Darwin's Theory of Evolution

The Puzzle of Life's Diversity

- **Evolution** = the process by which modern organisms have descended from ancient organisms.
- **Theory** = a well-supported testable explanation of phenomena that have occurred in the natural world.

Voyage of the Beagle

- Charles Darwin – naturalist that joined the crew of the *HMS Beagle* in 1831 for a voyage around that world.
- During his travels, Darwin made numerous observations and collected evidence that led him to propose evolution as the mechanism for the diversity of life on earth.

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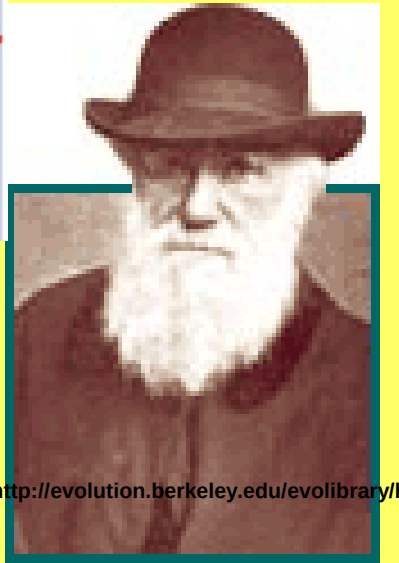
www.darwinday.org/englishL/life/beagle.html



http://evolution.berkeley.edu/evolibrary/home.php

Darwin's Observations

Patterns of Diversity

- Plants and animals well suited to their environment survive and reproduce.
- Grassland ecosystems of Argentina, Australia, and Europe had different sorts of animals.

Darwin's Observations

Living Organisms and Fossils

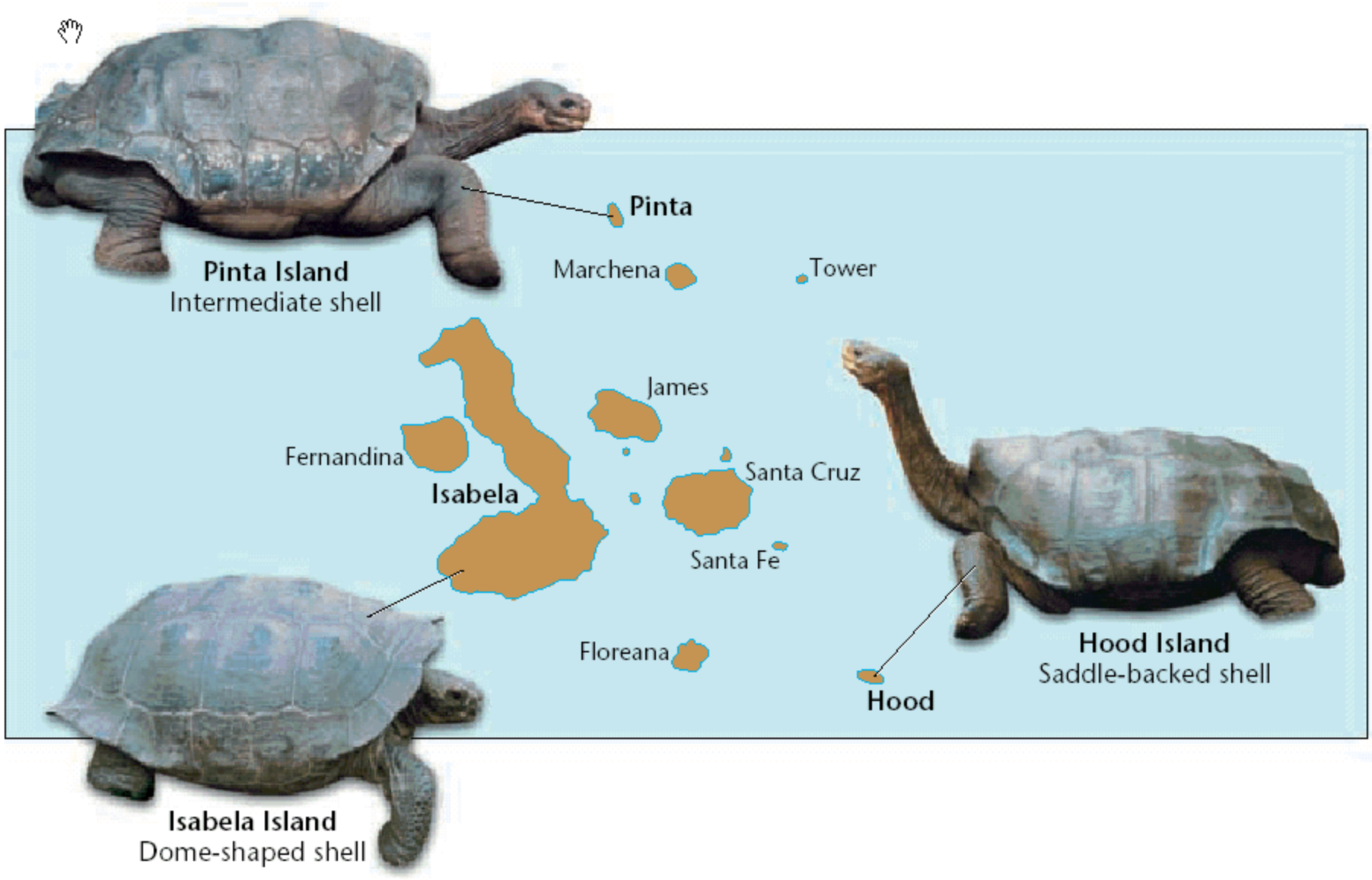
- Collected fossils throughout voyage.
- Some of the fossils resembled organisms that were still alive.
- Others looked unlike any living organism.
- Where did these organisms go? How were they related to the living organisms?

