
    - Use plants that are all the same species and age
    - Keep all the plants at the same temperature

Step 4: Analyze Data



- Compile data from experiment in order to develop a conclusion

- Data may be **quantitative** or **qualitative**
  - Quantitative—think numbers: time, distance, height, pH
  - Qualitative—color, smell, texture, taste

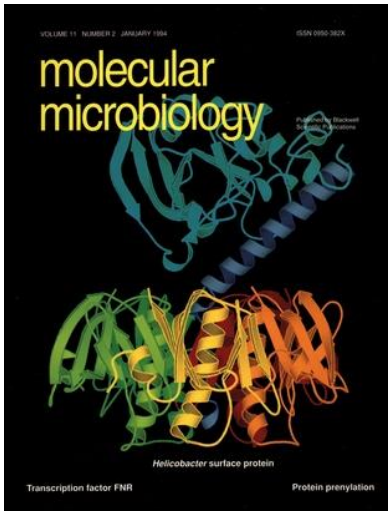
- Use graphs/charts/tables
  - Look for connections within data
  - Reflect on experiment: what could I have done differently

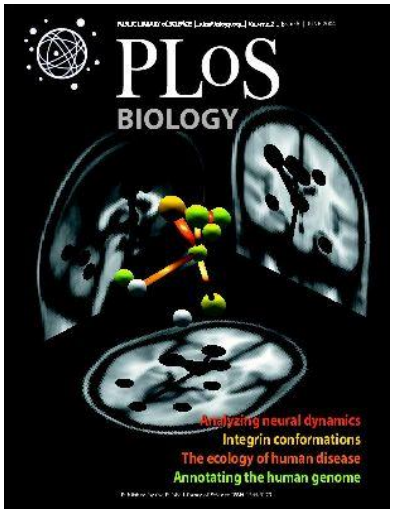
Step 5: Conclusion

- May **support (*NEVER prove)*** a hypothesis or lead one to reject a hypothesis
- Use evidence from the experiment to support your conclusion

Step 5: Publish and Repeat

- If hypothesis rejected – revise hypothesis or re-do experiment
- If hypothesis is supported – publish results (Scientific Journal) and have other scientists repeat
- *Science is under constant revision – never "proven"*





Scientific Method Mnemonic:

PINK HIPPOS EAT DARK

CHOCOLATE PUDDING

What next? Laws and Theories

- A scientific ***law*** is a principle that has been observed and is valid everywhere in the universe.
- A scientific ***theory*** isn't a random, untested idea (as the word often means in casual conversation). Instead, a scientific theory is developed only after the testing of many related hypotheses.

- *Scientists view theories as explanations that are **most likely true**, but are continually being tested.*
- Theories and laws are two separate things. ***A theory does not become a law after enough testing***. A good way to think about the difference between the two:
  - Law: description of something that is observed
  - Theory: explanation of *why* or *how* something happens (open to interpretation)