Chemistry Basic Training: Module 2

The Scientific Method

Module Concepts

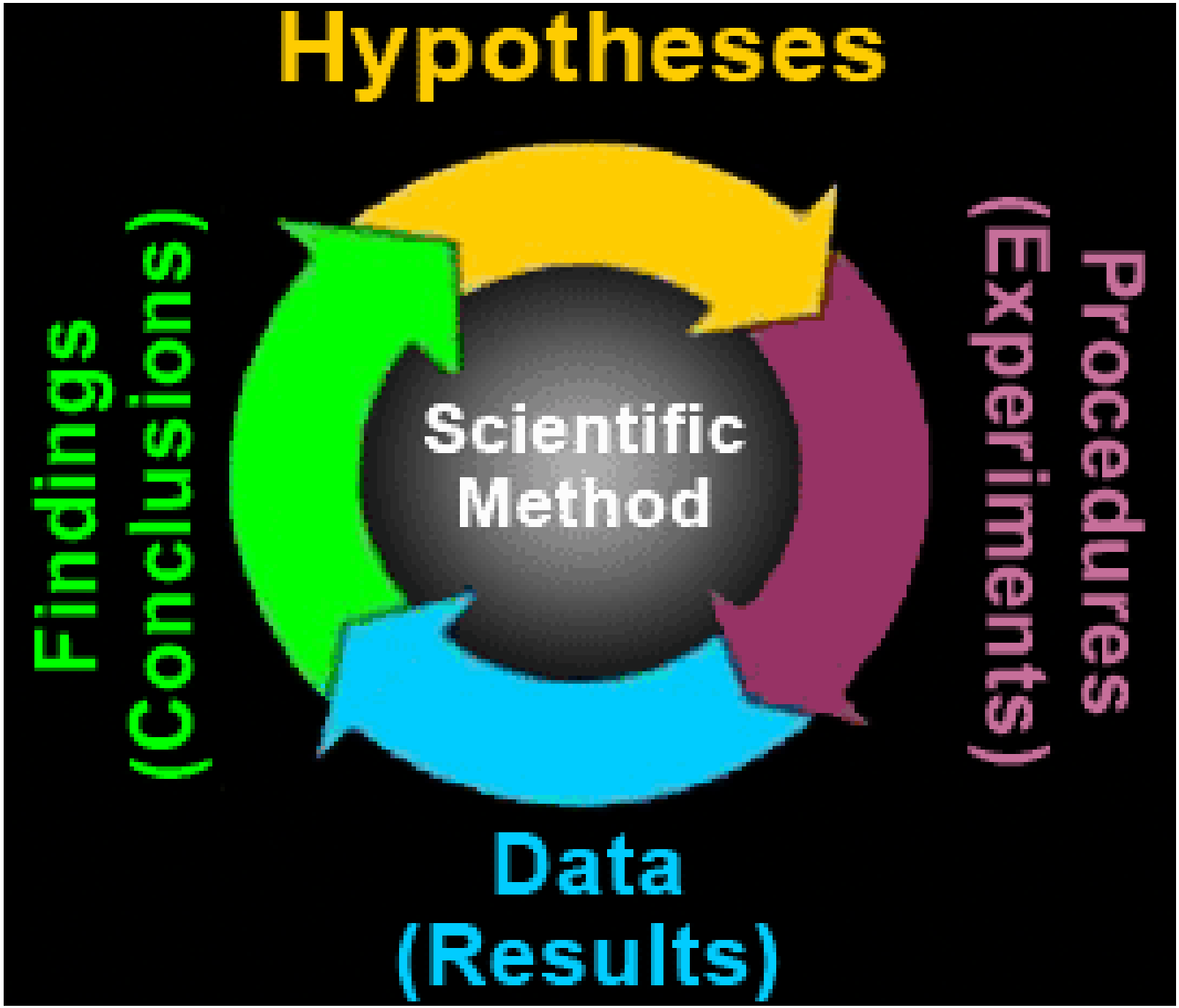
- **What is chemistry?**
- **The Scientific Method**
- **Scientific Graphs**

What is Chemistry?

- Chemistry is the study of the composition, structure, and properties of matter and the changes it undergoes.

