

Descent with Modification



History of Organism Classification

- Aristotle, 384-322 BC
 - *Scala Naturae*
 - Linear hierarchy
- Old Testament
 - Individually designed by God
- Carolus Linnaeus (1700s)
 - Nested classification
 - Divine Creator

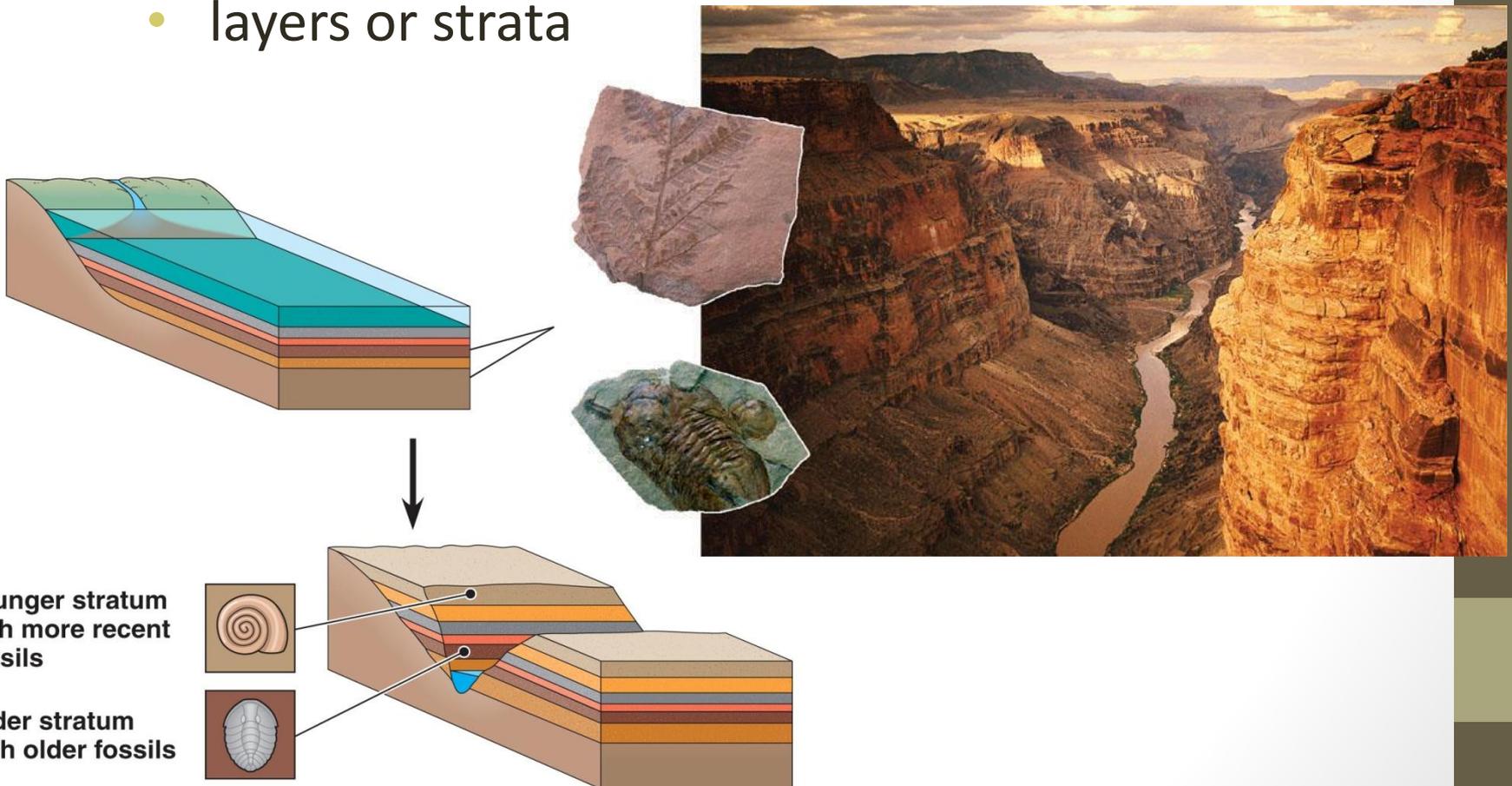
Scientists of the 18th-19th Century

- George Cuvier
 - largely developed Paleontology
 - advocated catastrophism

- James Hutton and Charles Lyell
 - geologists
 - changes in Earth's surface can result from slow continuous actions still operating today

Fossils

- Remains or traces of organisms from the past
- Usually found in sedimentary rock
 - layers or strata





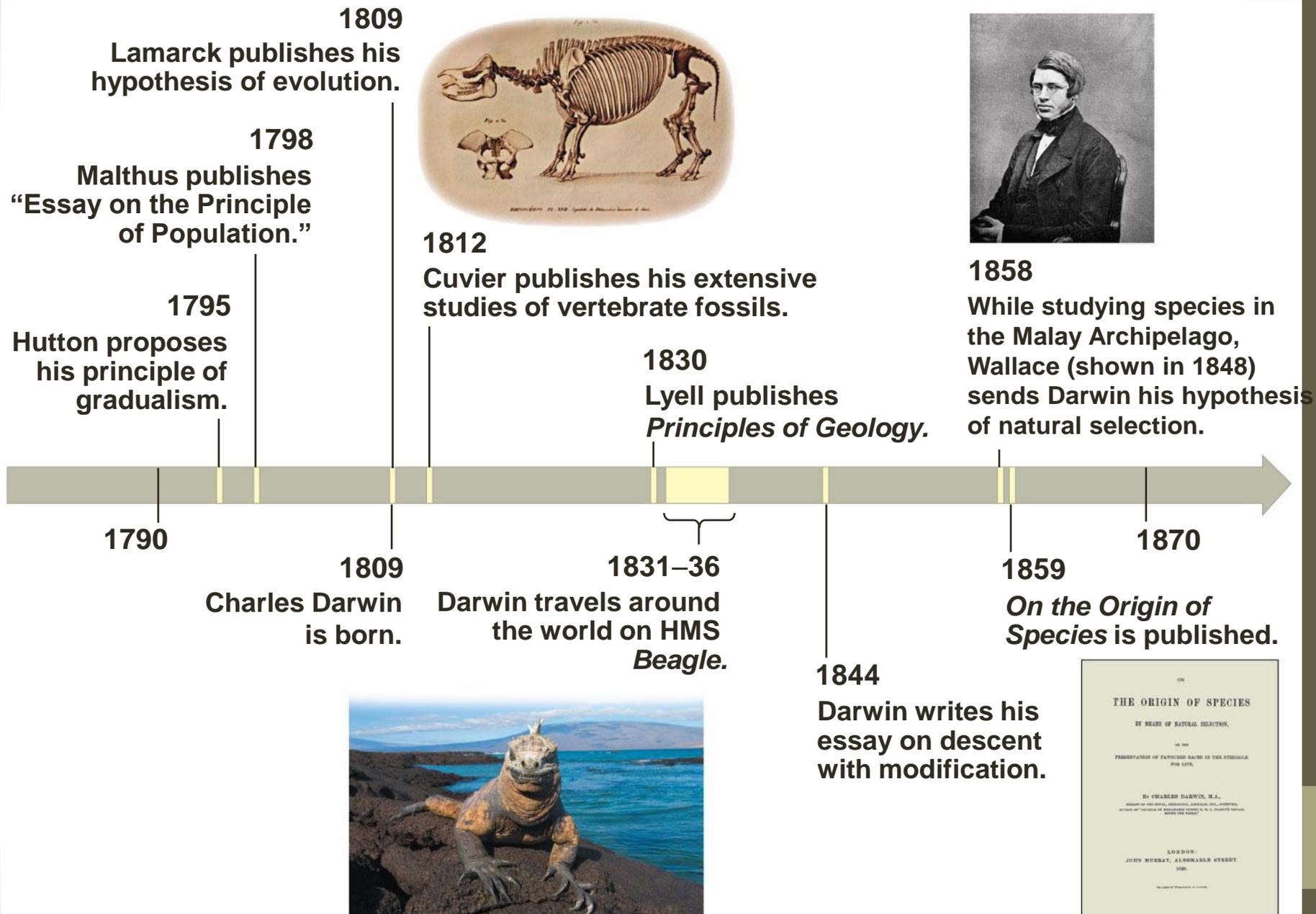
Lamarck's Hypothesis of Evolution

- Species evolve through
 - **use and disuse** of body parts
 - the inheritance of *acquired* characteristics
- Unsupported by evidence

