EARTH HISTORY AND MACROEVOLUTION

- The combination of events associated with the origin, diversification, extinction, and interactions of organisms which produced the species that currently inhabit the Earth.
- Large scale evolutionary change such as the evolution of new species (or even higher taxa) and extinction of species.

Are Birds Really Dinosaurs with Feathers?

- Did birds evolve from dinosaurs?
- Evolutionary biologists investigate this question by looking at the fossil record

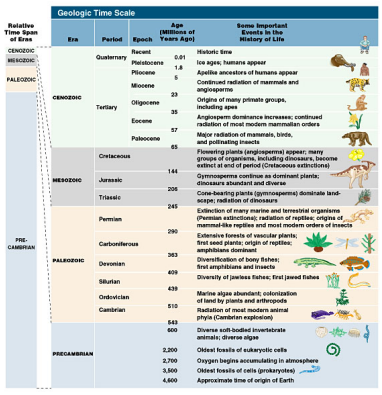
- The fossil of the earliest known bird, *Archeaopteryx*, was discovered in 1861

- Fossils of dinosaurs with feathers may support the bird-dinosaur theory

EARTH HISTORY AND MACROEVOLUTION

The fossil record chronicles macroevolution

- Macroevolution consists of the major changes in the history of life
  - The fossil record chronicles these changes, which have helped to devise the geologic time scale

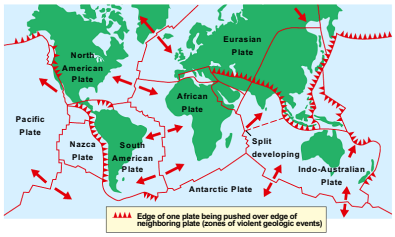


The actual ages of rocks and fossils mark geologic time

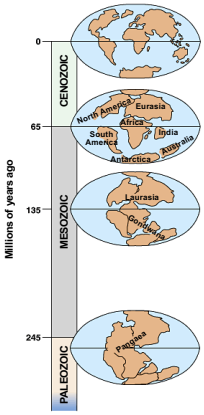
- The sequence of fossils in rock strata indicates the relative ages of different species
- Radiometric dating can gauge the actual ages of fossils

Continental drift has played a major role in macroevolution

- Continental drift is the slow, incessant movement of Earth's crustal plates on the hot mantle



- This movement has influenced the distribution of organisms and greatly affected the history of life
  - Continental mergers triggered extinctions
  - Separation of continents caused the isolation and diversification of organisms



- Continental drift explains the distribution of lungfishes
  - Lungfishes evolved when Pangaea was intact

Connection: Tectonic trauma imperils local life

- Plate tectonics, the movements of Earth's crustal plates, are also associated with volcanoes and earthquakes
  - California's San Andreas fault is a boundary between two crustal plates

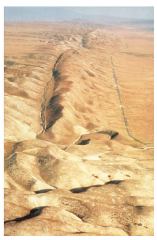
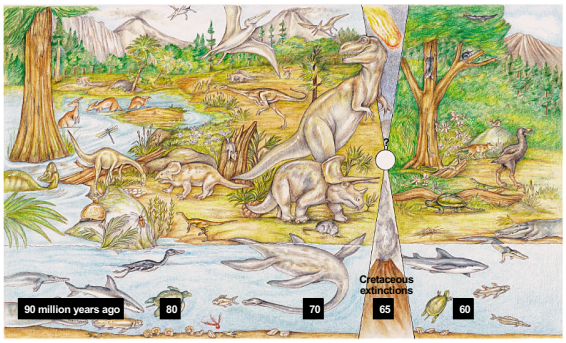


Figure 15.4A

- By forming new islands, volcanoes can create opportunities for organisms
  - Example: Galápagos
- But volcanic activity can also destroy life
  - Example: Krakatau

Mass extinctions were followed by diversification of life-forms

- At the end of the Cretaceous period, many life-forms disappeared, including the dinosaurs
  - These mass extinctions may have been a result of an asteroid impact or volcanic activity