The Scientific Method – Studying Changes in Matter

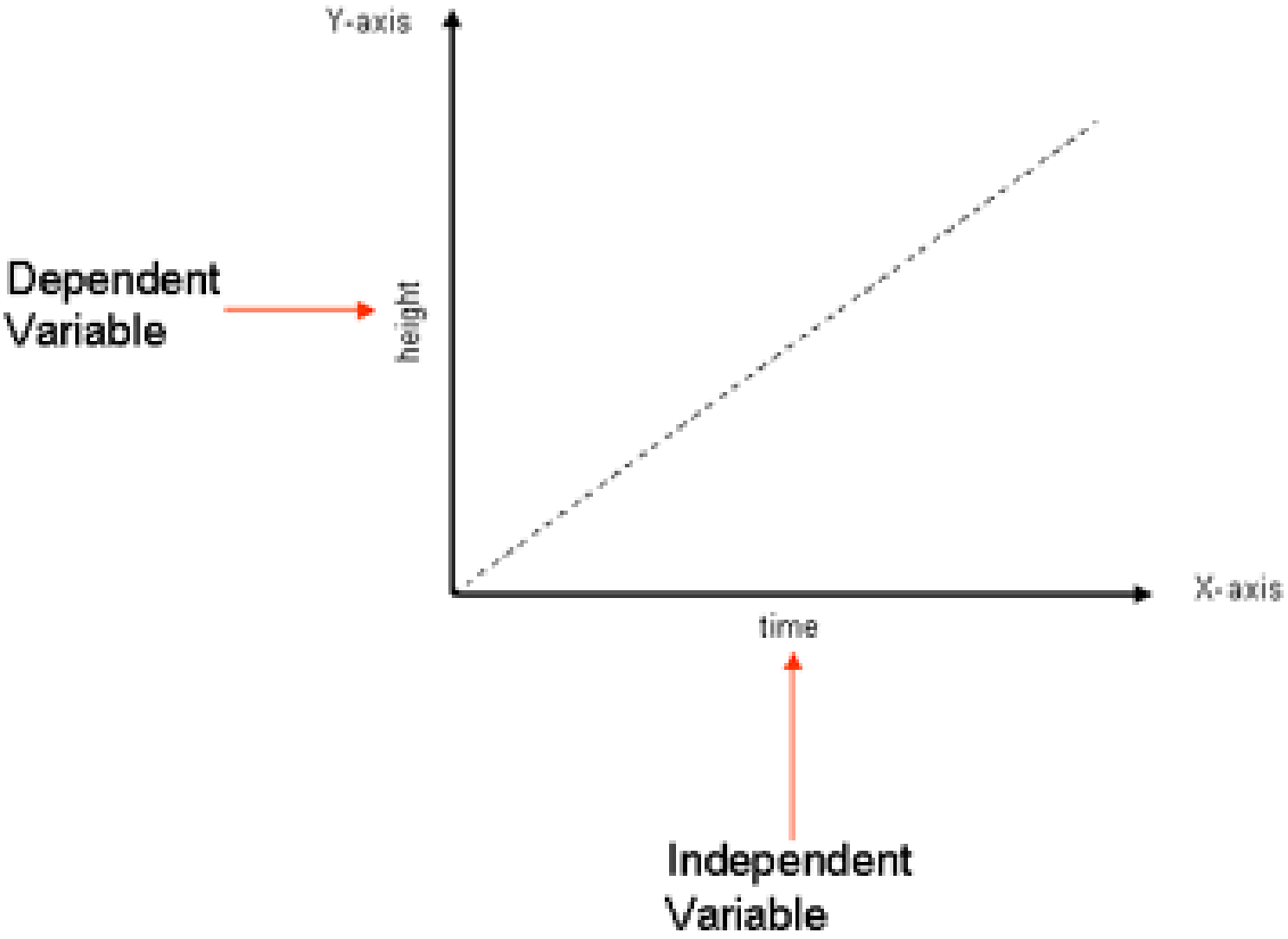
- To study the changes in matter, chemists typically use the traditional scientific method.
- The scientific method is the process of studying natural phenomena. This process includes:
  - Observation of a phenomenon.
  - Formation of a question.
  - Statement of hypothesis, a proposed solution to explain the phenomenon.
  - Experiment(s) performed to collect data to test the hypothesis.
  - Data analysis and interpretation.
  - Conclusion, always referring back to the hypothesis.
  - Repeat.
  - Generate a theory, a set of assumptions put forth to explain some aspect of the observed behavior of matter.