Darwin's Observations

The Galapagos Islands

- Located 1000 km west of South America.
- Islands are close together yet had very different vegetation.
- Hood Island – hot, dry, and nearly barren.
- Isabela Island – greater rainfall, diversity of plants and animals, and rich vegetation
- Observed tortoises, marine iguanas, and finches among other organisms.

Giant Tortoises of the



The Journey Home

- Darwin observed that the characteristics of many animals and plants varied noticeably among the different islands of the Galapagos.
- Are the animals living on the different islands once members of the same species?
- Did they evolve from an original South American ancestor species after becoming isolated from one another?

Scientific Influences on Darwin

1581-1656

Arch Bishop James Usher– biblical

Charles Lyell – *Uniformitarianism*.

1797-1875

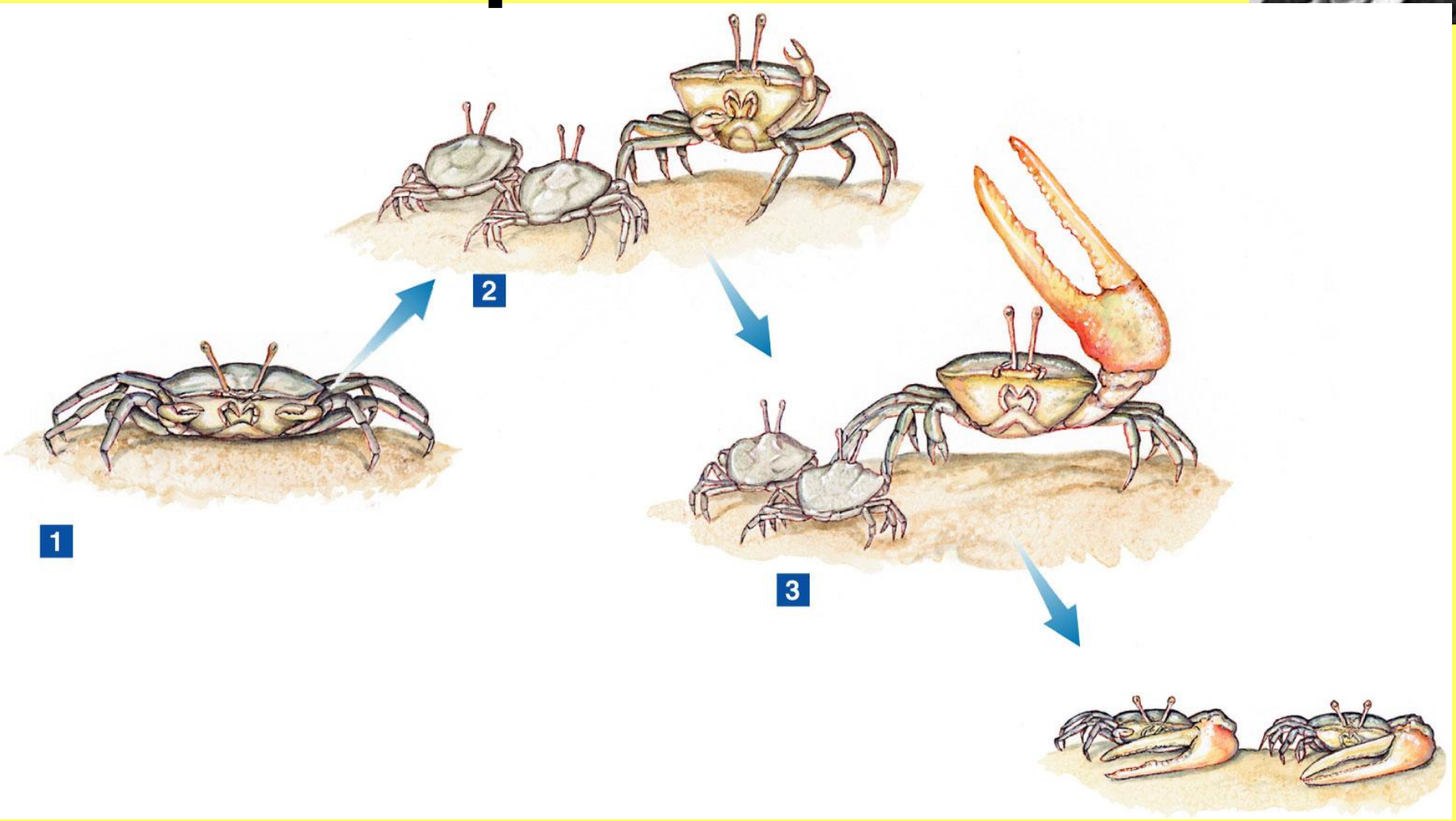
Georges Cuvier – species extinction.

