THE SCIENTIFIC METHOD

NOT JUST FOR SCIENTISTS!

Processes of Science

- Collecting data
- Organizing data
- Analyzing data
- Communicating

What is Science?

- A process through which nature is studied, discovered, and understood.
- All areas of science involve posing **INQUIRIES** (questions) about nature.

Terms and Definitions

- Theory -- The most probable **EXPLANATION** based on the best available **EVIDENCE.**
  - Example: Cell Theory, Theory of Evolution

Processes of Science

- Observing
- Hypothesizing
- Experimenting
- Measuring

Terms and Definitions

- Facts -- Data or **EVIDENCE** that can be **OBSERVED** repeatedly
  - Example: The sun rises in the East and sets in the West

Terms and Definitions

- Inference -- A **CONCLUSION** drawn on the basis of **FACTS**
  - Example: Red food dye will turn water red

Terms and Definitions

- Superstition -- A **BELIEF** that is **NOT** based on evidence
  - Example: It is considered bad luck to open an umbrella indoors.

Terms and Definitions

- Hypothesis -- An **EDUCATED** guess – a **TESTABLE** statement
  - Example: The sidewalk is wet because the sprinklers came on

Scientific Method

- 1. Stating a **problem** - something is considered a problem if its solution is not obvious. Some crucial information is missing. Solving the problem involves finding this **missing** information.

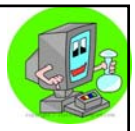
Terms and Definitions

- Law -- A general statement that **DESCRIBES** or explains a wide variety of **PHENOMENON**
  - Example: Law of Thermodynamics, Law of Gravity

Scientific Method

- 2. **Collecting** information on the problem -- the more you know about the problem the more **precisely** you can state the problem and the less time you will waste looking for solutions.

Scientific Method



- 3. Making a **hypothesis**-
  - a. Use what you know about the problem to **predict** a solution and try it.
  - b. Look for **patterns** that will help you make predictions about the problem.

Scientific Method

- 5. Make a **conclusion** - a solid conclusion is related to the hypothesis and based on the **results** of a well designed experiment.

Scientific Method

- 3. Making a **hypothesis**-
  - c. Make a **model**, or a representation, of what you're working with.
  - d. Break the problem **down** into smaller, simpler problems.

Experimental Design Concepts

- A science experiment is designed so that only **ONE** variable is being tested at a time.

Scientific Method

- 4. **Performing** an experiment - design an experiment that will provide a means for you to make a solid **conclusion** about your hypothesis

Experimental Design Concepts

- A **VARIABLE** is something that is changed to study how this change effects the thing being studied.

Experimental Design Concepts

- By changing only one variable, when you make your conclusion you can be assured that it is only that one variable that is causing the **EFFECT**.

Experimental Design Concepts

- Constant (C) - all factors that are kept the **SAME** during the experiment.

Experimental Design Concepts

- Independent variable **(IV)** - the variable that is purposely **CHANGED** by the experimenter.

Experimental Design Concepts

- **CONTROL** - the standard to compare the experimental effect against.

Experimental Design Concepts

- Dependent variable **(DV)** - the variable that responds and is the variable **MEASURED**.

Experimental Design Concepts

- Repeated trials - the **NUMBER** of objects/organisms undergoing treatment for each value of the independent variable, or the number of **TIMES** the experiment is repeated.

SCENARIO ONE: The effect of fertilizer on plants.

- **DESCRIPTION:** John's biology class was studying various ways to recycle materials, including the use of compost as fertilizer. Members of John's class are investigating the effectiveness of various recycled materials in promoting plant growth. John and three members of his lab group decided to compare the effect of compost and commercial fertilizer on plant growth. Three flats of bean plants (25 plants per flat) were grown for five days. The plants were then fertilized as follows: Flat A received 10g of commercial fertilizer; Flat B received 10g of aged compost; and Flat C received no fertilizer. The plants received the same amount of sunlight and water each day. At the end of 20 days, the students recorded the height of the plants in centimeters.

Scenario #2

IV:	Type of Metal			
Treatment:	Iron	Aluminum	Magnesium	Lead
Trials:	1 Nail	1 Nail	1 Nail	1 Nail
DV:	Amount of Rust (small, med., large) color of water			
Constants:	same water, same type of nail, equal amounts of metal, 5 days			

Scenario #1

IV:	Type of Fertilizer		
Treatment:	Comm. Fert	Compost	None
Trials:	25 plants	25 plants	25 plants
DV:	Height of plants in cm		
Constants:	Soil, type of plants, sunlight, water, amount of fertilizer, number of days		

SCENARIO THREE: The effect of perfume on the behavior of bees.

- **DESCRIPTION:** JoAnna read that certain perfume esters would cause bees to leave the hive and act in an agitated fashion. She decided to investigate the response of bees to four different perfumes- designated A, B, C, and D. She placed a saucer containing 25mL of perfume "A" 10m from a beehive. She then recorded the total number of bees that emerged from the hive during a 15-minute interval and made observations on their behavior. Using a 30-minute interval between tests to allow recovery time for the bees, she then repeated the procedure to test the remaining three samples. Each test was conducted on the same day with similar weather conditions (humidity, temperature, and wind were the same).

SCENARIO TWO: The effectiveness of various metals in preventing rust of iron.

- **DESCRIPTION**: Several weeks after Allen conducted a classroom experiment on the effectiveness of various metals in releasing hydrochloric acid, he read that the gas company was burying sheets of magnesium next to iron pipelines in order to prevent rusting. Allen wondered if other active metals would also be effective in preventing rust. To investigate, he placed each of the following into separate test tubes containing water: one iron nail; one iron nail wrapped with an aluminum strip; one iron nail wrapped with a magnesium strip; and one iron nail wrapped with a lead strip. He used the same amounts of water from the same source, equal amounts (mass) of the metal wraps, and the same type of iron nails. At the end of five days, he described the amount of rusting as small, moderate, or large. He also recorded the color of the water.

Scenario #3

IV:	Type of Perfume			
Treatment:	A	B	C	D
Trials:	1 test	1 test	1 test	1 test
DV:	Number of bees emerging, behavior observations			
Constants:	Same day, weather conditions, same bees, 30 min. interval, amnt. of perfume, distance from hive			