

The Science of Life (pg. 1)

- Biology unifies much of natural science
 - Biological systems are the most complex chemical systems on Earth
 - The complexity of living organisms is made possible by the Sun, a constant source of energy
 - The process of photosynthesis is "one of the most beautiful and complex processes in physics and chemistry"
- Life defies simple definition
 - Biology is the study of living things (the science of life)
 - Characteristics of living organisms:
 - Cellular organization: All organisms consist of one or more cells, all bounded by a membrane that separates it from its surroundings.
 - Ordered complexity: All living things are very complex and ordered. Although nonliving things can be complex, they do not compare to the complexity of living things.
 - Sensitivity: Living things respond to stimuli.
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 - Plants respond to light
 - Pupil size changes upon a change in darkness
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 - Growth, development and reproduction: all living organisms are capable of reproduction in which the offspring is the same species with the same hereditary traits
 - Energy utilization: Organisms take in energy and use it in some way.
 - Homeostasis: a process in which organisms maintain constant internal conditions different from their environment.
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 - Body temperature remains stable despite the environmental conditions
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 - Evolutionary adaptation: Organisms interact with one another along with the nonliving environment. They do this for their survival- therefore; organisms evolve adaptations to their environments.
- Living systems show hierarchical organization
 - The Cellular Level
 - Atoms: the fundamental elements of matter
 - Molecules: a grouping of atoms into clusters
 - Organelles: Molecules assembled into tiny structures
 - Cells: membrane-bound units
 - Considered the basic unit of life
 - The Organismal Level
 - Tissues: groups of similar cells that act as a functional unit
 - Organs: groups of tissues. Can also be composed of several

- different tissues
 - Organ systems: Organs group together.
 - Example: The nervous system
 - Composed of sensory organs, the brain and spinal cord and neurons.
- The Populational Level
 - Population: a group of organisms of the same species living in the same place.
 - Species: populations of a particular kind of organism together.
 - Biological community: consists of all the populations of different species living in one place together.
- The Ecosystem Level
 - Ecosystem (or ecological system): a biological community.
 - Example: A mountain ecosystem (consisting of soil, water and the atmosphere) interact with the biological community.
- The Biosphere
 - Biosphere: The entire planet
- Therefore: Atoms → Molecule → Organelle → Cell → Tissue → Organ → Organ system → Organism → Population → Species → Community → Ecosystem → Biosphere
- Emergent properties: the changing of novel properties as one moves up the biological hierarchy (above). One cannot draw conclusions from the knowledge of a single component.
 - Example: One cannot examine a single cell and determine that it is a giraffe.

The Nature of Science (pg. 4)

- Science uses both deductive and inductive reasoning
 - Deductive reasoning: applies general principles to predict specific results.
 - Example: If all mammals have hair, and an animal is found that does NOT have hair, one can conclude that the hairless animal is not a mammal.
 - Inductive reasoning: applies specific principles to generate generic results.
 - Example: If poodles have hair, if Terries have hair, then all dogs must have hair.
- Hypothesis-driven science makes and tests predictions
 - After making observations, scientists construct a hypothesis (a suggested explanation that accounts for the recorded observations)
 - Hypothesis can be iterative, meaning that they can be changed based upon new data.
- Testing hypotheses
 - Experiment: the test of a hypotheses
 - A successful experiment is one which hypotheses have been tested, rejected, and then discarded.
- Establishing controls
 - Variable: A factor that influences an outcome. Often, scientists try to

- isolate variable to test their hypotheses.
 - Test experiment: When a variable is altered in an experiment in order to test a hypothesis
 - Control experiment: When the variable is left unaltered in an experiment.
- Reductionism breaks larger systems into their component parts
 - In order for scientists to understand a large, complex system, they use the process called **reductionism** (breaking the system down to its component parts)
 - This process is not easy because sometimes the components may act differently by themselves than they do as a system.
- The nature of scientific theories
 - Several uses for the word "theory"
 - A proposed explanation for some natural phenomenon;
 - Body of interconnected concepts, explained by scientific reasoning and experimental evidence, that explains facts in a specific area of study
- Research can be basic or applied
 - Basic research: intended to extend the boundaries of what we know.
 - These individuals usually work in universities
 - Applied research: When people apply the findings from basic researching.
 - Individuals are employed in some type of industry; such was manufacturing goods, creating new drugs or testing environmental qualities.

An Example of Scientific Inquiry: Darwin and Evolution (pg. 8)

- The idea of evolution existed prior to Darwin
 - Evolution: Genetic change in a population of organisms. Generally, evolution change is from simple to complex.
- Darwin proposed natural selection as a mechanism for evolution
 - Natural selection: the differential reproduction of genotypes that is caused by factors in the environment, which leads to evolutionary change.
 - Artificial selection: Change in the genetic structure of populations due to interference with humans.
 - Often, animals and crops are artificially selected in order to appear more appealing.
- The predictions of natural selection have been tested
 - Darwin's theories have been tested many ways:
 - The fossil record: Darwin predicted that fossils would yield links between groups of organisms, such as fishes and amphibians. Natural selection allows scientists to see the transitional forms of several organisms.
 - The age of earth: Physicists argued that the Earth was only a few thousand years ago, however Darwin proved them wrong through his theory of evolution.
 - Comparative anatomy:
 - Homologous: bones in species that have the same evolutionary origin, however now they differ in structure