Charles Darwin (1809-1882)

- November 24, 1859
 - *On the Origin of Species by Means of Natural Selection*
 - Charles Darwin
 - Focused biologists' attention on the great diversity of organisms





The Galápagos Islands

Contemporaries

Linnaeus (classification)

Hutton (gradual geologic change)

Lamarck (species can change)

Malthus (population limits)

Cuvier (fossils, extinction)

Lyell (modern geology)

Darwin (evolution, natural selection)

Wallace (evolution, natural selection)

American Revolution

French Revolution

U.S. Civil War

1750

1800

1850

1900

1795 | Hutton proposes his theory of gradualism.

1798 | Malthus publishes "Essay on the Principle of Population."

1809 | Lamarck publishes his hypothesis of evolution.

1830 | Lyell publishes *Principles of Geology*.

1831–1836 | Darwin travels around the world on HMS *Beagle*.

1837 | Darwin begins his notebooks.

1844 | Darwin writes essay on descent with modification.

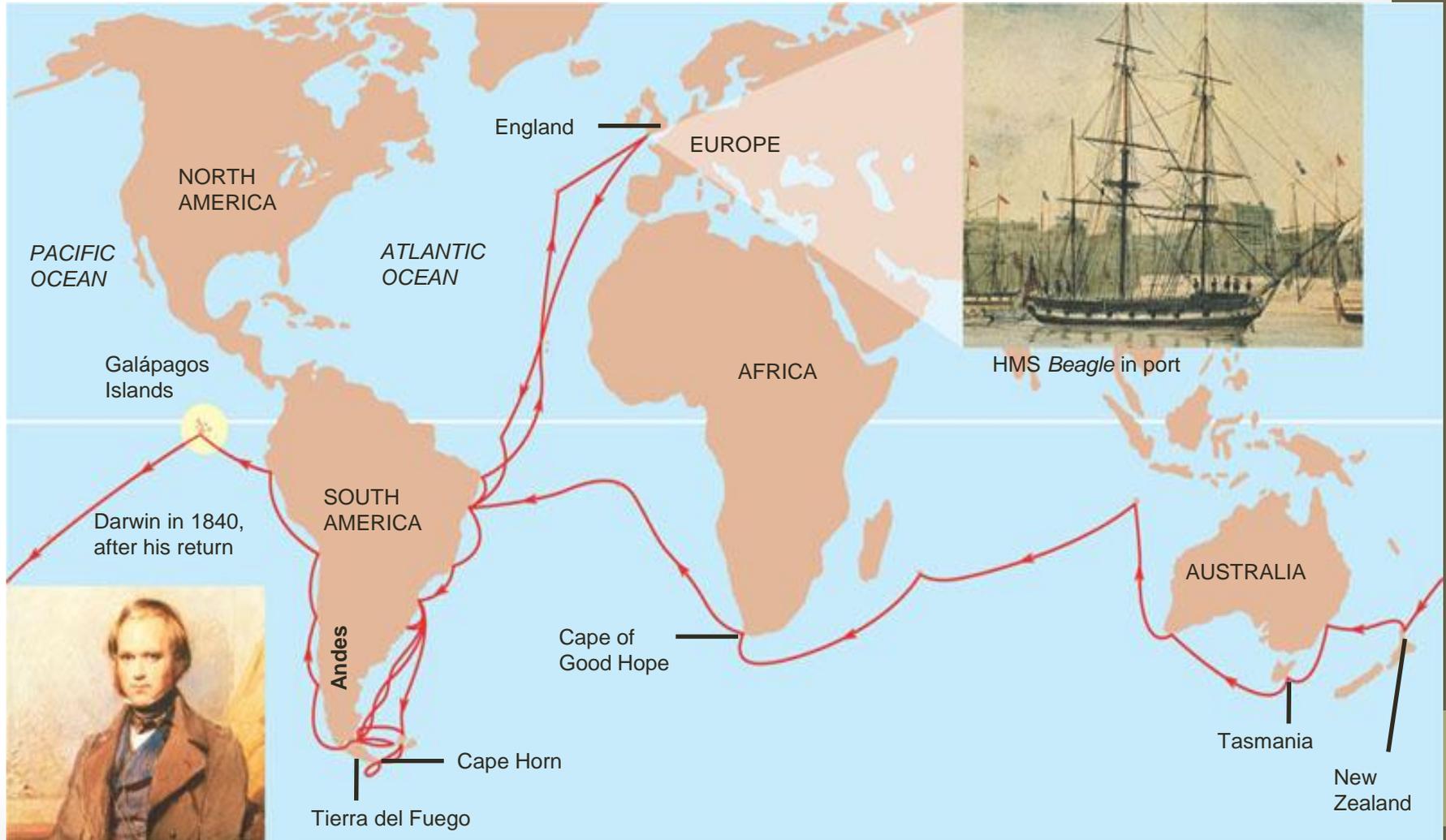
1858 | Wallace sends his hypothesis to Darwin.

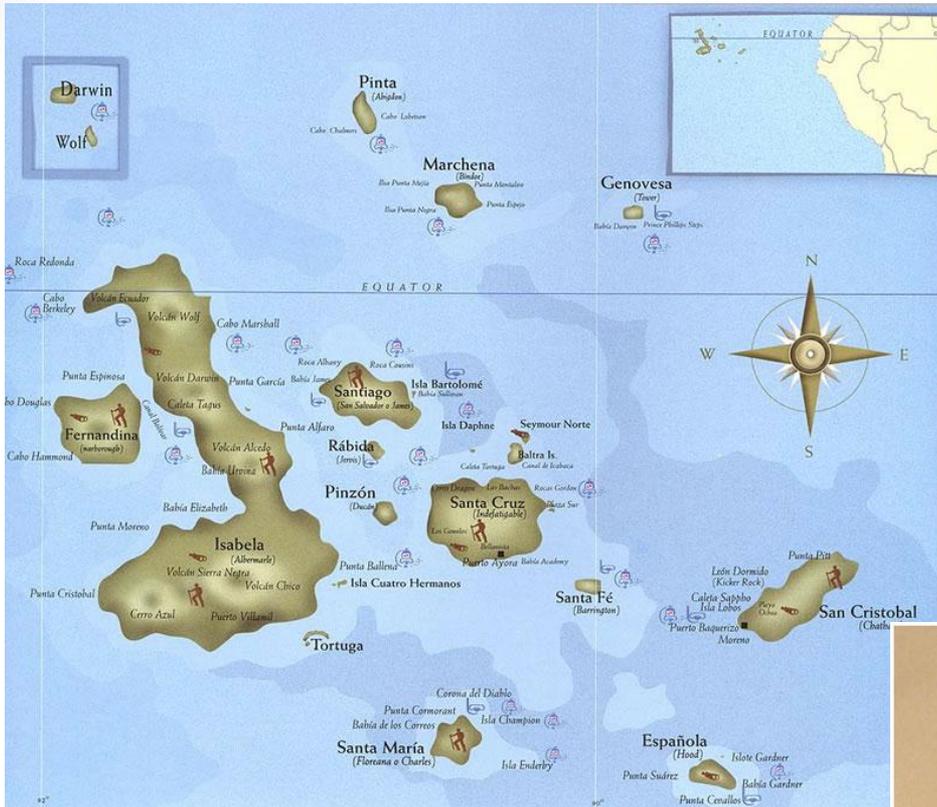
1859 | *The Origin of Species* is published.