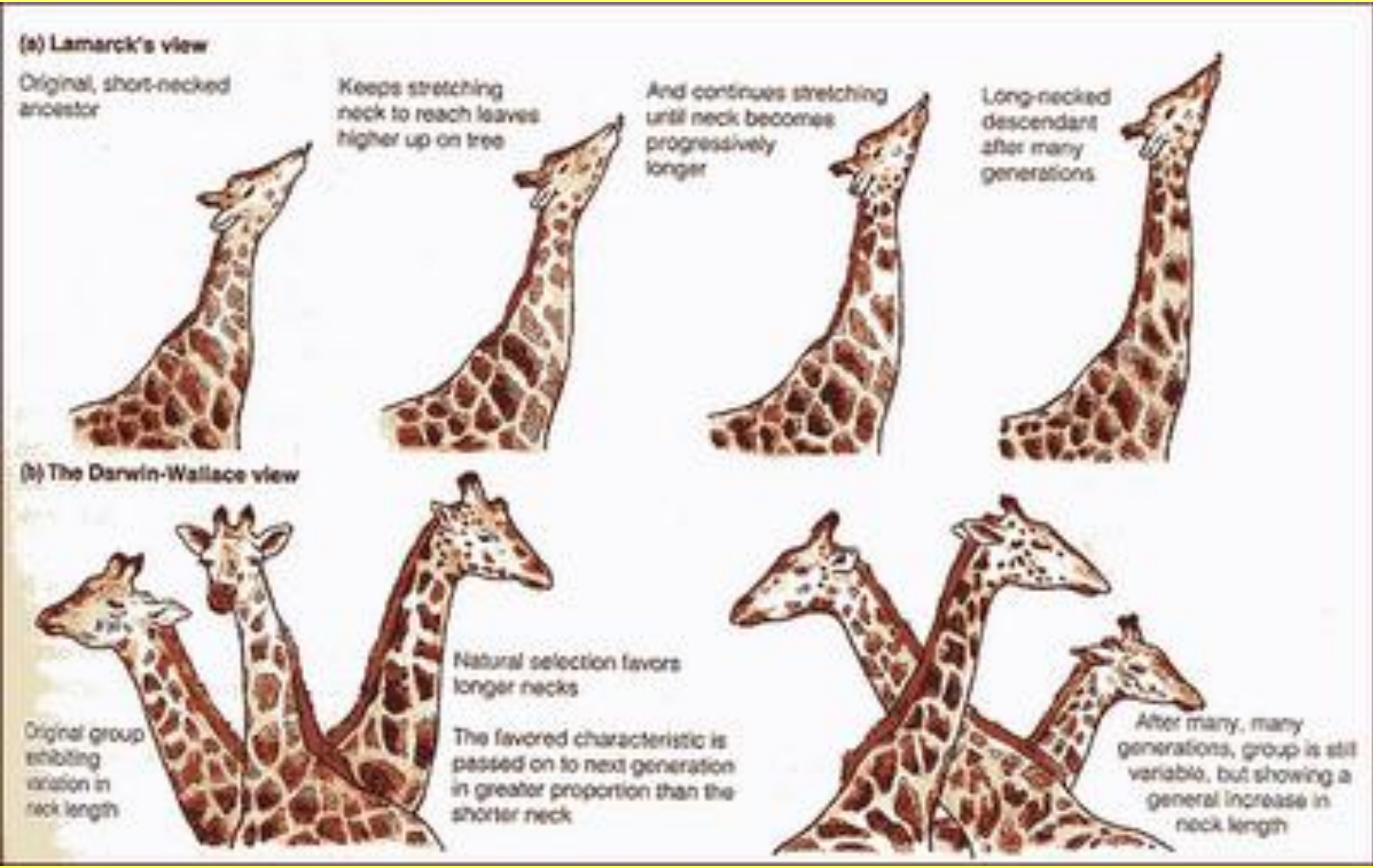
1769-1832

Thomas Malthus – human struggle for existence.

