CHAPTERS 14 & 15: BASICS OF EVOLUTION

Honors Biology 2012

1

SPECIES

- Group of organisms whose members can breed and produce fertile offspring, but who can not produce fertile offspring with members of other groups
- Speciation - emergence of new species
  - As speciation occurs, biodiversity increases

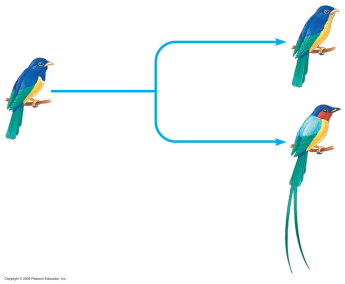

Fig. 14.1

2

SPECIES

- Taxonomy - branch of biology that names and classifies species and groups into broader categories
  - Linnaeus developed a binomial system for naming organisms
- Biological species concept - species is a population or group of populations whose members have the potential to interbreed in nature and produce fertile offspring

3

DIFFERENT WAYS TO DEFINE A SPECIES

- Morphological species concept - classifies organisms based on observable phenotypic traits
  - Can be applied to cases where we don't know about interbreeding (asexual organisms, fossils)
- Ecological species concept - defines a species by its ecological role or niche
  - Could be similar in appearance but feed at different locations
- Phylogenetic species concept - defines a species as a set of organisms representing a specific evolutionary lineage
  - Must define the amount of difference required to distinguish separate species

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REPRODUCTIVE BARRIERS

- Reproductive barriers - isolate a species gene pool and prevent interbreeding
- Prezygotic barriers - prevent mating or fertilization between species
  - temporal isolation - breed at different times
  - habitat isolation - do not occupy the same habitat (garter snakes)
  - behavioral isolation - little or no sexual attraction
  - mechanical isolation - sex organs are not compatible
  - gametic isolation - gametes are not compatible

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REPRODUCTIVE BARRIERS

- Postzygotic barriers - operate after hybrid zygotes are formed
  - reduced hybrid viability - most hybrid offspring do not survive
  - reduced hybrid fertility - hybrid offspring are sterile
  - hybrid breakdown - first generation hybrids are viable and fertile, but offspring are feeble or sterile

Fig. 14.3

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SPECIATION

- Allopatric speciation - populations of the same species are geographically isolated which separates their gene pools
  - Gene flow reduced by: natural selection, genetic drift, and mutation
- Sympatric speciation - new species may arise within the same geographic area as a parent
  - Gene flow reduced by: polyploidy, habitat differentiation, and sexual selection

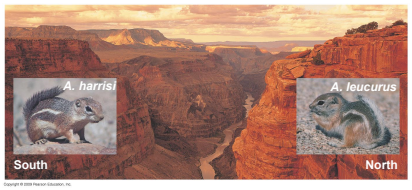
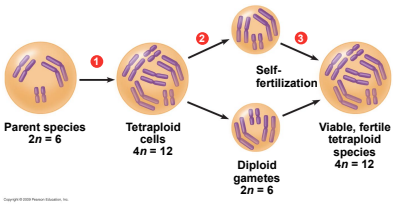


Fig. 14.4 & 14.5



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ADAPTIVE RADIATION

- Adaptive radiation - many different species evolve from a common ancestor
  - Occurs when organisms colonize new unexploited areas or after a mass extinction

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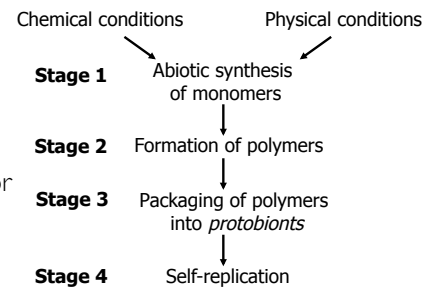
CONDITIONS FOR LIFE

- Raw materials + suitable environment + energy sources
  - Early Earth (formed 4.6 billion years ago, 3.5 billion years ago photosynthetic bacteria):
    - Raw materials: water vapor and other compounds from volcanic eruptions (N_2, CO_2, CH_4, NH_3, H_2, and H_2S)
    - Energy: volcanic activity, lightning, and UV radiation