Charles Darwin (1809-1882)

- Darwin first studied medicine (unsuccessfully), and then theology at Cambridge University
- In 1831, sailed aboard the HMS Beagle
 - 5-year voyage around the world
 - Mission:
 - chart the South American coast

Beagle Voyage





<http://www.dcwalls.com/Photos/galapagos.htm>



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(a) Cactus-eater



(c) Seed-eater



(b) Insect-eater

Darwin's Focus on Adaptation

- **Adaptation**

- Characteristics of organisms
 - enhance their survival and reproduction
 - in specific environments

- **Natural selection**

- A *process*
- Certain inherited traits are favored
 - Individuals with these traits have more offspring

Overview

- 1844, essay
 - natural selection as mechanism of evolution
- June 1958
 - Manuscript from Alfred Russell Wallace
- November 24, 1859
 - *On the Origin of Species by Means of Natural Selection*
 - Charles Darwin



- Darwin made two major points in his book
 - Present day organisms are descendants of ancestral species
 - **Natural selection** is the mechanism of evolution

- **Evolution:**

- *descent with modification*
- Change in the genetic composition of a population from generation to generation

- Darwin explained three broad observations:
 - The unity of life
 - The diversity of life
 - The match between organisms and their environment

The Origin of Species

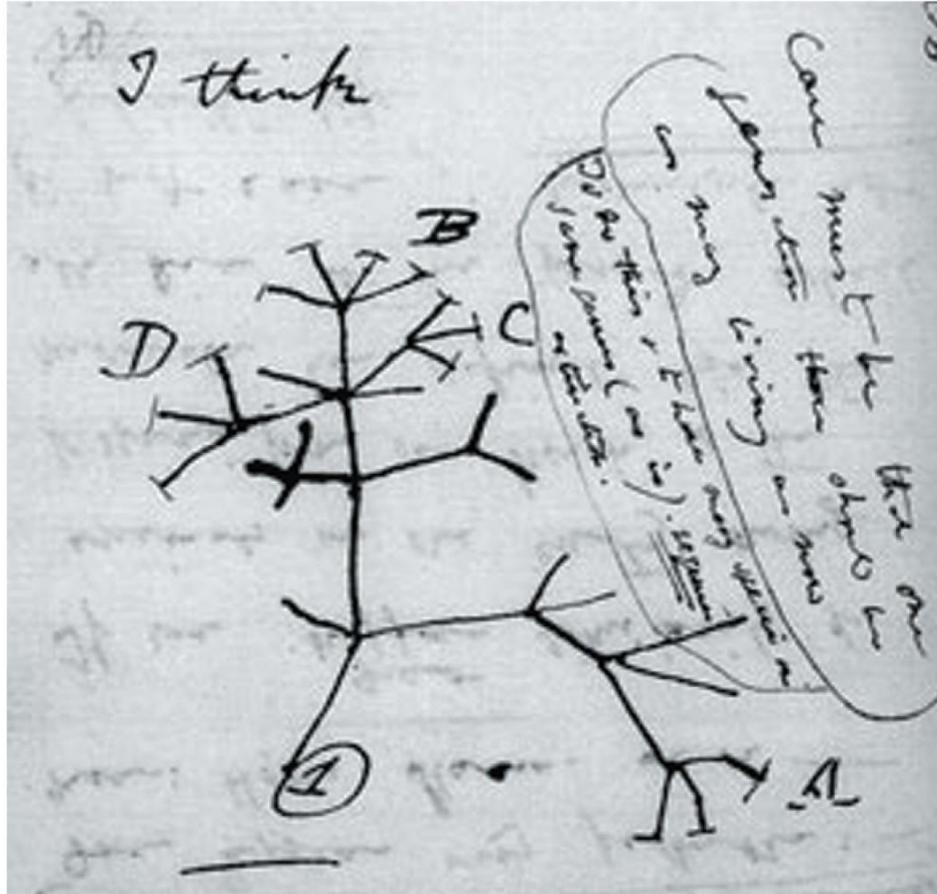
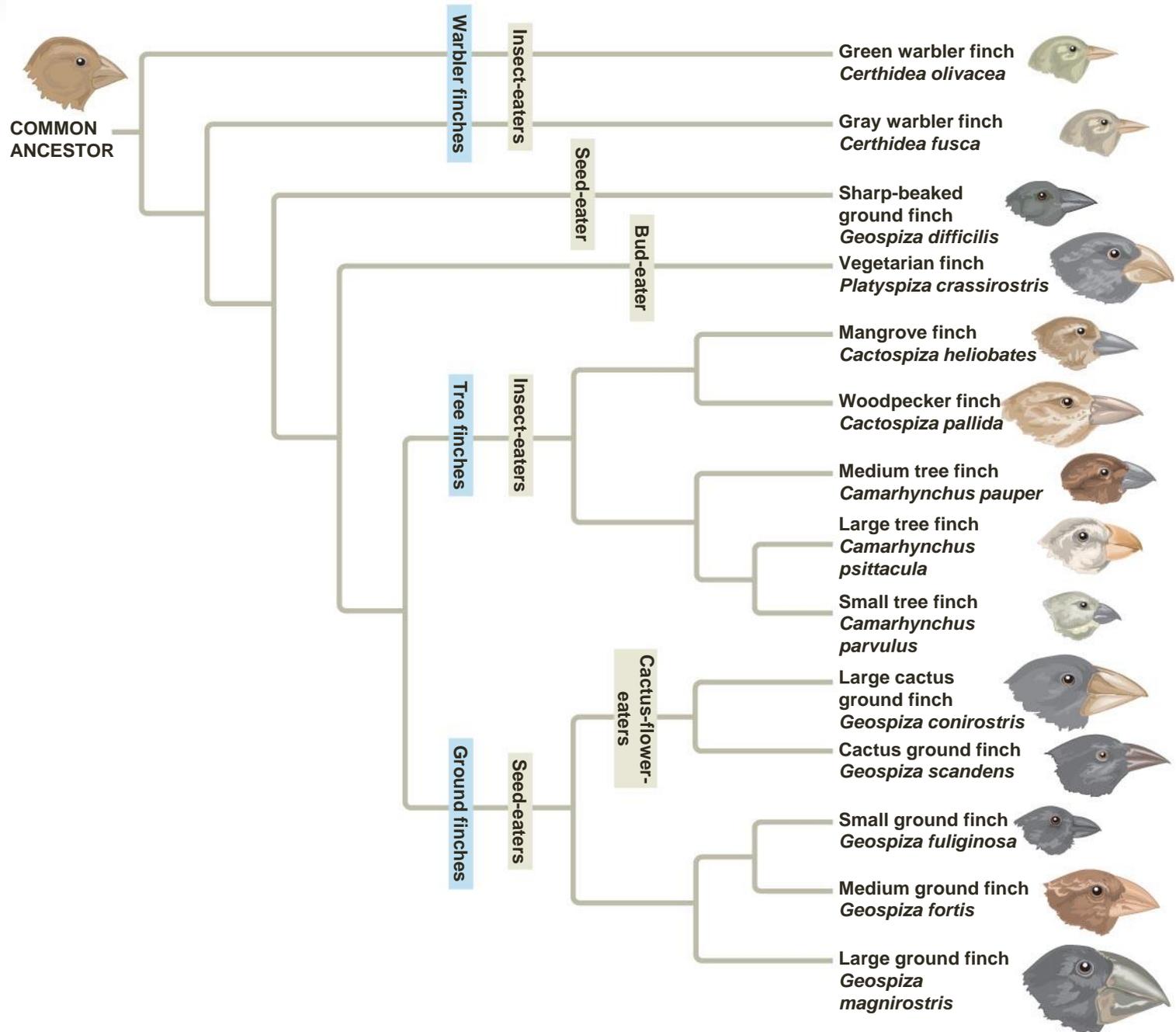


