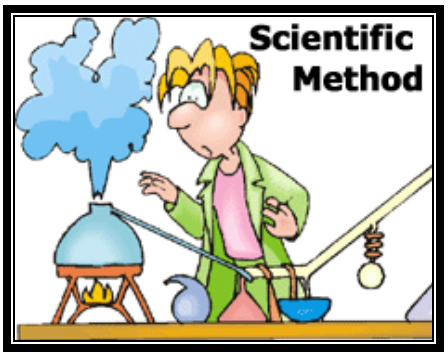
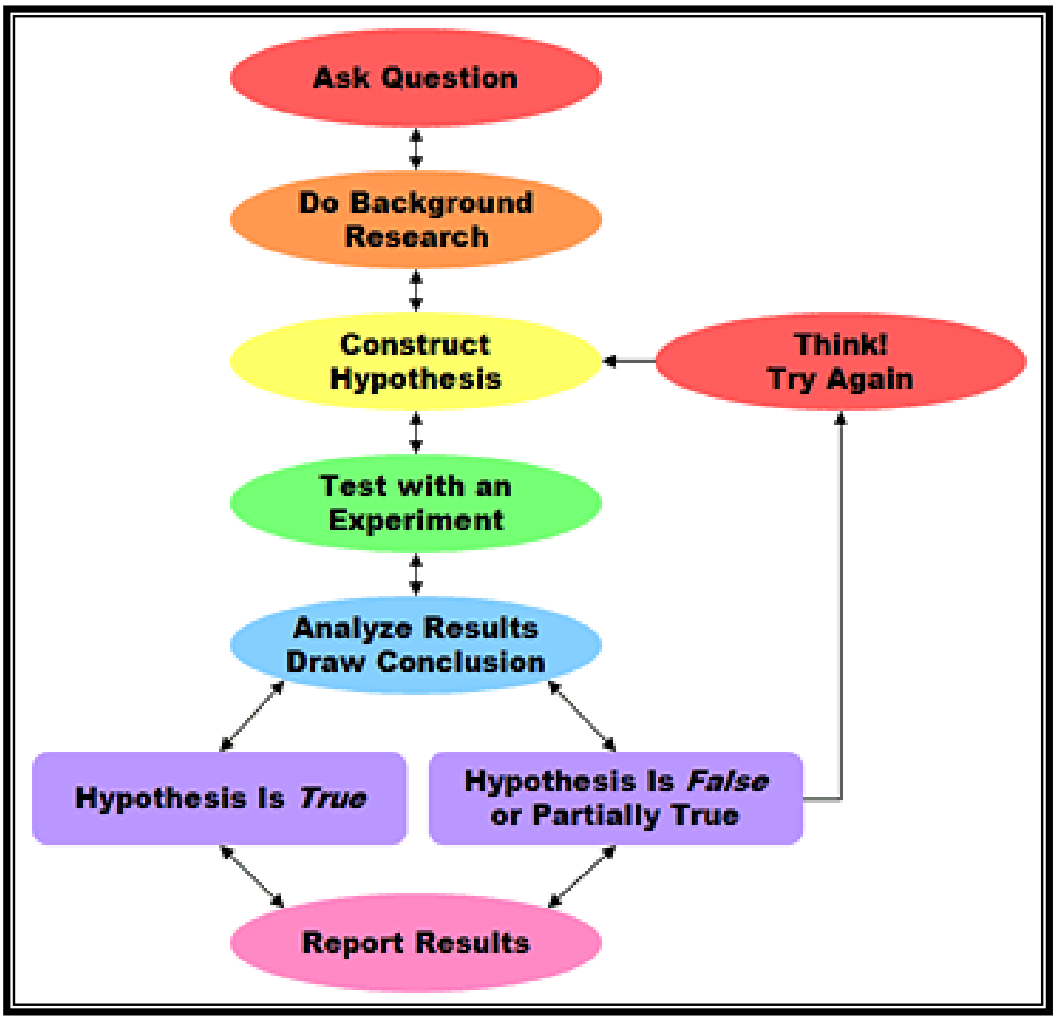


Introduction:
Science is more than a body of information. Science is dynamic; it constantly grows and changes. Scientists carry on an unending search for new information and understanding. With new knowledge, they re-evaluate old information to find out whether it is still valid.

The **SCIENTIFIC METHOD** offers a means of testing ideas and solving problems. Experimentation is the foundation on which science rests. Experimentation is also the heart of the scientific method.

DIAGRAM of the SCIENTIFIC METHOD



STEP 1: Defining the Problem

a) Make Observations

b) Ask Questions

c) Conduct Background Research*:*

--back up observations and investigate questions by reading the research of other scientists

--provides information and understanding about what has already been done to solve the problem you are interested in.

