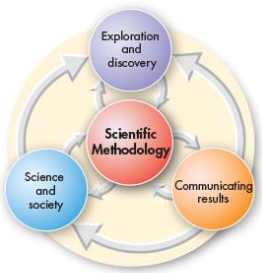
The Science of Biology: What is Science

SC.912.N.1.1; SC.912,N.2.1; SC.912.N.2.2; **SC.912.N.1.7;** SC.912.L.14.1

Exploration and Discovery: Where Ideas Come From

- Scientific methodology is closely linked to exploration and discovery.
- Scientific methodology starts with observations and questions that may be inspired by scientific attitudes, practical problems, and new technology.



Adapted from Understanding Science, UC Berkeley, Museum of Paleontology

Science as a Way of Knowing

- Science enables us to take actions that affect events in the world around us.
- To make certain that scientific knowledge is used for the benefit of society, all of us must understand the nature of science.

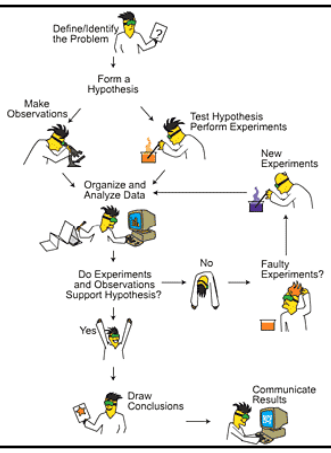
Adapted from Understanding Science, UC Berkeley, Museum of Paleontology

Science, Ethics, and Morality

- When scientists explain "why" something happens, their explanation involves only natural phenomena. Pure science does not include ethical or moral viewpoints.

Adapted from Understanding Science, UC Berkeley, Museum of Paleontology

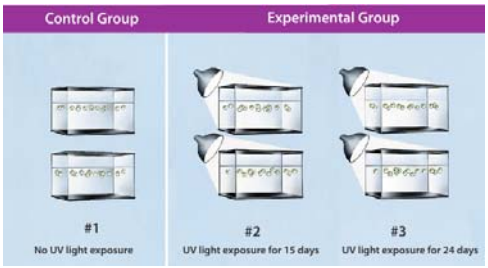
- For example, biologists try to explain in scientific terms what life is and how it operates, but science cannot answer questions about why life exists or what the meaning of life is.
- Similarly, science can tell us how technology and scientific knowledge can be applied but not whether it should be applied in particular ways.



Designing an Experiment

- **Performing the Experiment**
  - A ***controlled experiment*** compares an *experimental group* and a *control group* and only has one variable.

Controlled Experiment and Variable



Testing the Effect of UV Light on Frogs

— Factors — Groups —

	#1 Control	#2 Experimental	#3 Experimental
Type of frog	leopard frog	leopard frog	leopard frog
# of eggs	100	100	100
Temperature of water	25°C	25°C	25°C
Variable: UV light exposure	0 days	15 days	24 days

Remember: A variable is a factor in a controlled experiment that changes The other factors should remain consistent

Designing an Experiment

- **Performing an Experiment**
  - The **control group** provides a normal standard against which the biologist can compare results of the experimental group.
  - The **experimental group** is identical to the control group except for one factor.
  - The experimenter manipulates the **independent variable,** then measures the **dependent variable** as it is affected by the independent variable.

Designing an Experiment, *continued*

- **Testing the Experiment**
  - Experiments should be conducted without bias and they should be repeated.

Collecting and Analyzing Data

- **Analyzing and Comparing Data**
  - Scientists analyze data to draw conclusions about the experiment performed.

Observations:

Qualitative -
describes (color, solid, bubbles)
"the powder is white"

Quantitative -
number (mass, length, temperature)
"the mass is 25.7 grams"

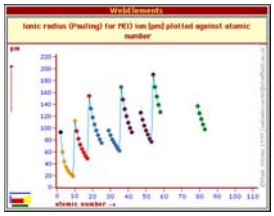
Drawing Conclusions

- **Making Inferences**
  - An *inference* is a conclusion made on the basis of facts and previous knowledge rather than on direct observations.
- **Applying Results and Building Models**
  - Scientists often apply their findings about the natural world to solve practical problems.

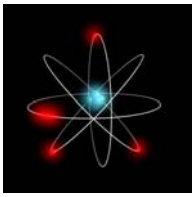
Scientists AVOID:

Inferences -
implies meaning to an observation without data
the solution is hot vs. 100° C

Instead they
find relationships and patterns and form generalizations based on data

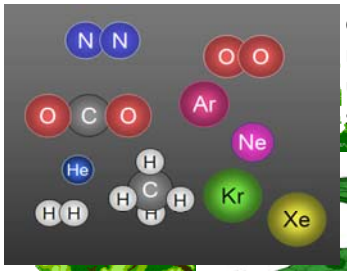


Create models:



Models –
an object that explains or simulates how phenomena occur and events are related

Ex: Visual, Graphics, Simulations



observe and create models so we can understand the submicroscopic

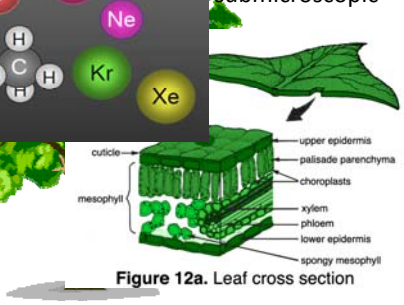


Figure 12a. Leaf cross section

Scientists experiment

Hypothesis:
A *testable* statement
"if . . . then"

Theory:
An accepted *explanation* of a body of facts or phenomena with considerable evidence to support it
"Tells why"

Law: *Statement* that summarizes natural phenomena (does not explain)
"Tells what"

Unlike acorns growing into trees…

Theories do **NOT** grow into Laws!

Communicating Ideas

- **Publishing a Paper**
  - Scientists submit research papers to scientific journals for publication.
  - In *peer review*, the editors of a journal will send submitted papers out to experts in the field who anonymously read and critique the paper.

Honesty and Bias

- Communication between scientists about their methods and results helps prevent dishonesty and bias in science.

Peer Review

- Scientists share their findings with the scientific community by publishing articles that have undergone peer review.
- In peer review, scientific papers are reviewed by anonymous, independent experts.
- Reviewers read them looking for oversights, unfair influences, fraud, or mistakes in techniques or reasoning.
  - They provide expert assessment of the work to ensure that the highest standards of quality are met.

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Science is . . .	Science is NOT . . .
Observable	A collection of facts
Based on experimentation	Based on beliefs
Theories derived from solid evidence	Subject to debate or law
Open to change	Rigid, absolute certain

Units of Measurement

- **Base and Other Units**
  - The metric system has seven base units

SI Base Units

Base quantity	Name	Abbreviation
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	cd

Scientific Measurement: Common Metric Units

Common Metric Units

Length	Mass	Volume	Temperature
1 meter (m) = 100 centimeters (cm) 1 meter = 1000 millimeters (mm) 1000 meters = 1 kilometer (km)	1 kilogram (kg) = 1000 grams (g) 1 gram = 1000 milligrams (mg) 1000 kilograms = 1 metric ton (t)	1 liter (L) = 1000 milliliters (mL) 1 liter = 1000 cubic centimeters (cm^3)	0°C = freezing point of water 100°C = boiling point of water