Fig. 1-22



Tree of Life

- In the Darwinian view, the history of life is like a tree

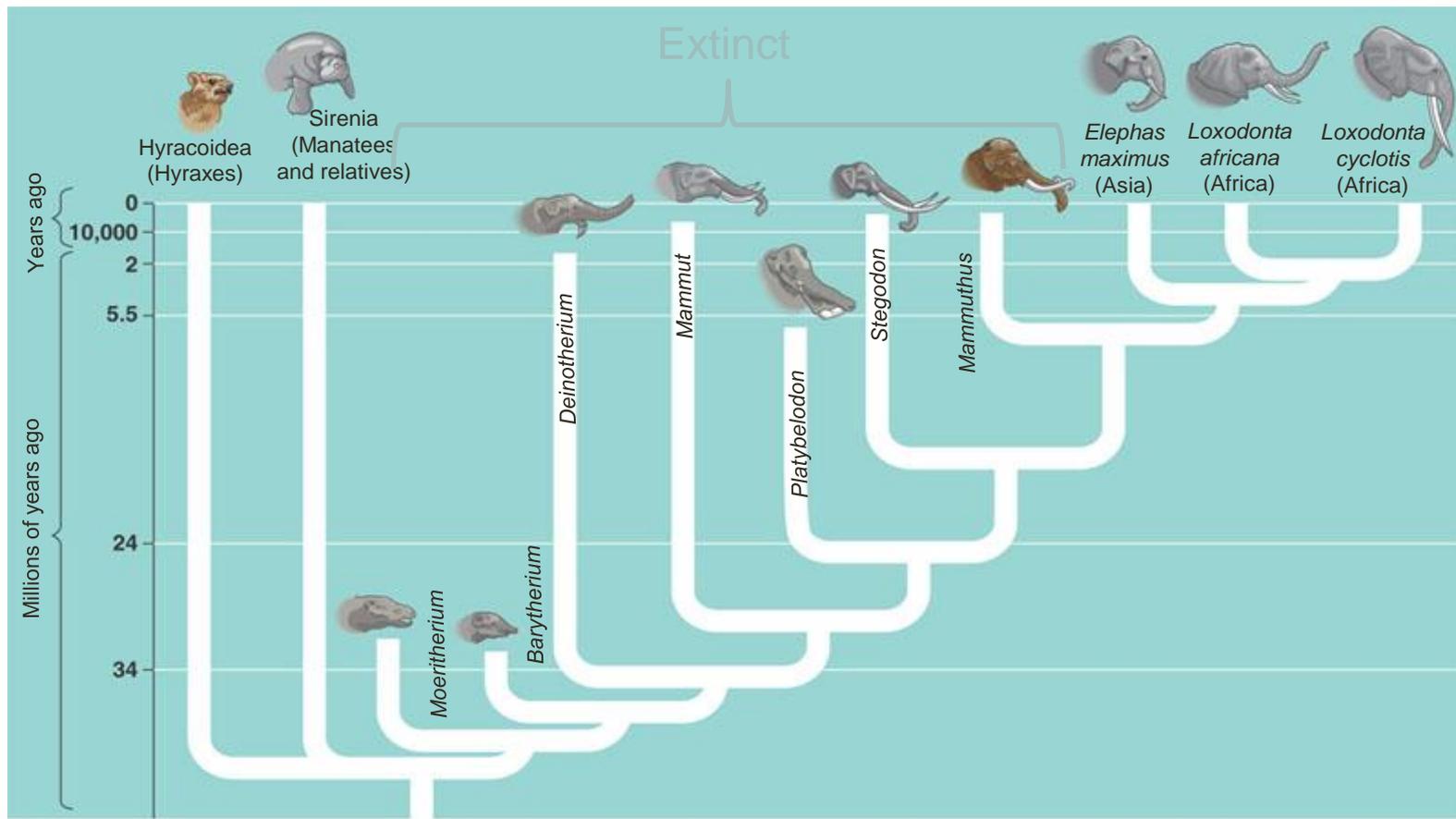
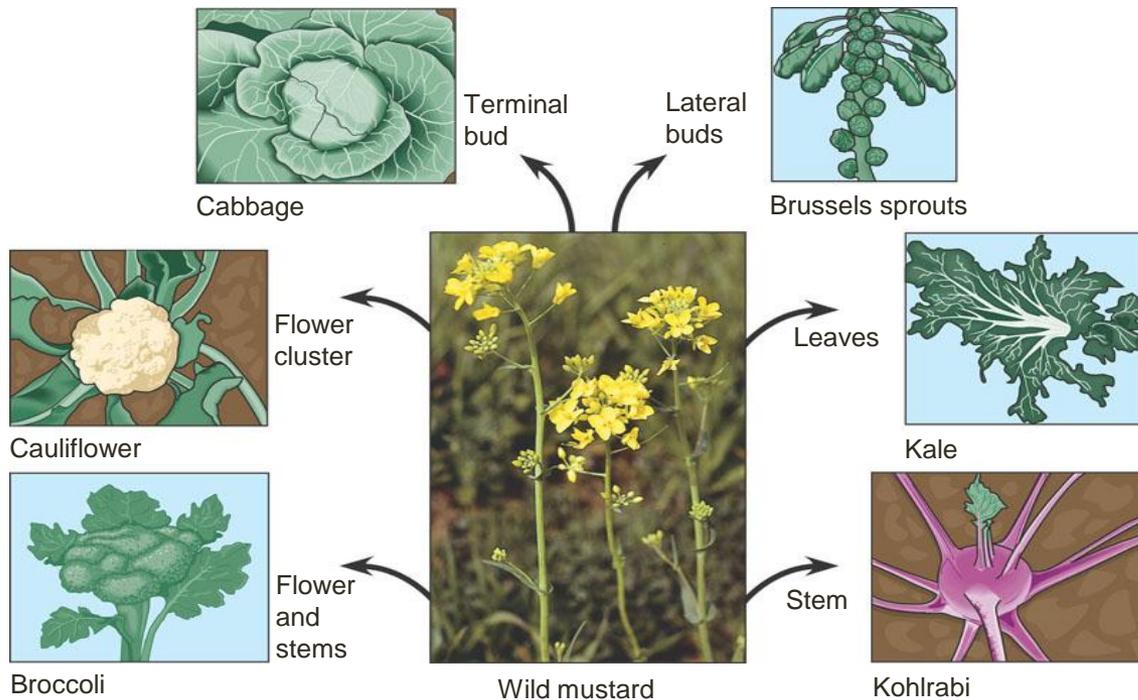


Figure 22.7

Artificial Selection

- Humans modify other species



Artificial Selection



Over 150 “recognized” breeds of the domestic dog (*Canis lupus familiaris*) are now in existence, all descending from the Grey Wolf (*Canis lupus*)

How does Natural Selection work?