1766-1834

Lamarck's Evolution Hypothesis – Use or Disuse & Inheritance of Acquired Traits

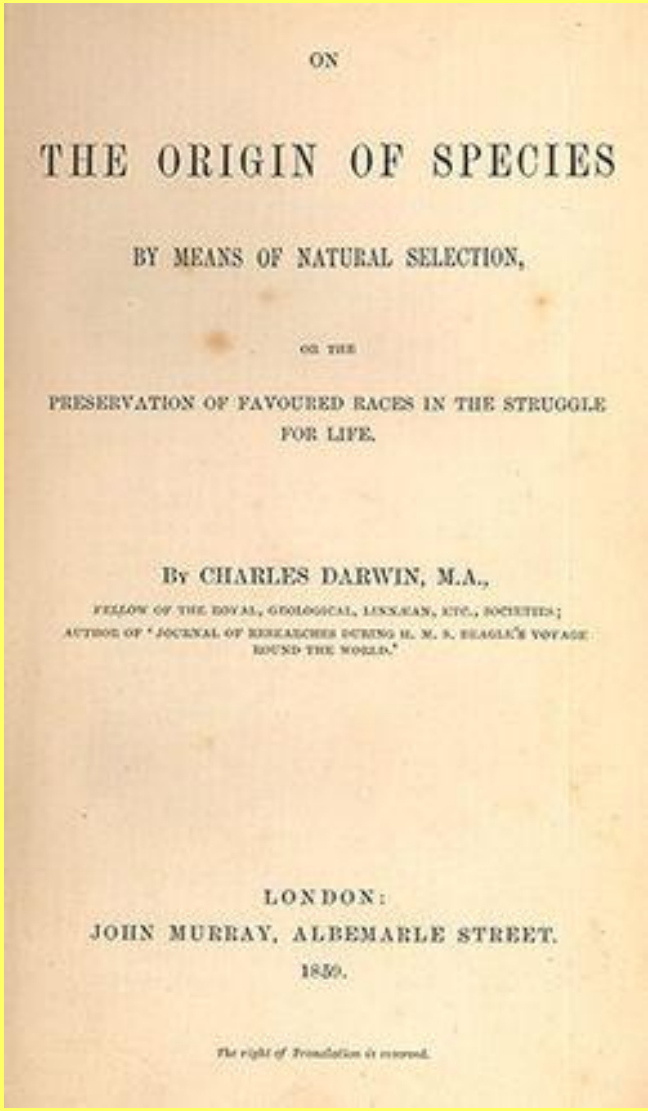



(a) Lamarck's view
Original, short-necked ancestor
Keeps stretching neck to reach leaves higher up on tree
And continues stretching until neck becomes progressively longer
Long-necked descendant after many generations
(b) The Darwin-Wallace view
Original group exhibiting variation in neck length
Natural selection favors longer necks
The favored characteristic is passed on to next generation in greater proportion than the shorter neck
After many, many generations, group is still variable, but showing a general increase in neck length

Darwin Presents His Case for Evolution

- Darwin did not immediately publish his ideas on evolution because they challenged fundamental scientific beliefs of the time.
- In 1858, Darwin received an essay by Alfred Russel Wallace that presented ideas on evolution very similar to Darwin's.
  - Papers from Wallace and Darwin were jointly presented (with little impact) to the Linnaean Society in 1858.
- 1859, Darwin publishes *On the Origin of Species*.

Clip Darwin and Wallace



ON

THE ORIGIN OF SPECIES

BY MEANS OF NATURAL SELECTION,

OR THE

PRESERVATION OF FAVOURED RACES IN THE STRUGGLE FOR LIFE.

By CHARLES DARWIN, M.A.,

FELLOW OF THE ROYAL, GEOLOGICAL, LINNÆAN, ETC., SOCIETIES;

AUTHOR OF 'JOURNAL OF RESEARCHES DURING H. M. S. BEAGLE'S VOYAGE ROUND THE WORLD.'

LONDON:

JOHN MURRAY, ALBEMARLE STREET.

1859.

Inherited Variation and Artificial Selection

- Individuals of each species vary from one another.
- Darwin argued that this variation was important.
- In artificial selection, humans select from among the naturally occurring genetic variations in a species.

Artificial selection

- Dogs
  - All breeds descended from wolves
    - (AKC > 160)
  - Selected for color, hair length, size, behavior, & oddities

Artificial selection

- Wheat, corn, for resistance to rust fungi, etc.
- USDA spends $$ to breed new resistant varieties.

