Evolution: Diversification of Life
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Major Concepts

• Evolution involves three processes
  – reproduction (heritability and over-production)
  – variation
  – “selection”
• Natural selection and genetic drift drive evolution
• Not a linear or directed process
• Extant diversity is a result of >3.5 billion years of evolution
Nothing in biology makes sense except in the light of evolution

- Theodosius Dobzhansky

I am a creationist and an evolutionist. Evolution is God's, or Nature's method of creation. Creation is not an event that happened in 4004 BC; it is a process that began some 10 billion years ago and is still under way.

- Theodosius Dobzhansky
Evolution

- Life has a history
- Different species share common ancestors

Phylogeny: “family tree”, or how organisms are related

Evolution: descent with modification

- small scale changes (gene frequency in a population from one generation to another, “microevolution”)
- large scale changes (descent of different species from a common ancestor over many generations, “macroevolution”)
Evolution requires three processes:

- Reproduction (heritability and over-production)
- Variation
- “Selection” (natural selection and genetic drift)

Evolution: Reproduction

- Heritability: traits are passed to offspring
  - Recognized early in history, but Gregor Mendel ("father of genetics") formalized its study using peas (29,000!)
  - 50 years later DNA indentified (Watson and Crick) as the carrier of genetic information
  - Many many more details...
Evolution: Reproduction

- **Over-production**: more offspring produced than survive to reproduce (typically)

Evolution: Variation

- Offspring are not identical to parent or each other
- Mechanisms:
  - **Mutations**: changes in the DNA caused by the environment or the lack of 100% fidelity in replication
  - **Gene flow**: movement of genes from one population to another (i.e. new genes or alleles (different forms of a gene) introduced, or taken away)
  - **Sex**: new combinations of genes or alleles
Evolution: “Selection”

- **Natural selection**: favorable heritable traits become more common in successive generations of a population of reproducing organisms.

- **Genetic Drift** (allelic drift): accumulation of random events that change the makeup of a gene pool slightly, but often compound over time.
Evolution: in process

Origin of Species, Darwin (1859)

Evolution is not directed (“trees not ladders”)

Aristotle’s “Chain of being”

Many aborted paths...
Evolution: Key Events

**Serial Endosymbiosis Theory**

Eukaryotes arose through the merger of multiple prokaryotic cells.

- **Aerobic Bacteria** → Eukaryote → Animals
- **Anaerobic Bacteria** → Eukaryote
- **Photosynthetic Bacteria** → Photosynthetic Eukaryote → Plants

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Evolution: Key Events

**Origins of Plants**

- **Colonial**
- **Unicellular**
- **Multicellular**
  - marine alga
  - terrestrial moss
Evolution: Key Events

Origins of Animals

Evolution: Timing of Key and Selected Events

<table>
<thead>
<tr>
<th>Organism</th>
<th>First Appearance (mya)</th>
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<tbody>
<tr>
<td>Prokaryotes</td>
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<tr>
<td>Photosynthetic</td>
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<td>Eukaryotes</td>
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<td>Invertebrates</td>
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<td>Vertebrates</td>
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<td>Land Plants</td>
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<td>Mammals</td>
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<td>Apes</td>
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<td>Humans</td>
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<td>You</td>
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Most of evolution (historically) occurred in the oceans
Organisms that we are familiar with (higher organisms) are relatively recent
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