Hypotheses
Procedures
(Experiments)
Data
(Results)
Findings
(Conclusions)
Scientific
Method

Experiments

- Variables are the factors that could potentially affect the outcome of the experiment.
  - The independent variable is manipulated by the experimenter in order to produce a change. This appears on the x-axis when the data is plotted.
  - The dependent variable is what is being measured or observed in response to the independent variable. This appears on the y-axis when the data is plotted.

Scientific Graphs



Experiments – Cont'd

- Constants are possible variables that are kept the same throughout the experiment.
- The experimental control (if any) is the experiment done without or in the absence of the "variable" whose effect on the outcome of the experiment is being investigated.

Experiments – Cont'd

- A good experiment only changes one variable at a time.

Using the Scientific Method in Real Life: Mrs. Karpovich's Green Hair!

The Question/Problem:

- Mrs. Karpovich discovered, much to her dismay, that her blond hair turned green. What is causing her hair to turn green?

Preliminary Observations:

- Mrs. Karpovich noticed that greenish-blue colored residue formed around her shower and sink drains.
- Mrs. Karpovich's house had copper pipes! (What *color* are copper ions?)
- Mrs. Karpovich's plumbing system used untreated well water.

The Hypothesis:

- The highly acidic well water dissolved the copper from the pipes. The presence of copper ions in Mrs. Karpovich's plumbing system caused her hair to turn green.

Using the Scientific Method in Real Life: Mrs. Karpovich's Green Hair!

The "Experiment":

- To test her hypothesis, Mrs. Karpovich measured the pH of the well water.

The Results:

- The pH of the water was very acidic (pH = ~3).

The Conclusion:

- The experimental data verified Mrs. Karpovich's hypothesis and compelled her to come up with a plan to renovate the outdated copper plumbing system in her house.

Laws vs. Theories

With your elbow partner, define a scientific law and scientific theory.

Discuss with the class.

Scientific Law

- Laws are generalizations or universal relationships related to the way that some aspect of the natural world behaves under certain conditions.
- Laws **DESCRIBE** a phenomenon.

Scientific Theory

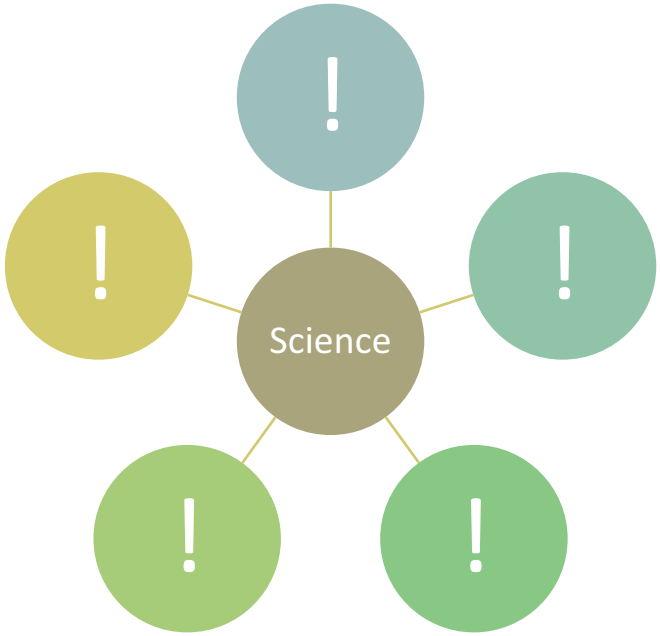
- Theories are inferred **EXPLANATIONS** of some aspect of the natural world.
- Theories DO NOT become laws even with additional evidence; they explain laws.
- However, not all scientific laws have accompanying explanatory theories.

Laws vs. Theories

- Laws **describe**.
- Theories **explain.**
- Theories **DO NOT** got “promoted” to laws.

The Nature of Science
Mind Mapping Exercise

- Think about various characteristics, attributes, assumptions about science in general.
- Let's make a class mind map on the chalkboard about science.



The Nature of Science (NoS)

The nature of science refers to the foundational concepts that govern the way scientists formulate explanations about the natural world. The nature of science includes the following concepts:

- The natural world is understandable;
- Science is based on evidence - both observational and experimental;
- Science is a blend of logic and innovation;
- Scientific ideas are durable yet subject to change as new data are collected;
- Science is a complex social endeavor; and
- Scientists try to remain objective and engage in peer review to help avoid bias.

The Nature of Science (NoS)

Discuss:

- What are some common themes in our mind map?
- How do these themes compare to the NoS?