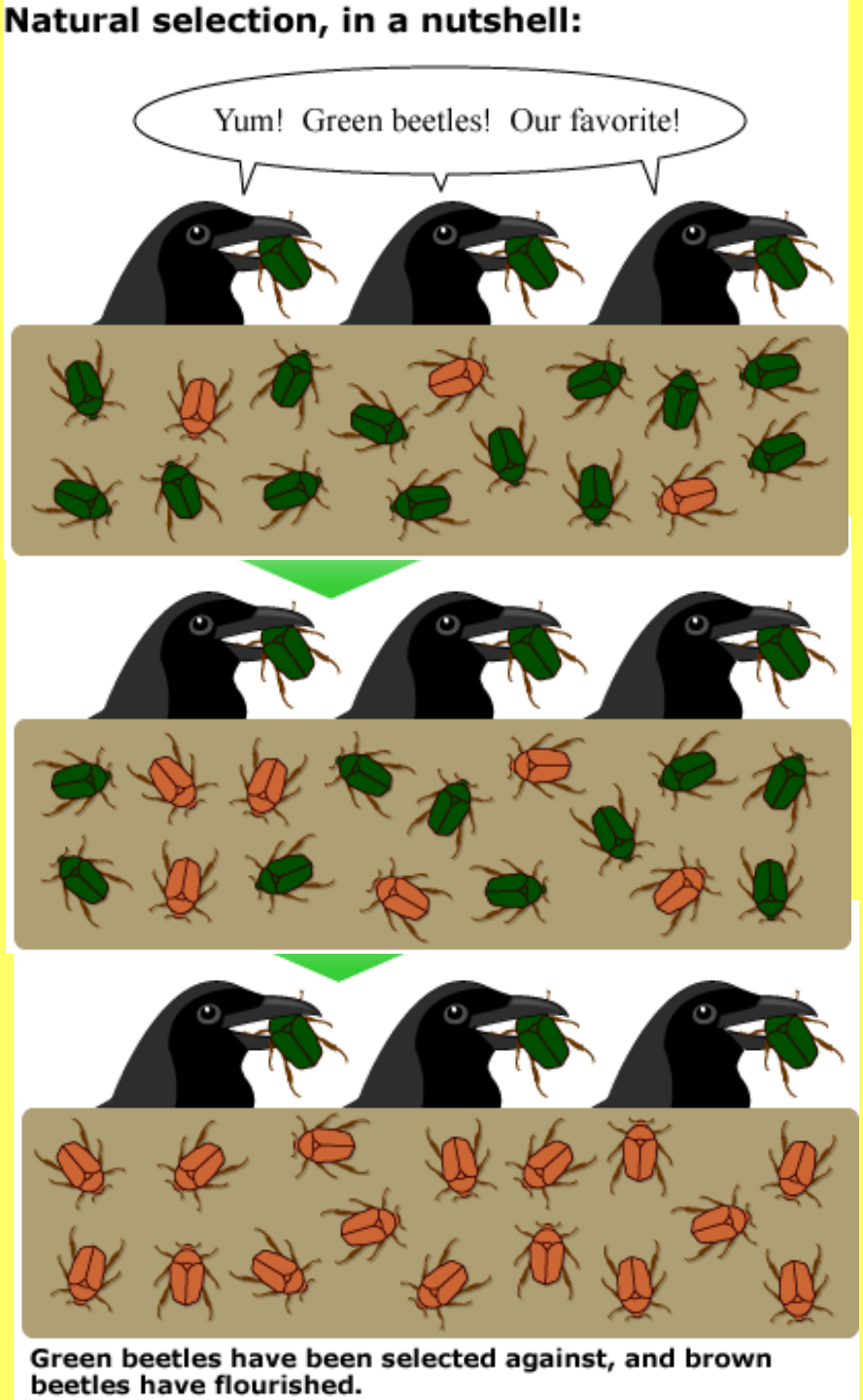
Artificial selection

- **Unintentional artificial selection**
  - Antibiotic resistance in bacteria
    - Penicillin, Streptomycin, Tetracycline, etc.
    - “Multidrug resistant” tuberculosis
  - Pesticide resistance in insect pests
    - DDT, Chlordane, etc.

- **Adaptation** = any **inherited** characteristic that increases an organism's chance of survival. Can be anatomical, physiological, or behavioral.
  - Successful adaptations enable organisms to become better suited to their environment.
- **Fitness** = the ability of an individual to survive and reproduce in its specific environment. Result of adaptation.

