Theories of Organic Evolution

**X Multiple Centers of Creation (de Buffon)**

- developed the concept of "centers of creation"
- throughout the world organisms had arisen, which other species had evolved from

**X Catastrophism (Georges Cuvier)**

- suggestion that a succession of catastrophes periodically destroyed all life and necessitated the repopulation of the world by successive acts of special creation
Acquired characteristics (Jean Baptiste de Lamarck)

- change that occurs during a lifetime of an organism are the result of the use or disuse of parts which can be passed on to the next generation

theory is not valid ... acquired characteristics cannot be inherited

no experimental evidence has been found to support this theory
Principles of Evolution - Origin of Species

Natural Selection (C. Darwin / A. Wallace / T. Malthus)

Basic idea of natural selection:

- organisms that are better adapted to an environment in which they live produce more viable offspring, increasing their proportion to the population
- therefore, they are being selected for

Result of natural selection:

- evolutionary adaptation - a population’s increase in the frequency of traits that are suited to the environment
Evidence for Organic Evolution

**Paleontology** - the study of fossils

- **fossils** - preserved remains or impressions left by once-living organisms
- **fossil record** - reveals through the years, a general change and increase in the diversity and complexity of life
  - proves that organisms have appeared in historical sequences
Evidence for Organic Evolution

**Comparative Anatomy**

- **homologous organs**
  - derived from same basic evolutionary origin
  - similarities are seen best in embryonic development
  - organisms are classified on the basis of shared homologies
Homologous v. Analogous

Homologous structures
• features that have different functions, but are structurally similar
Homologous v. Analogous

**analogous structures**
- features that have similar functions, but have evolved independently and have entirely different structures
Evidence for Organic Evolution

vestigial organs
• humans (muscles to move their ears, vestigial tailbone)
• vestigial toes in the horse

• vestigial limbs in whales and snakes
Evidence for Organic Evolution

**Embryology**

**comparative embryology**

- comparison of structures that appear during the development of different organisms
- similarities in embryonic development gives evidence for evolutionary relationships
Evidence for Organic Evolution

Comparative Biochemistry

• similarities and differences in molecules (structure and function)
• "structure defines function"

example:
antigen-antibody technique reveals a basic similarity between blood proteins of organisms
Evidence for Organic Evolution

Molecular Biology

- evolutionary relationships among species leaves signs in DNA and proteins (genes and gene products)
- matching sequences of genes and proteins reveal common ancestors

<table>
<thead>
<tr>
<th>Species pairs</th>
<th>% difference in nucleotide sequence between species pairs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human - human</td>
<td>0.05 - 1.0</td>
</tr>
<tr>
<td>Human - chimpanzee</td>
<td>2.5</td>
</tr>
<tr>
<td>Human - gibbon</td>
<td>5.1</td>
</tr>
<tr>
<td>Human - Old world monkey</td>
<td>9.0</td>
</tr>
<tr>
<td>Human - New world monkey</td>
<td>15.8</td>
</tr>
<tr>
<td>Human - lemur</td>
<td>42.0</td>
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</table>
Basic Principles of Natural Selection

**Overpopulation** - organisms produce an excessive numbers of offspring

- natural resources are limited
- excessive offspring --> struggle for existence among individuals of a population
- only a small percentage of offspring will survive in each generation

**Variation** - offspring possess different characteristics (inheritable)
Basic Principles of Natural Selection

... putting it together ...

"Survival of the fittest"

- offspring with inherited traits that are best suited to the habitat (adaptation) are more likely to survive and reproduce than less fit individuals.
Principles of Evolution

Terminology

**organic evolution**
- the change in gene frequency

**population**
- a group of individuals of the same species living in the same area at the same time
- the smallest biological unit that can evolve

Evolutionary impact of natural selection is only apparent in tracking how a population changes over time (individual organisms do not evolve during their lifetime)
Principles of Evolution

Population Genetics

Field of science

• emphasizes the genetic variation within populations
• tracks the genetic makeup of populations over time
Principles of Evolution

Sources of Genetic Change (variation) in populations

mutations
• random changes in genetic material

bacteria
• short generation spans
• evolve rapidly by mutations alone

animals / plants
• long generation times
• depend on sexual reproduction (recombination) for genetic variation
Principles of Evolution

How can we tell if a population is evolving?

• understanding through defining what is *not evolving*
  non-evolving = genetic equilibrium

• gene pool remains constant over time
  *gene pool* is the sum total of all genes in the population
Principles of Evolution

Microevolution

The generation-to-generation change in a population's frequency of alleles (alternate forms of genes)

Four mechanisms of microevolution

• mutations - random changes in genetic material
• natural selection
• genetic drift
• gene flow
Four mechanisms of microevolution

- genetic drift - random effects of chance on a gene pool of a small population
Principles of Evolution

Four mechanisms of microevolution

gene flow
• genetic exchange (gain or loss of genes) with another population

• via migration or immigration
  - organism enters (leaves) a population, introducing (removing) genes into (from) gene pool
Microevolution v. Macroevolution

**Microevolution** is a change in the gene pool of a population.
- changes within a species

If this is all that happens then we would find only one specialized population, but there exist many populations of organisms ...

**Macroevolution** is a change in life-form, the origin of a new taxonomic groups (new species, new genera, new kingdoms)
- formation of new species
Principles of Evolution - Effects of Evolution

Adaptation

• the inherited change of form, function and behavior

• natural selection exerts positive selection pressures
  --> producing the patterns in a population
Principles of Evolution - Effects of Evolution

Diversification

**adaptive radiation**
- offspring of a population already adapted to one habitat, radiate out into newly available habitats

**convergent adaptations** (convergent evolution)
- independent development of similar features in organisms in response to similar environmental factors
- fish and whales have evolved similar stream-lined bodies and fins

**divergent adaptations** (divergent evolution)
- independent development of different features as a result of different selective pressures
Principles of Evolution - Effects of Evolution

Speciation

• formation of a new species