- 'Simplified' into 2 inferences
 - Based on 2 observations
 - Observations are based on nature

Natural Selection and Adaptation

- Observation #1:
 - Members of a population vary greatly in their inherited traits



Natural Selection and Adaptation

- Observation #1:
 - Members of a population vary greatly in their inherited traits
 - Traits are inherited from parents to offspring



Natural Selection and Adaptation

- Observation #2:
 - All species can produce more offspring than the environment can support



Natural Selection and Adaptation

- Observation #2:
 - All species can produce more offspring than the environment can support
 - many of these offspring fail to survive and reproduce



Natural Selection and Adaptation

- Inference #1:
 - Survival depends on expression of inherited traits
 - Certain inherited traits will increase an organism's survival
 - Individuals with these traits:
 - Have a high probability of surviving
 - More likely to leave more offspring

Natural Selection and Adaptation

- Inference #2:
 - Individuals are not equal
 - Some individuals more likely to survive and reproduce
 - Leads to a gradual change in a population
 - Favorable characteristics accumulate over generations

Lab Exercise

Evolution Through Natural Selection

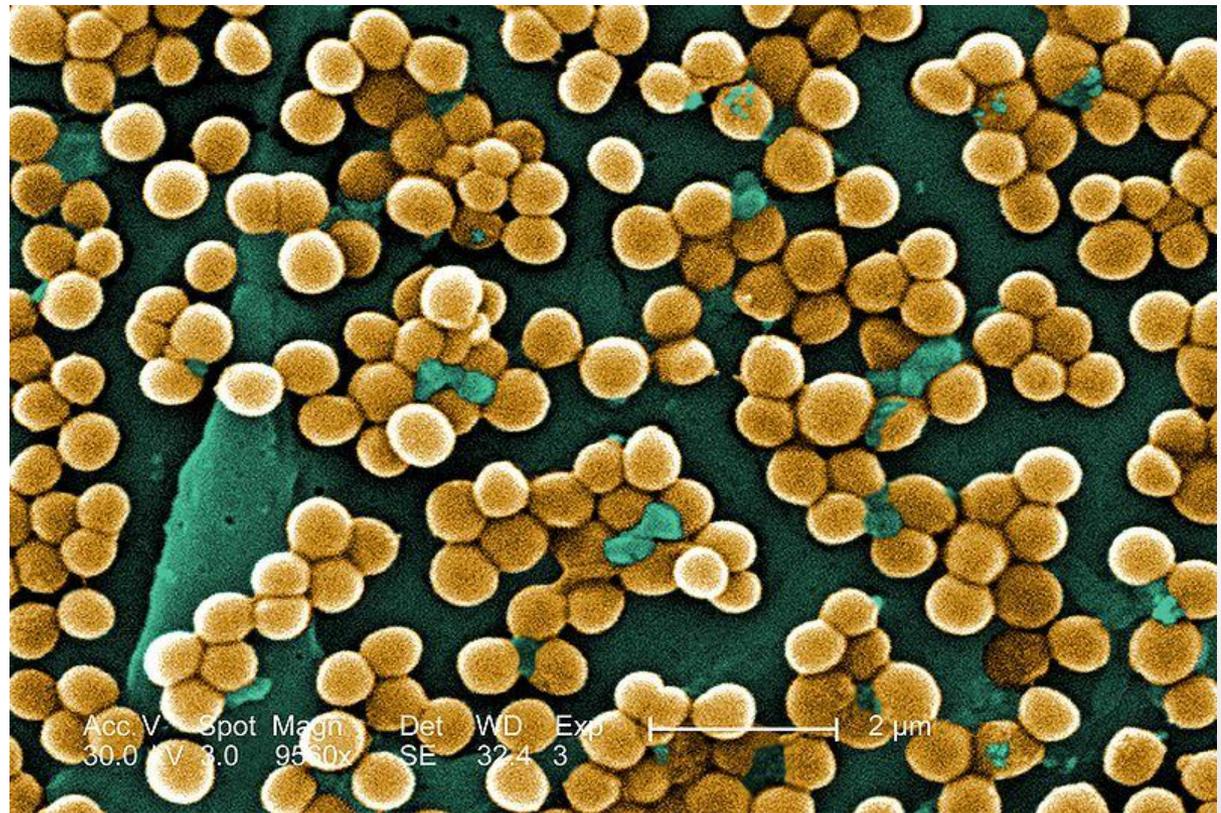
Important Points:

1. The population is the smallest unit by which evolution can occur. **Individuals do not evolve**
2. Natural selection can act only on heritable traits, traits that are passed from organisms to their offspring. **Acquired characteristics are not passed on**
3. Environmental factors vary from place to place and from time to time. A trait that is favorable in one environment may be useless or even detrimental in another environment.
Favored traits depend on the environment

Evidence of Evolution

Direct Observations of Evolutionary Change

- Researchers have observed natural selection
 - Example:
 - Evolution of Drug-Resistant Bacteria

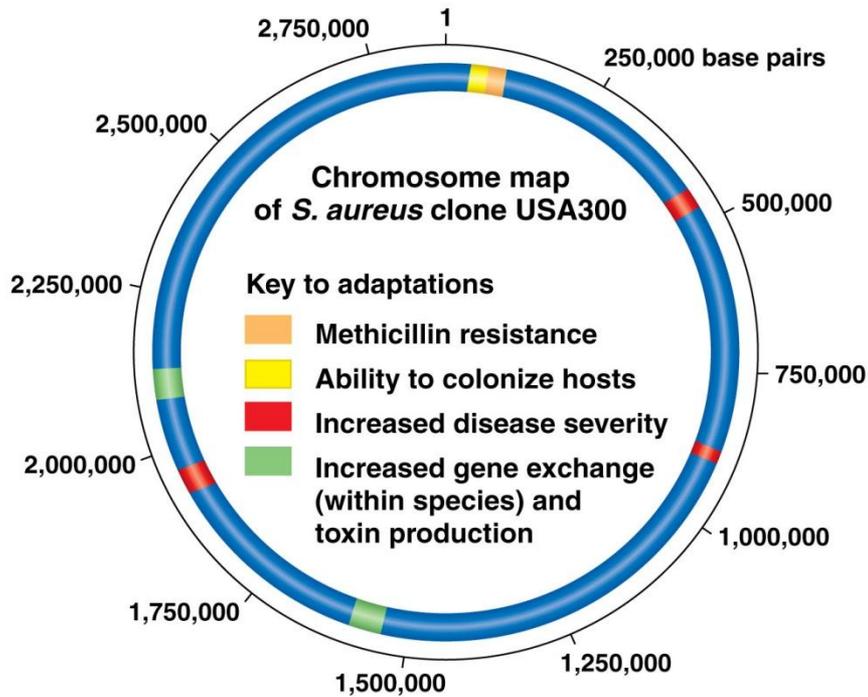


Drug-Resistant Bacteria

- *Staphylococcus aureus*
 - Methicillin-resistant *S. aureus* (MRSA)
- Resistance occurred within 2 years of antibiotic use
 - Penicillin resistant in 1945
 - Methicillin resistant in 1961



How did resistance occur?