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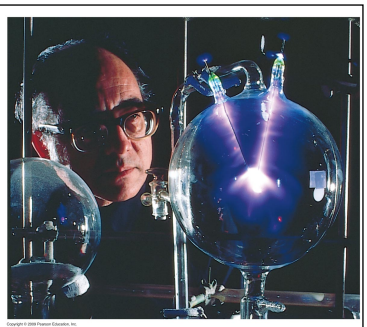
STANLEY MILLER



- Set up an airtight apparatus which gasses circulating past an electrical discharge to simulate conditions on early Earth
- After a week it produced amino acids and other organic molecules
- Proved that Stage 1 was possible on early Earth
- Also possible that life started at deep-sea hydrothermal vents

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MAJOR EVENTS IN THE HISTORY OF LIFE

- 4 billion years ago - Archaean and proterozoic
- 3.75 billion years ago - Prokaryotes (created the atmosphere and metabolic pathways)
  - Alone on Earth for over 1.5 billion years
- 2.1 billion years ago - Eukaryotes
- 1.5 billion years ago - Multicellular forms
- 500 million years ago - Fungi and plants colonized land
- 7-6 million years ago - Human lineage began
- 160,000 years ago - Our species originated

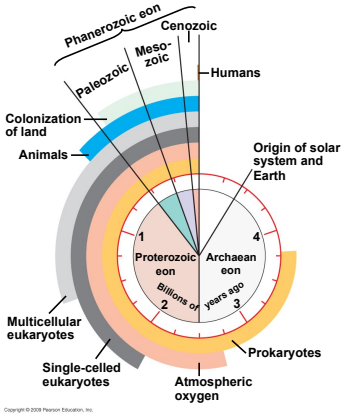

Fig. 15.4

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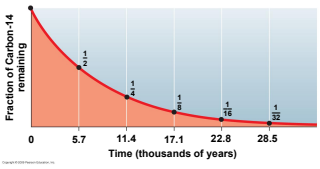
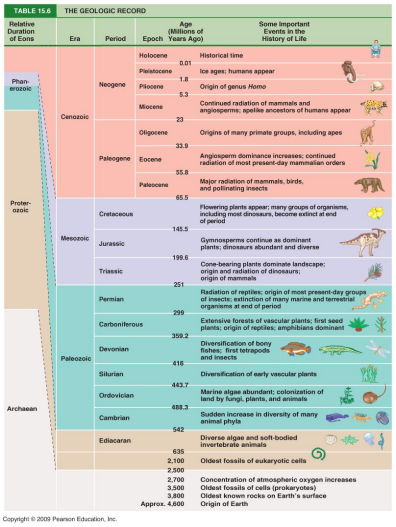
RADIOMETRIC DATING

- Measures the decay of radioactive isotopes
- Carbon-14 can date fossils up to 75,000 years old
- Potassium-40 (half life 1.3 billion years) can be used to date rocks that are older



Geologic Record Fig. 15.6



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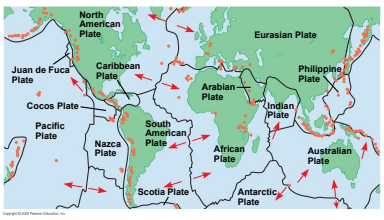
MACROEVOLUTION

- Macroevolution - major changes over evolutionary time (ex. origin of wings)
- Continental drift - slow continuous movement of Earth's plates on the hot mantle (earthquakes and mountains at the boundaries)
  - Causes different types of species to arise (marsupials in Australia and placentals on other continents)



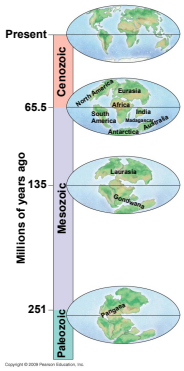


Fig. 15.7

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MASS EXTINCTIONS

- Permian extinction (96% of shallow water marine species died)
  - May have been caused by extreme vulcanism in Siberia (release of CO_2) which warmed global climate, caused slowed mixing of ocean water, and reduced O_2 availability in the ocean
- Cretaceous extinction (50% of marine species and many terrestrial species)
  - May have been caused by the impact of an asteroid that caused the blockage of the sun which disrupted global climates
- Adaptive radiation can occur after a mass extinction (ex. mammals after cretaceous extinction)

