

The Nature of Biology

The Nature of Science

- **Science** is an ongoing, human, cultural activity which involves the efforts of many people to describe the world in mutually acceptable terms.
- Scientific knowledge is the cumulative results of the best efforts of finite people.
- Science is never complete or perfect.

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The Scientist

- Fundamental Attitudes.
 - The events in the world are within the scope of human comprehension.
 - All experiences must eventually be explained with consistent terms.
 - Observations must be understandable and repeatable.
 - Generalizations must be testable.

The Nature of Biology

Common Methods

- Acquiring Knowledge.
 - **Reproducible observations** - foundation of scientific knowledge.
 - Qualitative - a simple description of an object or phenomenon.
 - Quantitative - careful measurements are made.
 - **Generalizations** - a summary explanation of the observation.
 - Inductive reasoning - formation of a general statement from specific observations (“persuasion”).
 - Hypothesis - initial, untested generalization (“educated guess”).

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Common Methods

- Acquiring Knowledge.
 - Experiment - practical test of the hypothesis.
 - Deductive reasoning - logical process of formulating predictions from hypothesis.
 - Controlled experiments - the *control group* and the *experimental group* differ in only one factor known as the controlled variable.
 - Fact - correct hypotheses that have been thoroughly tested
 - Theory (Laws and Principle)
 - Scientifically acceptable general principle offered to explain observed facts.

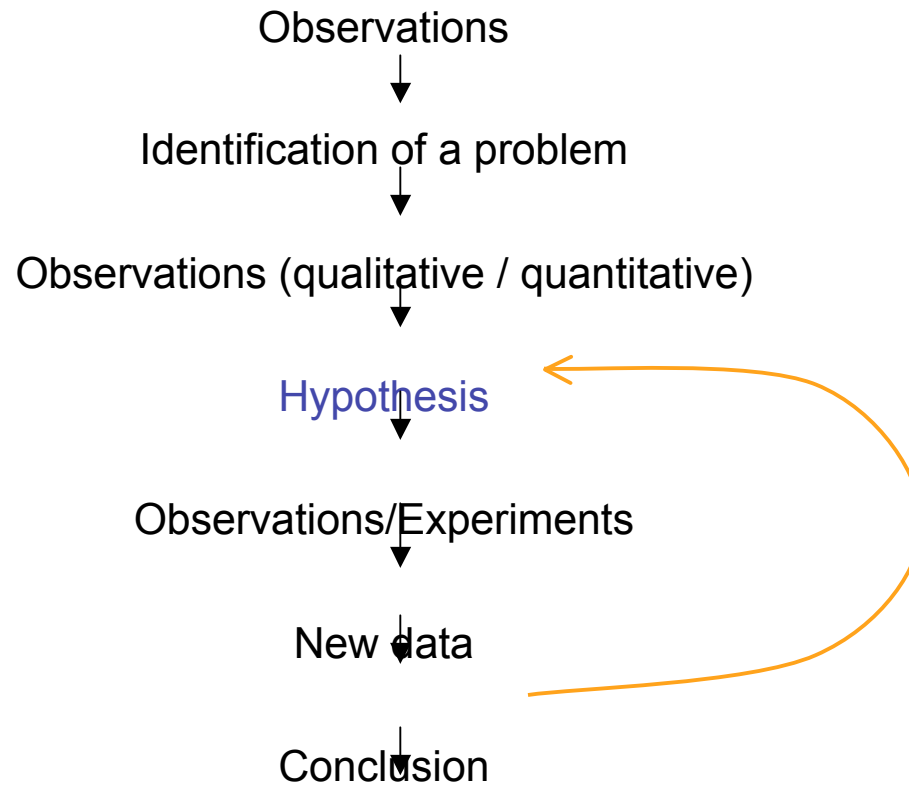
The Nature of Biology

The **Scientific Method**

- The set of procedures that form a rational approach to studying the natural world

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The **Scientific Method** includes:



Conclusion --> **Theory** <-- Conclusion

The Nature of Biology

Why Study Biology ?