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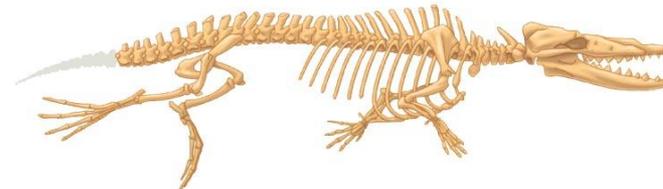


The Fossil Record

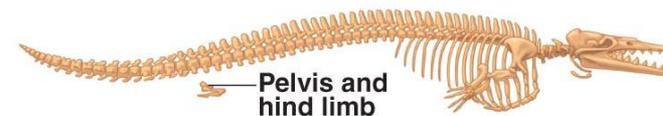
- Succession of forms
- Fossils of many transitional forms
 - i.e., land to sea



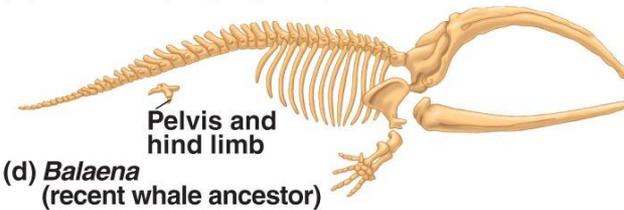
(a) *Pakicetus* (terrestrial)



(b) *Rhodocetus* (predominantly aquatic)



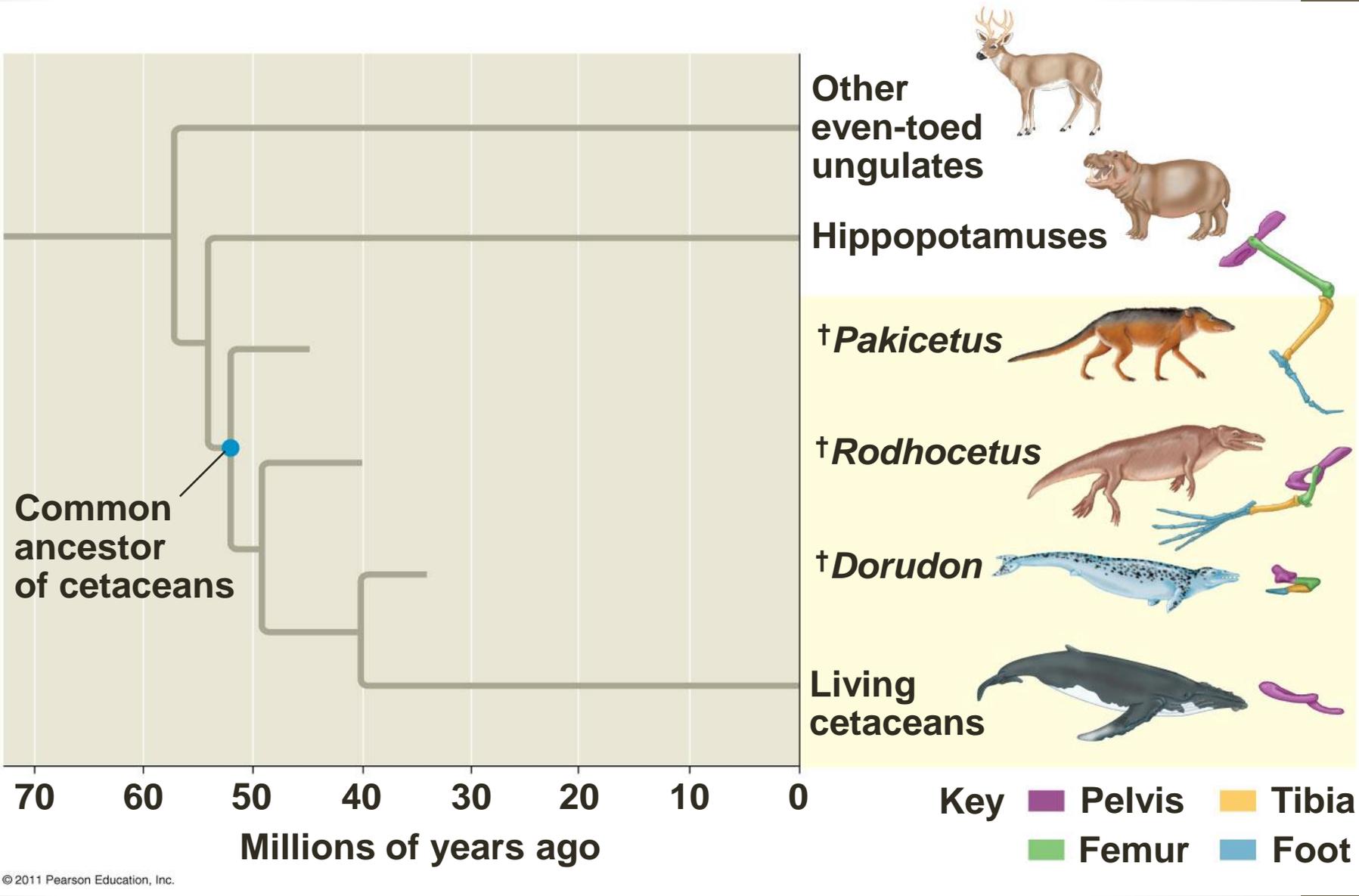
(c) *Dorudon* (fully aquatic)



(d) *Balaena*
(recent whale ancestor)

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Figure 22.20



Most mammals

Cetaceans and even-toed ungulates



(a) *Canis* (dog)

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(b) *Pakicetus*



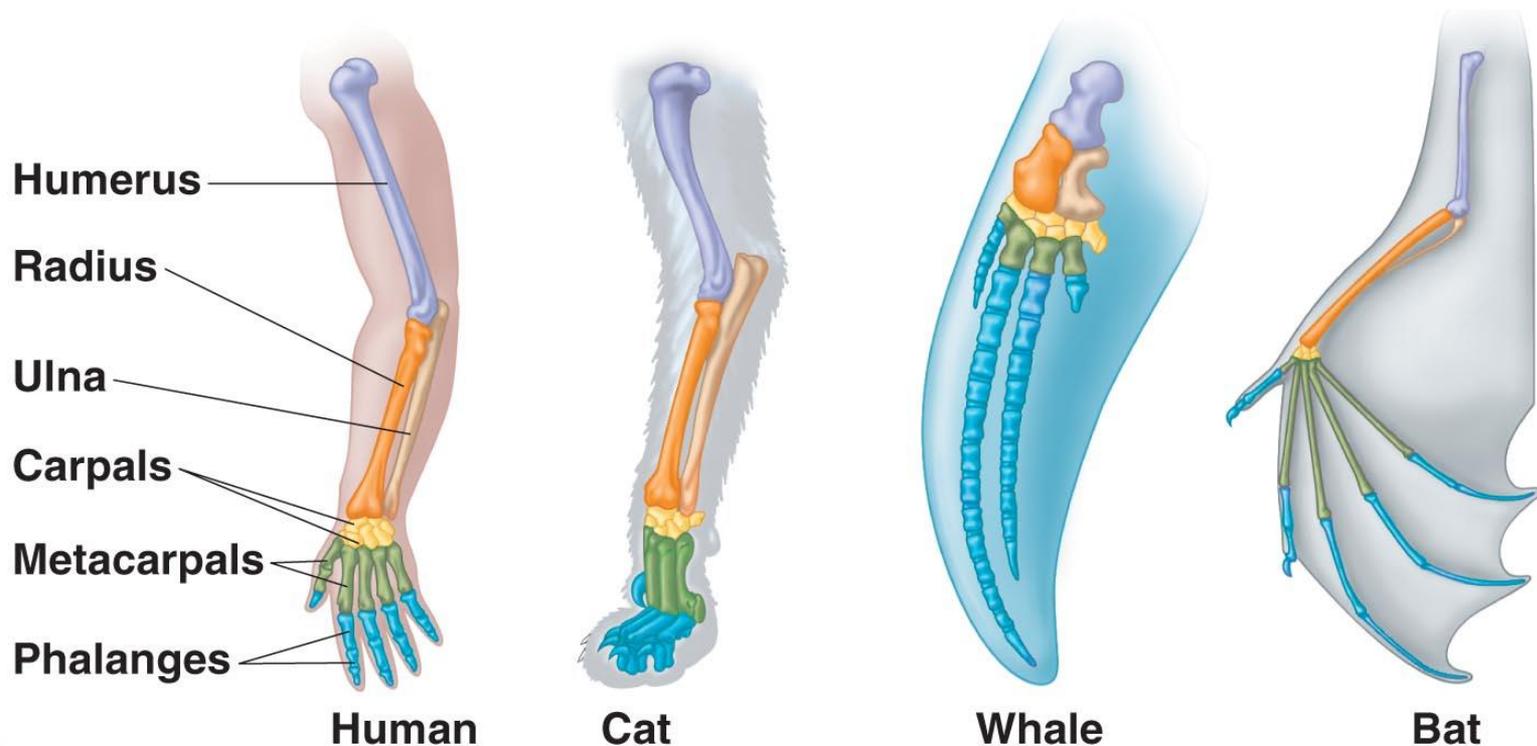
(c) *Sus* (pig)



