



## 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

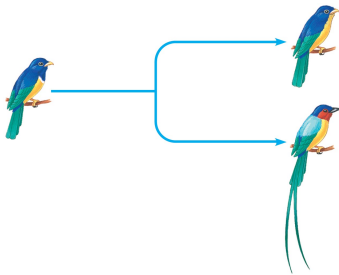


Fig. 14.1

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

4

## 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



5

## 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

6

# SPECIATION

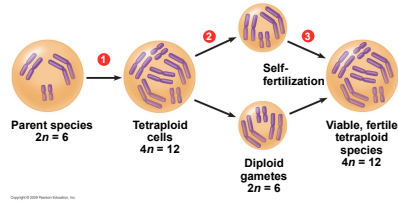
- Allopatric speciation - populations of the same species are geographically isolated which separates their gene pools



Fig. 14.4 & 14.5

- 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

7

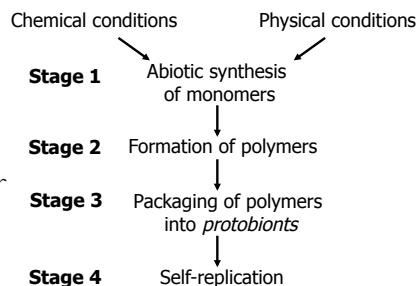
# ADAPTIVE RADIATION

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

8

# CONDITIONS FOR LIFE

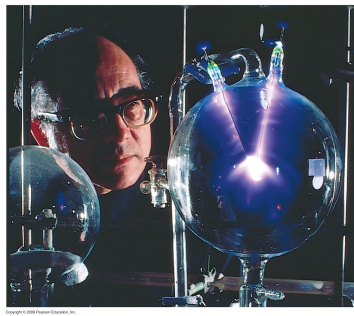
- Raw materials + suitable environment + energy sources
- Early Earth (formed 4.6 billion years ago, 3.5 billion years ago photosynthetic bacteria):
  - Raw materials: water vapor and other compounds from volcanic eruptions ( $N_2$ ,  $CO_2$ ,  $CH_4$ ,  $NH_3$ ,  $H_2$ , and  $H_2S$ )
  - Energy: volcanic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



9

# 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 I was possible on early Earth



- Also possible that life started at deep-sea hydrothermal vents

10

# 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

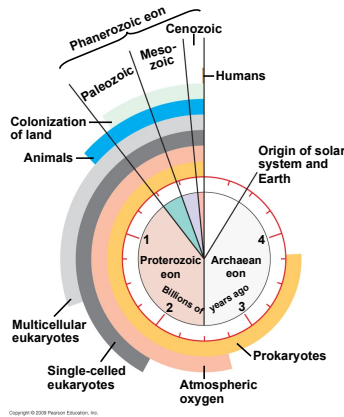


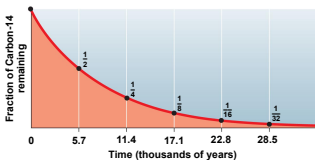
Fig. 15.4

11

# RADIOMETRIC DATING

# Geologic Record Fig. 15.6

- 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



Relative Duration of Eras	Era	Period	Epoch	Age Millions of Years Ago	Some Important Events in the History of Life
Phanerozoic	Cenozoic	Neogene	Holocene	0.01	Historical time
			Pleistocene	1.8	Ice ages; humans appear
			Pliocene	5.3	Origin of genus Homo
		Paleogene	Oligocene	23	Continued radiation of mammals and angiosperms; apellae ancestors of humans appear
				33.5	Origins of many primate groups, including apes
		Mesozoic	Cretaceous	65.5	Major radiation of mammals, birds, and pollinating insects
				145.5	Flowering plants appear; many groups of organisms, including most dinosaurs, become extinct at end of period
			Jurassic	198.6	Gymnosperms continue as dominant plants; dinosaurs abundant and diverse
				251	Extensive forests of vascular plants; first seed plants; origin of reptiles; amphibians dominant
			Paleozoic	Permian	299
359.2	Extensive forests of vascular plants; first seed plants; origin of reptiles; amphibians dominant				
Carboniferous	359.2			Diversification of body fishes; first tetrapods and insects	
Archaean	Proterozoic	Silurian	416	Diversification of early vascular plants	
		Ordovician	443.7	Marine algae abundant; colonization of land by fungi, plants, and animals	
		Cambrian	488.3	Sudden increase in diversity of many animal phyla	
		Ediacaran	542	Diverse algae and soft-bodied invertebrate animals	
		2,100	Oldest fossils of eukaryotic cells		
2,700	Concentration of atmospheric oxygen increases				
3,800	Oldest fossils of cells (prokaryotes)				
3,800	Oldest known rocks on Earth's surface				
Approx. 4,600	Origin of Earth				

