Biology 101 Section 1
The Scientific Study of Life

Biology = the study of living things and their interactions.

Bio – life

logy – study of

What is life? Consider the meaning of what is alive.

Organization in Nature (Life's Levels of Biological Organization)

1. Living and non-living matter are composed of the same material particles
2. DNA separates living from non-living things
3. The cell is the basic unit of life
4. Levels follow this series:

Molecular
Cellular
Tissues
Organs
Organ Systems
Organisms
Populations
Communities
Ecosystems (Biosphere)

*This order represents life's hierarchy of complexity, from least to most

The Scientific Method

The Scientific Method is an investigative process that seeks to discover rational explanations for the natural world. Explanations in biology are sought using the scientific method, a system of rational reasoning and critical thinking.

Steps:

1) Make **Observations** about the natural world: objective, quantitative, many forms using all senses
2) Ask **Questions** about those observations
3) Develop **Hypotheses**: tentative, logical explanations that attempt to answer the questions
4) Make **Predictions**: deductive reasoning to predict the results if hypothesis is correct, "If…..then" logic (like Sherlock Holmes)
5) Tests: test hypotheses with **Experimentation**, models, etc. and record observations
6) **Revision**: either accept present hypothesis in current form and form a conclusion or revise it. Re-test

The scientific process also is:

- involves critical thinking at every step
- a cyclic process of repeated experimentation
- is a cumulative process
- can either support or falsify a hypothesis

A word on "Hypothesis"!

- Must be *testable*
- Must be *falsifiable* (not the same thing as false)
- Must be evidential based
- Does not deal with absolute truths (it is not treated as dogma)

What is a Theory?

A hypothesis that has survived *rigorous testing*, is widely accepted, has a broad scope, depends upon measurable facts, and is supported by a large body of empirical evidence. (Note: a Scientific Theory is not the same as the term 'theory' used in the general culture!)

Ex. Theory of Evolution

What is a Law?

A widely accepted principle that makes predictions but has no explanatory power.

Ex. Laws of Thermodynamics

<u>Evolution, Unity and Diversity</u>

Some features of living organisms are determined by **ENVIRONMENT**.

Others are determined by **HEREDITY**.

Life is very diverse = >2 million species

Ex. plasmodium slime mold – grizzly bear

How many students in this class have heard of the French Impressionist painter Monet? Art students who are familiar with Monet's work can probably pick out a Monet painting from a gallery of different paintings, because of the unity of theme and style in his work. Each Monet painting is unique in its subject and effect, in other words, there is a tremendous diversity in his paintings. Yet there is also a stylistic unity. In Monet's work, there is unity in the midst of diversity.

Life is unified in a hierarchical classification system (Linnaean)

- Organisms are identified by genus and species scientific name
- Groupings go from least (bottom) to most (top) inclusive

Domain
Kingdom
Phylum/Division
Class
Order
Family
Genus
Species

3 Domains:

1) Bacteria
2) Archaea
3) Eukarya

5 Major Kingdoms

1) **Monera** = bacteria
2) **Protista** = algae and protozoans
3) **Fungi** = molds, yeast, mushrooms
4) **Plantae** = plants
5) **Animalia** = animals

What is life? What distinguishes life from non-life? What unifies life?

<u>Characteristics of Life</u>

1. Order
2. Regulation
3. Growth and Development
4. Energy Utilization
5. Responsiveness
6. Reproduction

<u>Evolution as a Unifying Theme of Life</u>

- Evolution explains the unity of life, how all things are connected
- Evolution = genetic (heritable) changes in a population or species over generations. All life is evolving.
- Charles Darwin:
  - born in 1809
  - in 1831 began a round-the-world voyage at age 22 on board the *H.M.S. Beagle* as a naturalist
  - 1859 published "On the Origin of Species"
  - proposed a mechanism for evolution

- Evolution vs. Spontaneous Generation

MACROEVOLUTION = big changes, accumulated from small changes over long periods of time
MICROEVOLUTION = small changes in the relative frequencies of traits (such as color) in a population

Theory of Evolution: Has two parts

1) Natural Selection = differential, or unequal, success in reproduction. (compare to artificial)
2) Adaptation = share a *common ancestor*, that is species arise as the result of descent with modification.

- Principles it is based upon:
  1. One has variation within a population
  2. These are largely heritable traits
  3. There is overproduction of offspring
  4. Presence of selection pressures (limited natural resources)
  5. Subsequent struggle to survive
  6. Better adapted traits lead to preferential reproduction
  7. Small changes over geologic time

What is a species?

Biological Species Definition!!!

A population or group of populations whose members have the potential to interbreed and produce fertile offspring.

Evolutionary Species Concept:

A species represents a cluster of organisms that share a geneology, or lineage of descent.

Origins of Life: Early Chemical and Biological Evolution