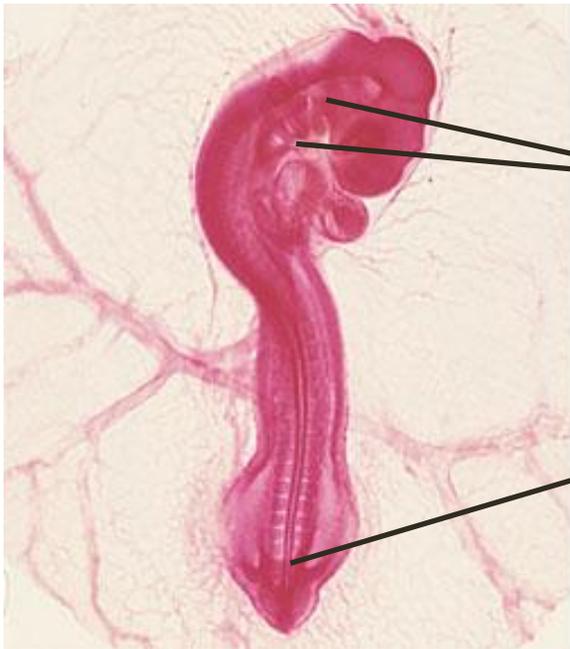
(d) *Odocoileus* (deer)

Homology

- Similarity resulting from common ancestry
- **Homologous structures**
 - Anatomical resemblances among organisms
 - present in a common ancestor

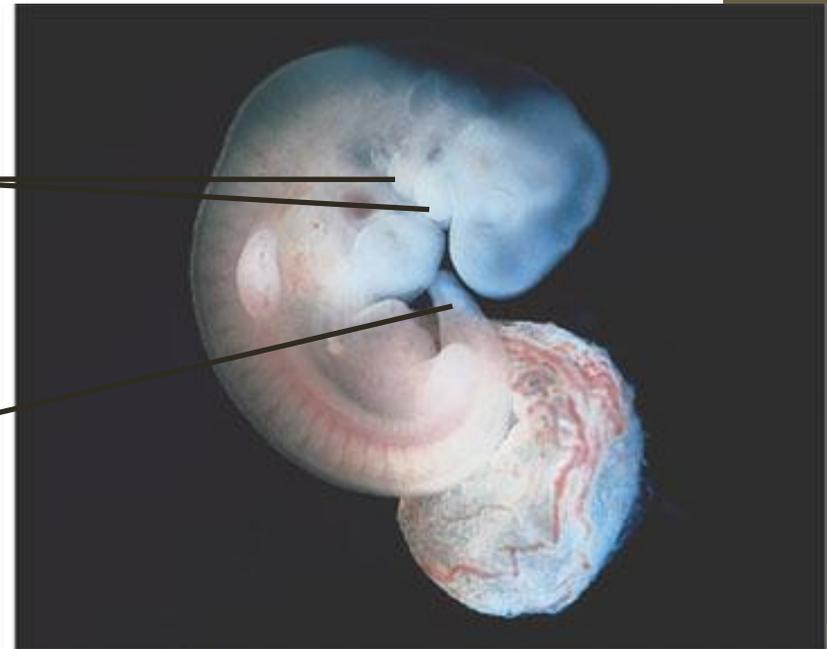


- Comparative embryology
 - Homologies not visible in adult organisms



Pharyngeal pouches

Post-anal tail



Chick embryo

Human embryo

- **Vestigial structures**

- Homologous structures

- Remnants

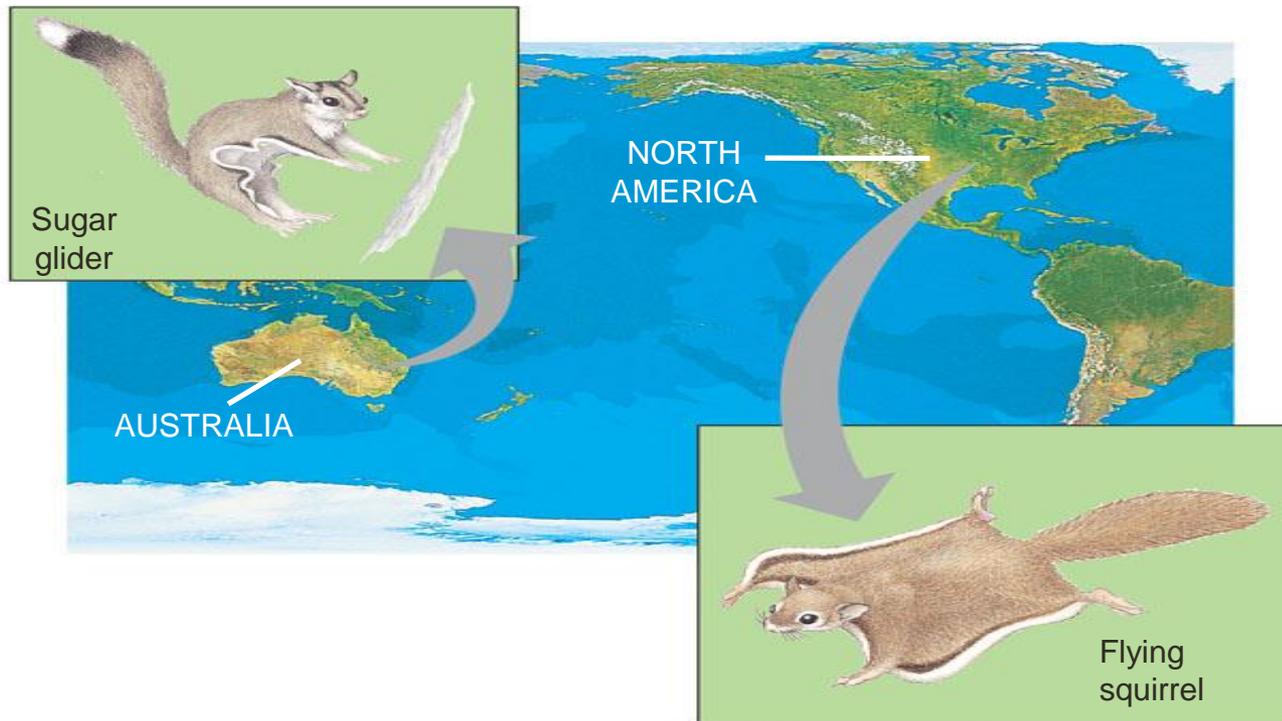
- Structures that served important functions in the organism's ancestors