Survival of the Fittest

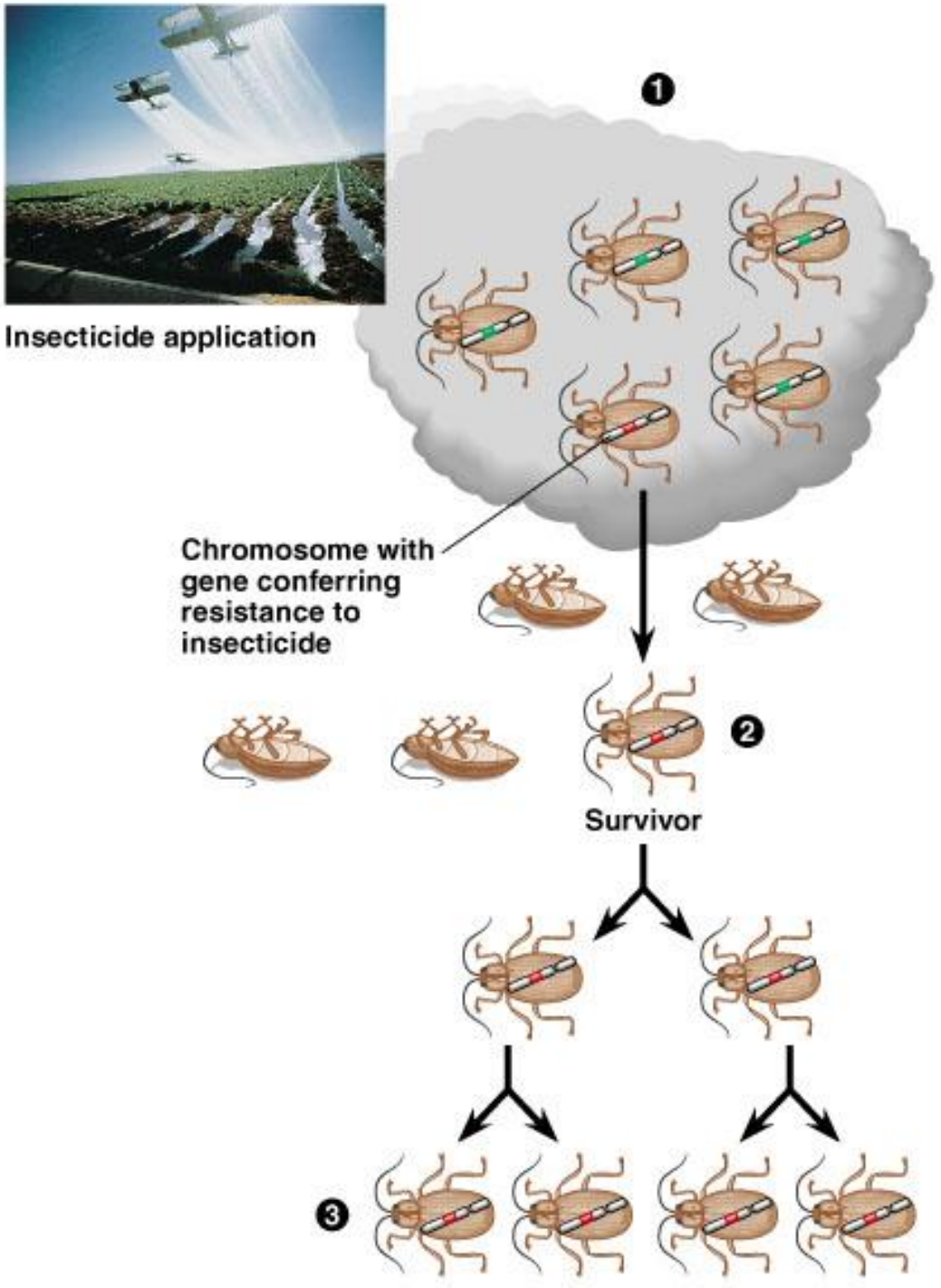
- **Survival of the fittest** = individuals with adaptations that make them better suited to their environment survive and reproduce most successfully.
- **Natural selection** = the traits being selected, and increasing over time, contribute to an organism's fitness in its environment.



Over time, natural selection results in changes in the inherited characteristics of a population. These changes increase a species' fitness in its environment.

Evidence for Evolution – Evolution Observed

Evolution of pesticide resistance in response to selection.