- Every mass extinction reduced the diversity of life
  - But each was followed by a rebound in diversity
  - Mammals filled the void left by the dinosaurs

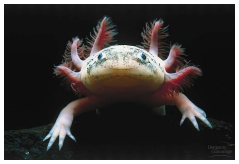
Key adaptations may enable species to proliferate after mass extinctions

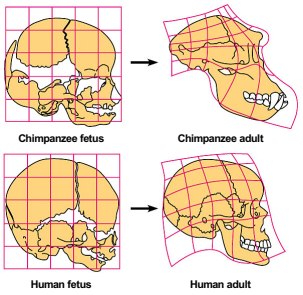
- Adaptations that have evolved in one environmental context may be able to perform new functions when conditions change
  - Example: Plant species with catch basins, an adaptation to dry environments

"Evo-devo:" Genes that control development play a major role in evolution

- "Evo-devo" is a field that combines evolutionary and developmental biology
- Major adaptations may arise rapidly if mutations occur in genes that control an organism's early development

- Paedomorphosis, the retention of juvenile characteristics in the adult, seems to have played a role in human evolution

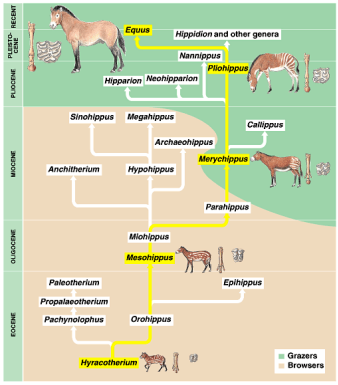




- Stephen Jay Gould argued that there was a connection between our juvenile physical traits and our long period of dependency
  - The youthful features of Mickey Mouse elicit affectionate, parental responses

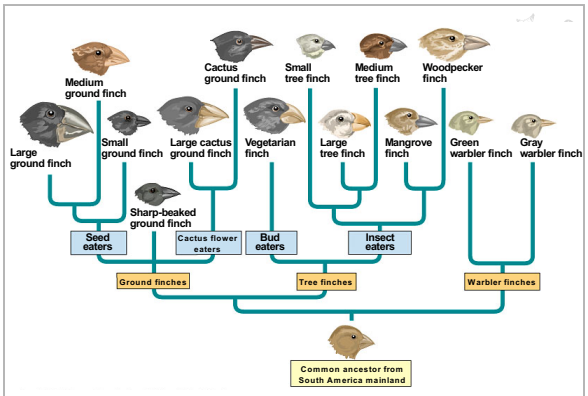
Evolutionary trends do not mean that evolution is directed toward a goal

- Evolutionary trends may reflect unequal speciation or survival of species on a branching evolutionary tree



Phylogenetic trees strive to represent evolutionary history

- Phylogeny is the evolutionary history of a group of organisms



SYSTEMATICS AND PHYLOGENETIC BIOLOGY

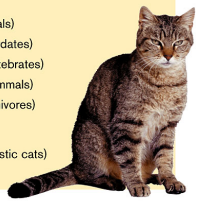
Systematists classify organisms by phylogeny

- Reconstructing phylogeny is part of systematics
  - the study of biological diversity and classification
- Taxonomists assign a two-part name to each species
  - The first name, the genus, covers a group of related species
  - The second name refers to a species within a genus

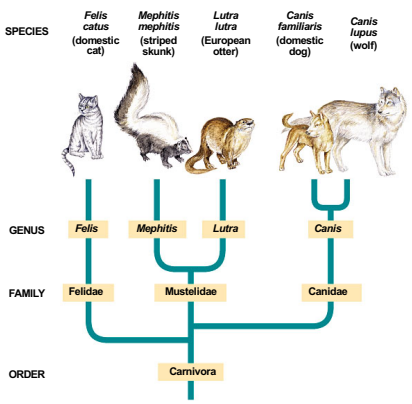
- Genera are grouped into progressively larger categories