- Even present at the molecular level

- 'pseudogenes'

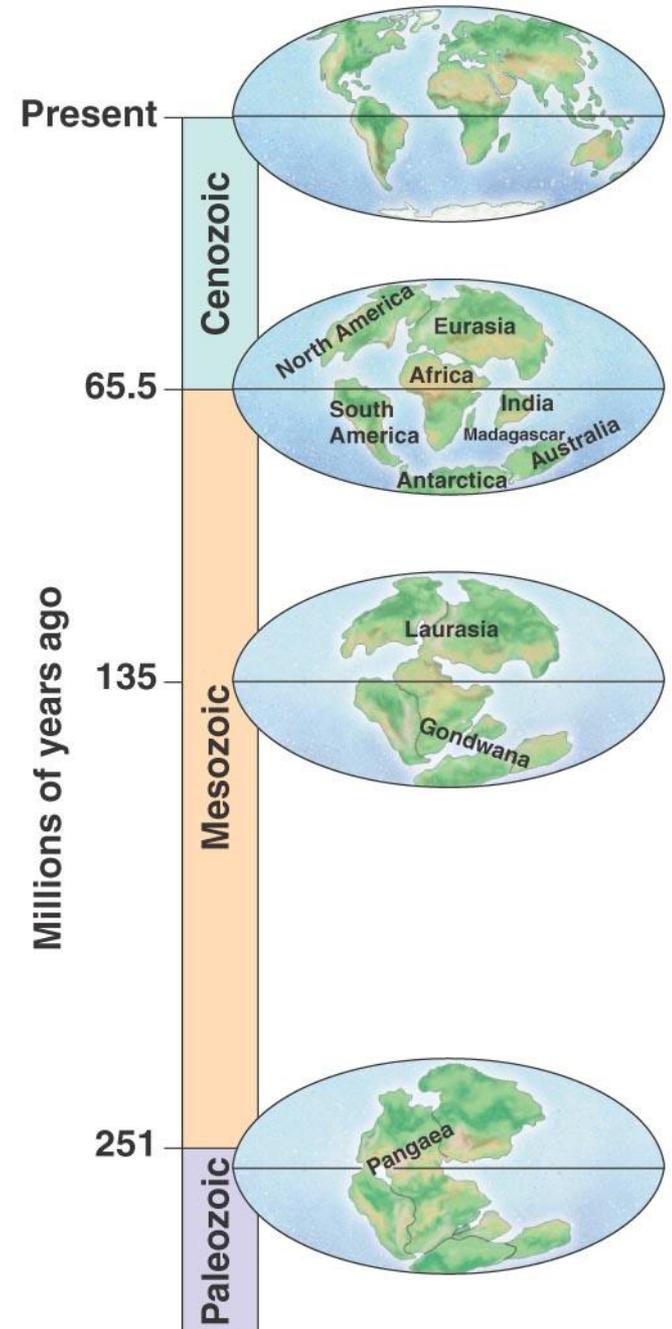
- **Convergent evolution**

- Distantly related groups
- Evolution of similar features - **Analogous**
 - Does **not** reflect ancestry
 - Groups adapt to similar environments in similar ways

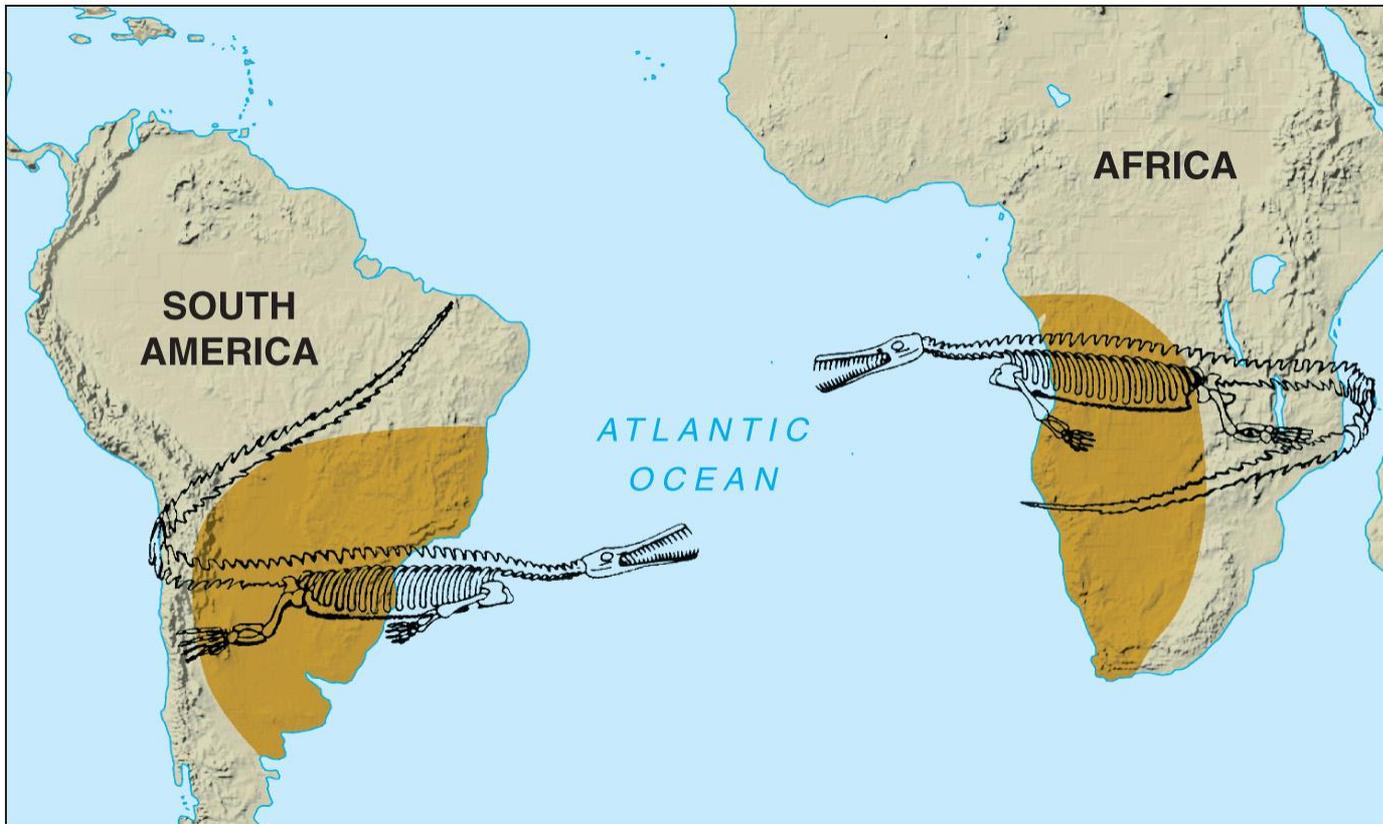


Biogeography

- Geographic distribution of species



- *Mesosaurus* (reptile) fossils
- *Glossopteris* (fern) fossils
- Modern organisms with similar ancestries



Evolution Through Natural Selection

- Important Points, AGAIN:
 - Individuals do **not** evolve;
 - populations evolve over time
 - Natural selection can only increase or decrease **heritable traits** in a population
 - Adaptations vary with different environments

Summary of Darwin's Ideas

- Pair up
- Compile a list of the main points of Darwin's theory
 - What is the theory?
 - What is the mechanism?