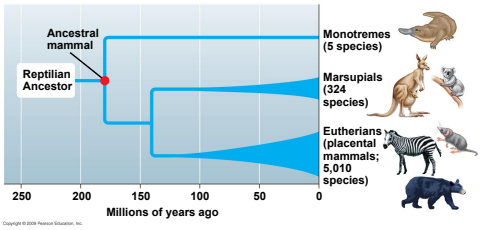

Fig. 15.10

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ROLE OF GENES

- Homeotic genes - master control genes that determine basic features
- For mutations in these genes to be expressed in the population, the mutation must provide an increase in the organism's fitness (ex. eye development in molluscs)

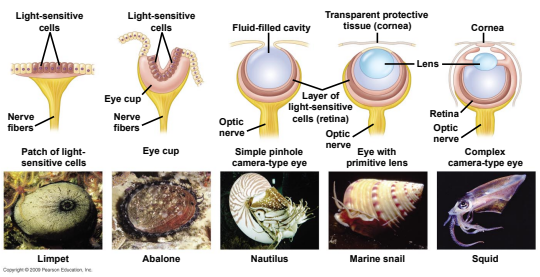

Fig. 15.12

15

PHYLOGENY

- Phylogeny - evolutionary history of a species or group of species
- Convergent evolution - similarities in organisms that are not closely related

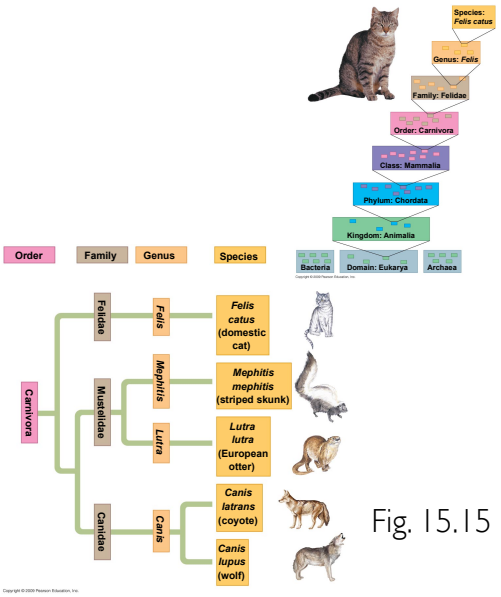

Fig. 15.15

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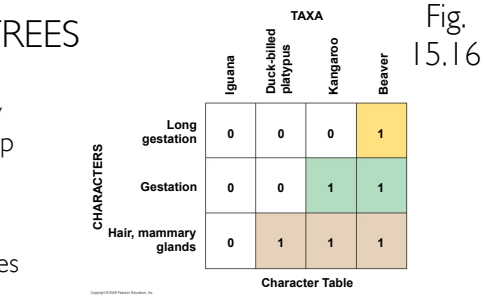
PHYLOGENETIC TREES

- Phylogenetic tree - hypothesis of evolutionary relationships within a group
- Cladistics uses shared derived characteristics to group organisms into clades (include the ancestor and its descendants)
  - Ingroup - taxa being studied
  - Outgroup - taxon that diverged before the lineage leading to the ingroup



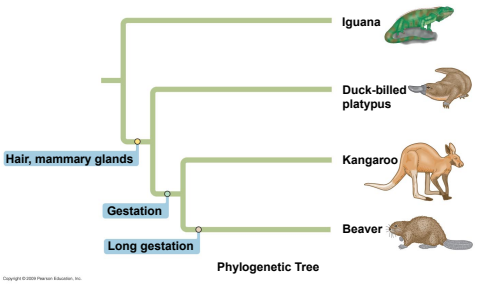


Fig. 15.16

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