**Chapter 8**

**Where Did We Come From? The Evidence for Evolution**

**What is Evolution? – The Process of Evolution**

* Biological populations
  + Groups of individuals of the same species that are subdivided from other populations by geography
* Biological evolution
  + Change in the characteristics of a population of organisms that occurs of over the course of generations.
  + Evolutionary changes are inherited via **genes**.
  + Other changes may take place because of environmental changes and are not necessarily evolutionary.
* Pesticide resistant lice are an example of biological evolution.
* **Natural selection** – the differential survival and reproduction of individuals in a population
  + Process by which **populations** adapt to varying environments
* Examples:
  + Pesticide resistance in crop-eating insects
  + Antibiotic resistance in infectious bacteria
* **Microevolution** – changes that occur within a species and the characteristics of a population. Easily observed, relatively non-controversial.
* **Macroevolution** – changes that occur, as a result of microevolution, over long periods of time and result in the origin of new species. Controversial among non-biologists.

**What is Evolution? – The Theory of Evolution**

* Ambiguity of the word “theory”
  + Everyday usage: theory = best guess, or tentative explanation
  + Scientific usage: theory = body of accepted general principles, supported by many lines of evidence.
    - Examples: atomic theory, gravity, germ theory.
* **Theory of evolution** 
  + All species present on earth today are descendents of a single common ancestor, and all species represent the product of millions of years of accumulated evolutionary changes.
* Theory of Evolution is sometimes called “Darwinism” because Charles Darwin is largely credited with introducing the concept to mainstream science.
* Many philosophers of science before Darwin had notions of organisms changing over time.
  + Anaximander – Greek philosopher who suggested that humans evolved from fish that had moved onto land
  + Lamarck – published ideas about inheritance of acquired traits in 1809

**Charles Darwin and the Theory of Evolution - The Voyage of the Beagle**

* At age 22, Darwin set sail as ship’s naturalist aboard the *HMS Beagle* on a five year long trip.
* Darwin’s job was to collect and observe “anything worthy to be noted for natural history.”
* Darwin had a book by Lyell, *Principles of Geology*, which postulated earth was old and changes occurred over long periods of time.
* The following had influences on Darwin during the voyage:
  + Rainforests of Brazil
  + Fossils that he collected
  + Birds and reptiles of the Galapagos Islands

**Charles Darwin and the Theory of Evolution - Developing the Hypothesis of Common Descent**

* Darwin returned to England in 1836, but did not publish his ideas immediately.
  + Spent about 20 years refining his ideas
  + Learned about animal husbandry (selective breeding)
  + Finally published *On the Origin of Species* in 1858

**Alternative Ideas on the Origins and Relationship among Organisms**

* Theory of common descent is controversial. There are some possible alternative hypotheses that can be tested against available data.
  + Static model hypothesis
  + Transformation hypothesis
  + Separate types

**Examining the Evidence for Common Descent**

* Several lines of biological evidence point to a common ancestor:
  + Biological classification
  + Anatomical similarities between organisms
  + Useless traits in modern species
  + Shared developmental pathways
  + DNA similarities
  + Distribution of organisms on earth (biogeography)
  + Fossil evidence
* **Biological classification** implies common ancestry.
* Linnaean Classification
  + Gives each species a two-part or binomial name in Latin
  + Carolus Linnaeus groups organisms in a hierarchy going from broadest to narrowest groupings
* **Anatomical homology**
  + Mammalian forelimbs have the same set of bones. The underlying structure is similar despite the very different functions.
* Useless traits in modern species
  + **Vestigial traits** are traits that function in one organism but are greatly reduced in others
  + For example:
    - Ostrich and penguins form wings but do not fly because the wings are non-functional
    - Humans have a tailbone by have no tail

**Examining the Evidence for Common Descent –Developmental Homologies**

* A consequence of shared developmental pathways is similarity among chordate embryos

**Examining the Evidence for Common Descent – Molecular Homology**

* DNA similarities
  + Birds in same genus have DNA that is more similar to one another, while distantly-classified birds have DNA that is less similar.
* **Molecular clock** allows the use of DNA sequence differences between species to determine when they diverged from their common ancestor.

**Examining the Evidence for Common Descent – Biogeography**

* **Biogeography** is the distribution of species on earth.
  + Different species of mockingbird found on Galapagos all resemble another species found on the mainland.

**Examining the Evidence for Common Descent –The Fossil Record**

* **Fossils** are remains of living organisms left in soil or rock.
  + Horse fossils provide a good sequence of evolutionary change within a lineage.
* **Fossilization** is the formation of fossils
* Bipedal humans have some unique anatomical traits, such as features of hips, knees, and skull.
* Anatomical differences between humans and chimpanzees allow for identification of fossils

**Examining the Evidence for Common Descent –Radiometric Dating**

* Radiometric dating
  + Used to determine age of rocks
  + Relies on decay of radioactive isotopes into daughter products
  + The rate of decay is measured by the element’s **half-life**
  + Using radiometric dating, scientists have estimated the age of fossil hominims.
  + Trends in human evolution
  + Larger brains, Flatter face, Reduced jaw size

**Are Alternatives to the Theory of Evolution Equally Valid?**

* The same lines of evidence that support common descent can be used to look for the closest relatives of humans.
* Table 10.1 summarizes the evidence for common descent.

**Are Alternatives to the Theory of Evolution Equally Valid? – The Origin of Life**

* The origin of life
  + Evolution is the study of how life changes.
  + It doesn’t really address issue of how life began.
  + Experiment evidence does give some clues about beginnings of life.
  + Evidence for the theory of common descent demonstrates **consilience**.
* Evolutionary theory informs all aspects of modern biology.
  + Evolutionary theory helps us understand the function of human genes.
  + Evolutionary theory is important to understanding species interactions.
  + Evolutionary theory is important for predicting the biological consequences of climate change.