IV. Macroevolutionary Pattern

A. Tempo of Speciation
   1. gradualism
   2. punctuated equilibrium

B. Phylogenetic Reconstruction
   1. an example
   2. the problem of convergent evolution
   3. molecular traits
A cartoon of the evolution of species diversity

Millions of species

MULTI-CELL ORGANISMS

EUKARYOTES

PROKARYOTES

EARTH FORMED

One species
Finches of the Galapagos Islands

- Medium ground finch
- Large ground finch
  - G. magnirostris
  - G. fortis
  - G. fuliginosa
  - G. conirostris
  - Sharp-beaked ground finch
    - G. difficilis
    - Seed eaters
    - Cactus flower eaters
      - Ground finches
        - Genus Geospiza
        - Common ancestor from South American mainland
      - Tree finches
        - Genus Camarhynchus
        - Bud eater
        - Insect eaters
      - Warbler finches
        - Genus Certhidea
          - Green warbler finch
          - Mangrove finch
          - Grey warbler finch
          - Certhidea olivacea
          - Certhidea fusca

(c) The Galápagos finches

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Fig. 24. 6

(a) Allopatric speciation
(b) Sympatric speciation
Sympatric speciation??
Fig. 24. 17

(a) Gradualism model

(b) Punctuated equilibrium model
Two possible phylogenetic reconstructions for 6 species

Time

1 2 3 4 5 6

= speciation

Ancestral species

OR

Ancestral species
The problem of **convergent evolution**: the Tasmanian wolf is more closely related to the kangaroo than it is to the North American red wolf.
<table>
<thead>
<tr>
<th>Species</th>
<th>Number of Amino Acids That Differ from a Human Hemoglobin Polypeptide (Total Chain Length = 146 Amino Acids)</th>
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<tr>
<td>Human</td>
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<tr>
<td>Rhesus monkey</td>
<td>8</td>
</tr>
<tr>
<td>Mouse</td>
<td>27</td>
</tr>
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<td>Chicken</td>
<td>45</td>
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<td>Frog</td>
<td>67</td>
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<td>Lamprey</td>
<td>125</td>
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</tbody>
</table>

Table 22.1 Molecular Data and the Evolutionary Relationships of Vertebrates
A cartoon of the Tree of Life

One species

Multi-cell organisms

Eukaryotes

Prokaryotes

Earth formed

Millions of species