

What is Science?

Science -

an organized way of gathering and analyzing evidence about the natural world

✓ Knowledge gained through experience

✓ Accumulated **body of knowledge** through observation and or experimentation

✓ Facts gained by **systematic study**

Science is more than a body of knowledge, it is a way of thinking, a way of skeptically interrogating the universe - Carl Sagan

Assumptions to do Science

- 1. There is order in the Universe
- 2. The human mind is capable of comprehending this order
- 3. If conditions are the same, the results of any study will be the same

Which of the following statements can be tested scientifically?

- Most of the energy from the Sun is in the form of visible light
- Marvel comics are better than DC comics
- Earth is about 4 billion years old
- Unicorns are real
- A trophy elk is more important than a wolf
- Evolution takes eons (a very long time!) to occur

Good scientists exhibit certain traits

- 1. Curiosity
- 2. Honesty
- 3. An open mind
- 4. Willingness to be wrong and make mistakes
- 5. Ask good questions
- 6. Skepticism



The School of Athens - Raphael (1511)

The Scientific Method

Thinking scientifically involves the development of knowledge by <u>observation</u> and <u>experimentation</u>

Observations can lead to 2 ways to approach an experiment:

- 1. <u>Inductive reasoning</u>: specific to general
- 2. <u>Deductive reasoning</u>: general to specific

The Scientific Method

The scientific method is more like a cycle than a series of steps



Case Study

Ignaz Semmelweis (1856) Semmelweis

Observations:

- Childbirth deaths are 5 times higher from clinics staffed by doctors and medical students than clinics staffed by nurses and midwifes due to "childbirth fever"
- Doctors often performed autopsies and nurses did not



CASE STUDY

Ignaz Semmelweis (1856)

Hypothesis:

Doctors transmit "cadaveric matter" to their patients

Prediction:

If Doctors washed their hands it would eliminate cadaveric matter from being transmitted to patients





Correlation does not always mean causation







Experimental Design

<u>Control – nothing changes (no new variable added)</u> (doctors do not wash hands)

Independent variable – what changes (doctors wash off *"cadaveric material"*)

Dependent variable – changes in response to independent variable – what you measure for results (# patients getting "childbed fever")



Data Collection

Quantitative data = numbers obtained by counting or measuring

(# of patients affected, % concentration of soap used etc....)

Qualitative data = descriptive observation

(severity of symptoms, age of patients, first birth? etc....)



Results and Analysis

Childbirth deaths reduced when doctors washed their hands

Conclusions

Did the experiment support the hypothesis? What new hypotheses can be made and tested? In biology, not all hypotheses can be tested in a controlled experiment (Does taking prenatal vitamins during pregnancy cause a higher IQ?)

Transmission of "cadaveric material" caused "childbirth fever"

CASE STUDY

So what affect did this have on the scientific community?

- Semmelweis's observations conflicted with the established scientific and medical opinions of the time.
- His ideas were rejected by the medical community.
- Semmelweis could offer no acceptable scientific explanation, and some doctors were offended at the suggestion that they should wash their hands.
- Semmelweis's practice earned widespread acceptance only years after his death, when *Louis Pateur* confirmed the *germ theory*

SCIENTIFIC THEORY

Theory = a well-tested explanation that unifies a broad range of observations and hypotheses

✓ Theories have been tested and supported by many lines of evidence

✓ They are the dominant view among scientists

Examples: Relativity (gravity), Cell, Germ, Natural Selection, Evolution



"Nothing yet. ... How about you, Newton?"

Scientific Law

Law = a statement based on repeated experimental observations that describes some aspect of the universe.

Example: Newtons Law of Universal Gravitation

Review: The Scientific Method

The scientific method is a process of <u>observing</u> natural phenomena, which leads to <u>asking questions</u>, and offering explanations that can be scientifically tested.

- 1. Observation
- 2. Hypothesis
- 3. Prediction
- 4. Experiment
- 5. Analysis
- 6. Conclusion
- 7. Observation

Characteristics of Living Things



Characteristics of Living Things

- 1) Universal genetic code DNA
- 2) Grow and develop
- 3) Respond to their environment
- 4) Reproduce (sexually or asexually)
- 5) Maintain a stable internal environment = homeostasis
- 6) Obtain and use material and energy = metabolism
- 7) Made of cells
- 8) As a group they evolve (change)