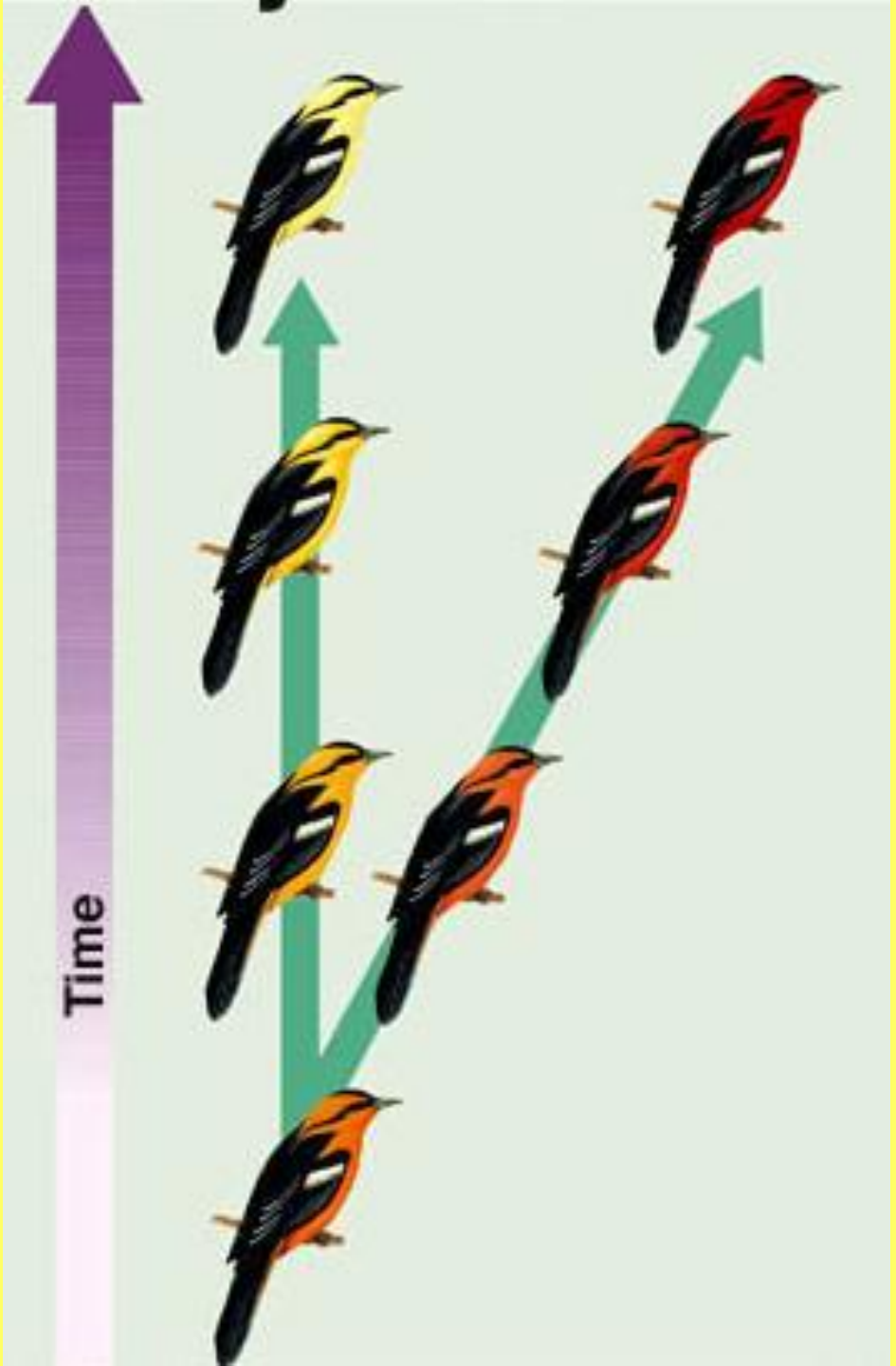
Natural selection in Peppered Moth

- England, before Industrial Revolution
  - Trees lichen covered, moths light gray, speckled
- After I.R. urban trees soot-covered, lichens dead
  - Urban moths dark

Natural selection in *Anolis sagrei*

- *A. sagrei* introduced to 14 small cays in Bahamas
- Populations on islands with trees did not change;
- On islands with only grasses and shrubs, populations evolved to have longer, thinner thighs.
  - Lizards run from cover to cover.
  - Longer thinner legs make runners faster.

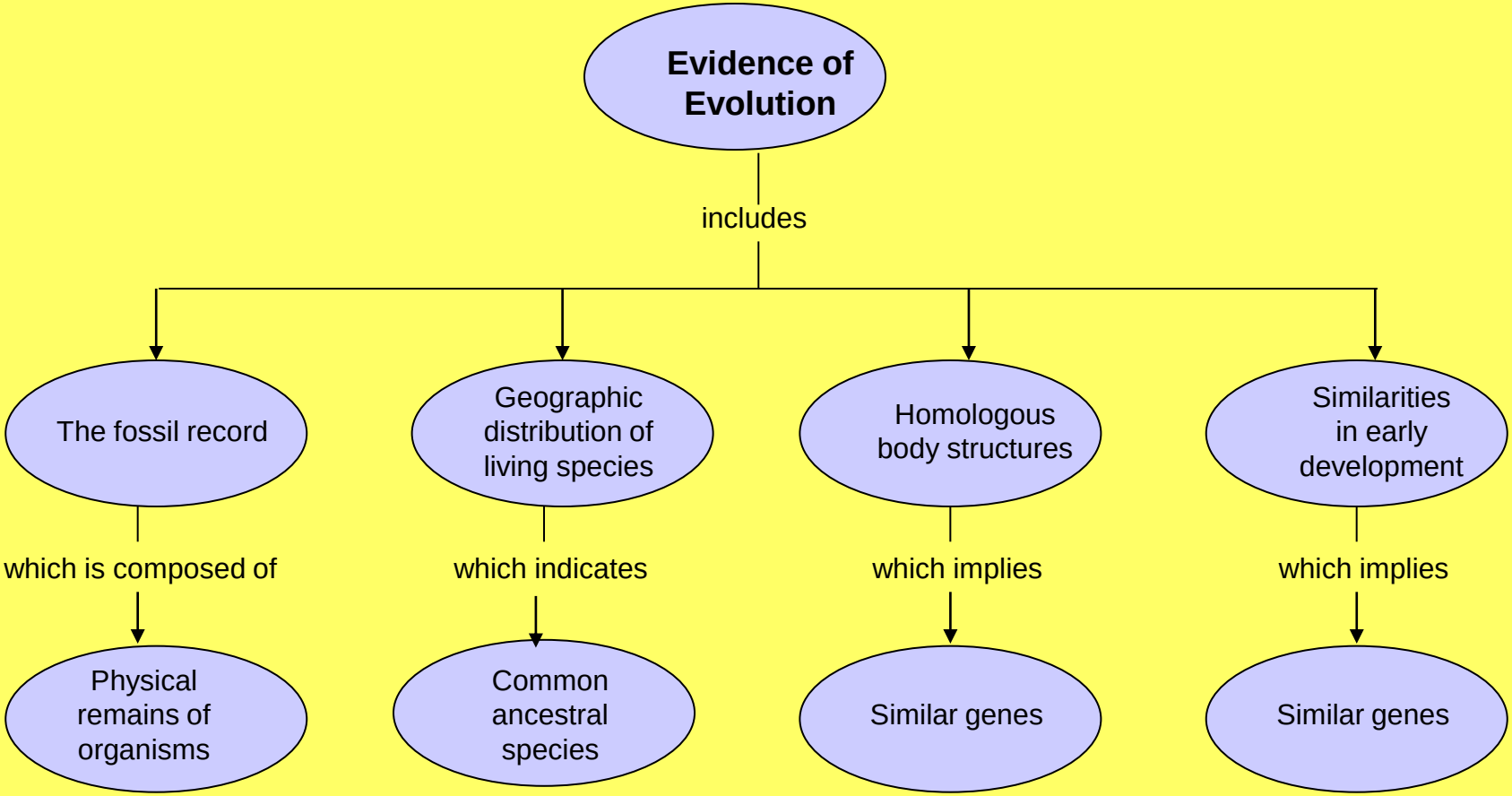
Descent with modification - over long periods of time, natural selection produces organisms that have different structures, establish different niches, or occupy different habitats from the original species.