STEP 2: Developing a Hypothesis

a) A ***hypothesis*** is a prediction that serves as a possible explanation of the problem being investigated.

b) ***Hypotheses*** are educated predictions that deal with cause and effect relationships.

c) Hypotheses are always in statement form and must be measurable!

d) It can be helpful to write a hypothesis as an ***"if (this happens)… then (this will occur) …" statement***

STEP 3: Designing the Experiment

a) ***Experiment:*** a series of trials or tests that are designed to test the validity of the hypothesis

b) ***Experimental variable:*** the factor that is ***CHANGED*** or ***ALTERED*** in the experiment.

c) There are ***two types*** of experimental variables:

--***independent variable*** is the variable that is ***CHANGED*** in the experiment (the "**IF"** part of the Hypothesis)

--***dependent variable*** is the factor you measure or observe. It changes as a result of altering the independent variable (the **"THEN"** part of the hypothesis)

d) ***Control of the experiment:*** the ***standard of comparison*** for the experiment. By having a control in the experiment, you can compare the experimental group to the control group to see if there are any changes that can be attributed to the experimental variable. In this example, the control would be water and the control group would be the plants receiving only water.

e) Controlled Experiment

--One variable is changed during the testing period

--there is a control to ***compare*** your results to

--in a controlled experiment, if something changes, then you know it must be the result of altering the independent variable.

f) Constants or controlled variables: all other variables in the experiment should remain the SAME!

--if you are using plants, they must be the same species of plants, planted in similar pots of the same brand with similar soil, watered with the same amount of water at the same time, receive the same amount of light, be exposed to the same quality of air, and so on.

g) placebos: used in studies to test medications on animals or humans

-- ***a "fake" pill*** (usually sugar) ***or injection*** (usually saltwater) that is made to look, taste, and/or feel like the real medication

--given to the control group participants so no one knows who is getting the real or fake medication

--used to control for any psychological effects that might occur if a participant thought they were not getting the test medication (participants can become depressed, angry, or sad if they know they are not getting the real medication – this can affect the outcome of the experiment)

STEP 4: Data Collection

a) Data that is collected includes all measurements and observations made when running an experiment

b) Once the data has been collected, it should be organized into tables and charts to facilitate analyses of the results.

STEP 5: Analysis of Results

a) The simplest form of data analysis is to calculate percentages

b) To determine if the data is statistically different (what changed was due to the independent variable) statistical analyses should be performed statistical analysis should be performed on all collected data to determine if the results are significant. Quite often results appear to be important, but mathematically, they are really only due to chance and do not provide the support necessary to back the hypothesis.

STEP 6: Drawing Valid Conclusions

a) Results can either support or refute the hypothesis.

b) Data is ***NOT*** proof that the hypothesis is true.

c) You should always ***REPEAT*** your experiment to ***VALIDATE*** that your results are ***RELIABLE.***

Example of Using the Scientific Method

What if you loved rose bushes and you wanted to make your sunflowers grow taller. You neighbor told you about a special natural fertilizer you mix with water that he says really helps sunflowers to grow healthy and strong. After doing some background research to make sure that the ingredients in the fertilizer are not harmful to the environment and particularly to your prize sunflowers, you decide to conduct an experiment to see if this fertilizer really works.

- **Problem:** What effect does this natural fertilizer have on the growth of sunflowers?
- **Hypothesis**: If fertilizer is applied to sunflowers, then the sunflowers will grow taller in height"
- **Experimental Variable**: the fertilizer
- **Independent Variable:** whether or not fertilizer is used (the "if" part of the hypothesis)
- **Dependent Variable:** how tall the sunflowers grow from the beginning of the experiment (the "then" part of the hypothesis)
- **Control:** water only
- **Experimental Group:** rose bushes getting fertilizer and water
- **Control Group:** rose bushes getting water only
- **Constants:** sunflowers of the same type, health, and height at the beginning of the experiment. They are planted in similar pots and have the same soil. They get watered the same volume of plain water or water and fertilizer the same number of times per week. All plants have equal amounts of sun, exposure to the air, and other environmental elements
- **Data to be Collected:** Height of sunflowers at the beginning and end of the experiment
- **Organization of Data:** data chart, graph like one below – ***always make labels for each column and each row!***

Plant Number	Experiment	Control	Beginning Height (cm)	Ending Height (cm)
1				
2				
3				
4				
5				
6				

- **Results:** calculate differences, percentages, perform statistical analyses
- **Conclusions:** do the results support or refute the hypothesis?

- **Repeat your Experiment for validity and reliability!**