- Biology is relevant
 - Great advances
 - Bioengineering
 - Population has grown
 - Emerging technologies

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Biology is Relevant

- Great Advances
 - 19th and 20th centuries
 - disease was caused by pathogens
 - Today
 - emphasis turning to physiological malfunctions
 - Past diseases fatal -- now treated
- *News flash ... Antibiotic resistance ('superbugs')*

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Biology is Relevant

- Bioengineering
 - New “Green” Revolution
 - development of new corn plant varieties
 - genetically enhanced
 - resist pests and draught
 - cold tolerant
 - Alleviate world hunger?

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Biology is Relevant

- Population growth
 - Tough decisions facing couples, nations, and beyond
 - Where to put new cities, farms, etc.?
 - How to monitor and manage existing wildlife areas
- *News flash ... Scientist acknowledge role of humans in climate change. ('Greenhouse gases')*

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Biology is Relevant

- Emerging Technologies (computers)
 - Bridging the gap between biology & technology
 - New career opportunities
 - biotechnology (labs)
 - applied technologies (fieldwork)
 - combination of both fields

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Biology can be Controversial

- Questions:
 - Family planning - birth control?
 - How much \$\$\$ to spend - endangered species?
 - Biomedical research - human fetal tissue ethical?
 - Dangers in cloning animals? Humans?
 - Irradiated food safe to eat?
- *News flash ... Chefs join campaign against altered fish*

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Biology can be Controversial

- Some controversies remain within biology
- Others involve economic, moral, ethical, & religious considerations
- Biology can help understanding
 - identify options
 - describe impacts
- *News flash ... Scientists seek approval to clone human embryos*

The Nature of Biology

Biology - the scientific investigation of life

- Complementarity of structure and function.
 - Every structure had a function
 - Structure implies function / function emerges from structure.
- For Biologists, life is:
 - The set of characteristics that distinguish living systems (organisms) from nonliving systems (inanimate objects).
 - Properties of living systems.

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Properties of living systems.

Properties of living systems

Cellular organization

Metabolism

Respond to stimuli

Homeostasis

Growth and development

Genetic material

Reproduction

Ecological relationships

- Organization

- The “[Cell Theory](#)”

- The cell is the smallest unit capable of exhibiting all characteristics of life.
 - All living systems are composed of one or more cells.
 - All cells comes from pre-existing cells.

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- Levels of Organization

- Each life form has levels of organization

(atoms >> molecules >> cells >> tissues >> organs >> organ systems >> organism)

- Molecules - cluster of atoms that are arranged in some order through molecular bonds
- Polymers - large molecules joined together from monomers
- Organelle - a structure with a specialized function within a cell

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- Levels of Organization

- Cell - a unit of living matter separated from its environment by a boundary (membrane)
- Tissues - groups a similar cells that have a common function
- Organs - a structure consisting of several tissues adapted as a group to perform a specific function

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- Levels of Organization

- Organ systems - group of organs that work together (performing specific functions)
- Organism - an individual living thing

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- Metabolism

- Chemical processes that occur in living cells.
- Every living cell has the capacity to
 - Obtain and convert energy from its surroundings
 - Use energy to maintain itself, grow & make more cells
- Metabolism is the foundation by which cells are able to maintain homeostasis.

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- Metabolism

- Metabolism is involved in all the of the following living processes:

- Reproduction
- Excretion
- Nutrition
- Respiration
- Growth
- Death
- “Movement”

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- Response to stimuli
 - Living organisms can respond to external stimuli.
 - Reaction of an organism to a stimulus is called **behavior**.

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- Homeostasis

- Capacity to keep a physiological “steady-state” that supports life.
- Examples:
 - the body’s ability to maintain a normal internal temperature.

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- Growth & Development
 - Living systems grow & develop.
 - **Growth** - increase in size & number of cells.
 - **Development** - includes all the changes that take place between conception & death.

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- Genetic material (“Genetic basis of life.”)
 - **Genetic material** (*DNA, nucleic acids*) possess a molecular code which regulates hereditary information of a living organism.
 - This genetic information is derived from previously living organisms.

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- Reproduction
 - **Biogenesis** - life comes from pre-existing life.
 - Living organisms produce offspring similar to themselves by transmitting at least some of their genetic material.

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- Ecological relationships

- In a given region, all living things are closely related with each other and the environment.
- Ecological organization

(species >> population >> community >> ecosystem >> biome >> biosphere)