12

# 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)

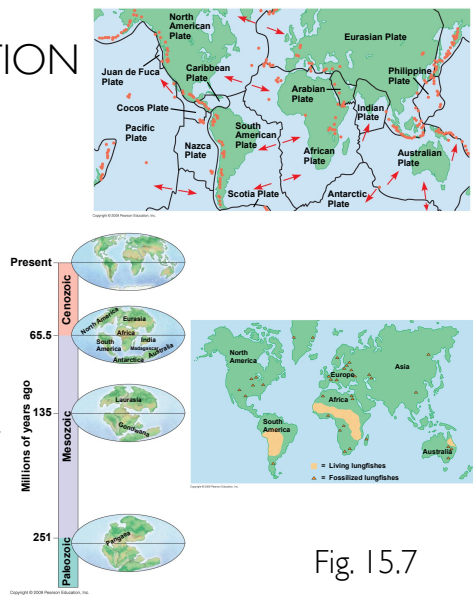


Fig. 15.7

# MASS EXTINCTIONS

- Permian extinction (96% of shallow water marine species died)
  - May have been caused by extreme vulcanism in Siberia (release of CO<sub>2</sub>) which warmed global climate, caused slowed mixing of ocean water, and reduced O<sub>2</sub> 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)

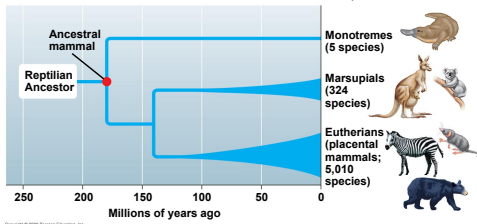


Fig. 15.10

# 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)

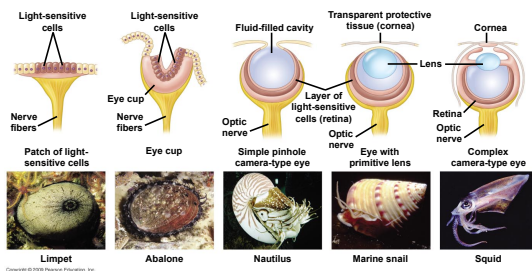


Fig. 15.12

# PHYLOGENY

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

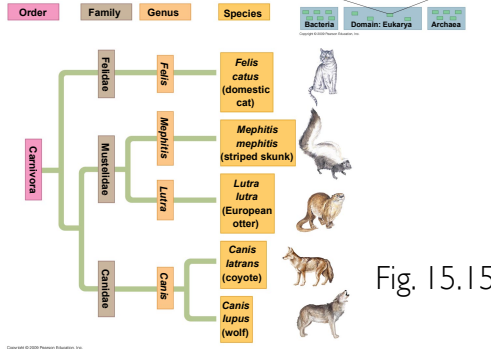
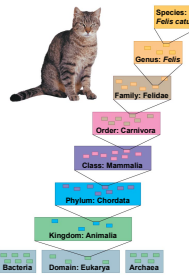


Fig. 15.15

16

# 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

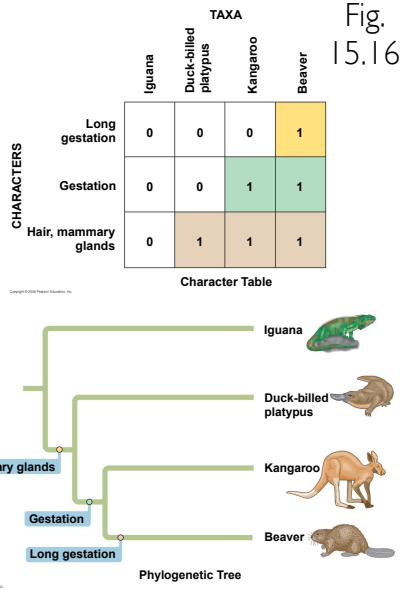


Fig. 15.16

17