CLASSIFICATION OF THE DOMESTIC CAT

Category	Domestic Cat
Domain	Eukarya
Kingdom	Animalia (animals)
Phylum	Chordata (chordates)
(Subphylum)	Vertebrata (vertebrates)
Class	Mammalia (mammals)
Order	Carnivora (carnivores)
Family	Felidae (cats)
Genus	*Felis*
Specific name	*catus* (domestic cats)



- Taxonomists often debate the particular placement of organisms in categories as they strive to make their categories reflect evolutionary relationships



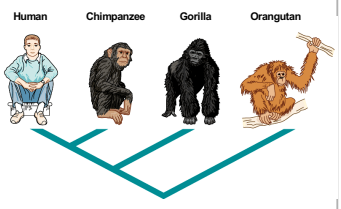
Homology indicates common ancestry, but analogy does not

- Homologous structures are evidence that organisms have evolved from a common ancestor
- In contrast, analogous similarities are evidence that organisms from different evolutionary lineages have undergone convergent evolution
  - Their resemblances have resulted from living in similar environments

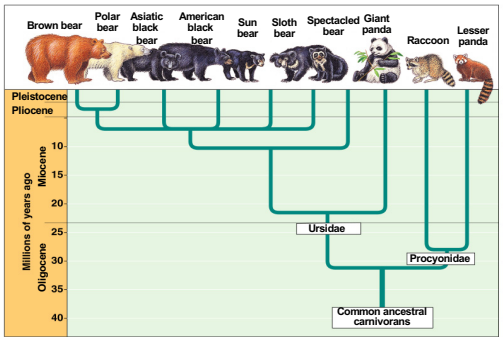
- Example: California ocotillo and allauidia of Madagascar

Molecular biology is a powerful tool in systematics

- Systematists increasingly use molecular techniques to
  - classify organisms
  - develop phylogenetic hypotheses

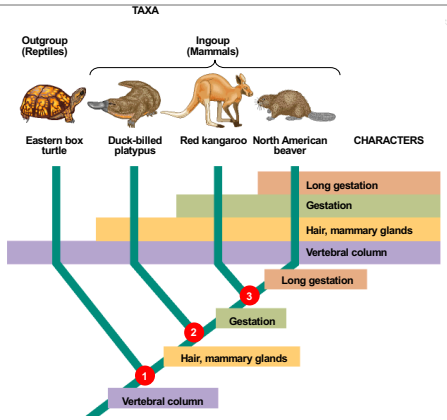


- A phylogenetic tree based on molecular data

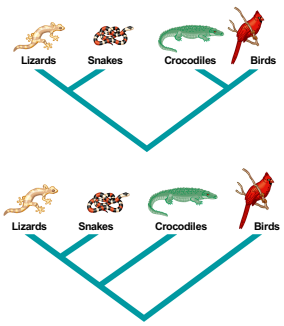


Systematists attempt to make classification consistent with phylogeny

- Homologous features are used to compare organisms
- Cladistic analysis attempts to define monophyletic taxa



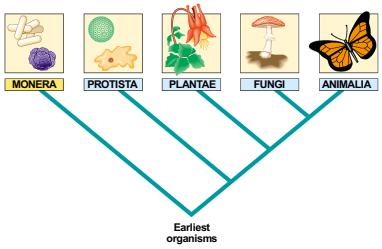
- Cladistic analysis is often a search for the simplest hypotheses about phylogeny
  - Phylogenetic tree according to cladistic analysis
  - Phylogenetic tree according to classical systematics



THE DOMAINS OF LIFE

Arranging life into kingdoms is a work in progress

- For several decades, systematists have classified life into five kingdoms



- A newer system recognizes two basically distinctive groups of prokaryotes
  - The domain Bacteria
  - The domain Archaea
- A third domain, the Eukarya, includes all kingdoms of eukaryotes