Summary of Darwin's Theory

- Individual organisms differ, and some of this variation is inheritable.
- Organisms produce more offspring than can survive, and many that do survive do not reproduce.
- Because more organisms are produced than can survive, they compete for limited resources.
- Individuals best suited to their environment survive and reproduce most successfully and pass on their heritable traits to their offspring. This process of natural selection causes species to change over time.
- Species alive today are descended with modification from ancestral species that lived in the distant past.

Concept Map



Darwin argued that living things have been evolving on Earth for millions of years.

Darwin argued that the fossil record provided evidence that living things have been evolving for millions of years.

(a) Strata of sedimentary rock with fossils embedded

(b) Fossilized sea urchin, at least 65 million years old

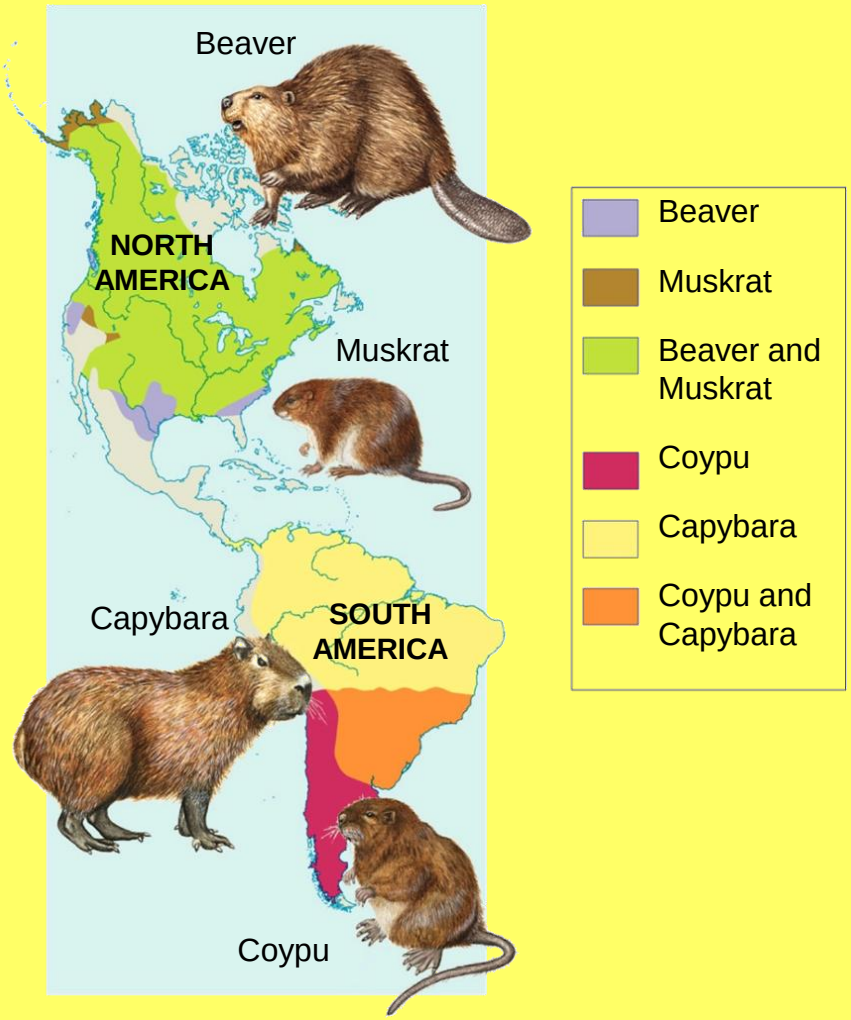
Evolution by Natural Selection

- Darwin proposed that a type of **artificial selection** occurred in nature.
- Members of each species **compete** regularly to obtain food, living space, and other necessities of life.
  - Selection removes (some) individuals with unfavorable phenotypes.
  - Selection preserves (some) individuals with favorable phenotypes.
- The **struggle for existence** was central to Darwin's theory of evolution.

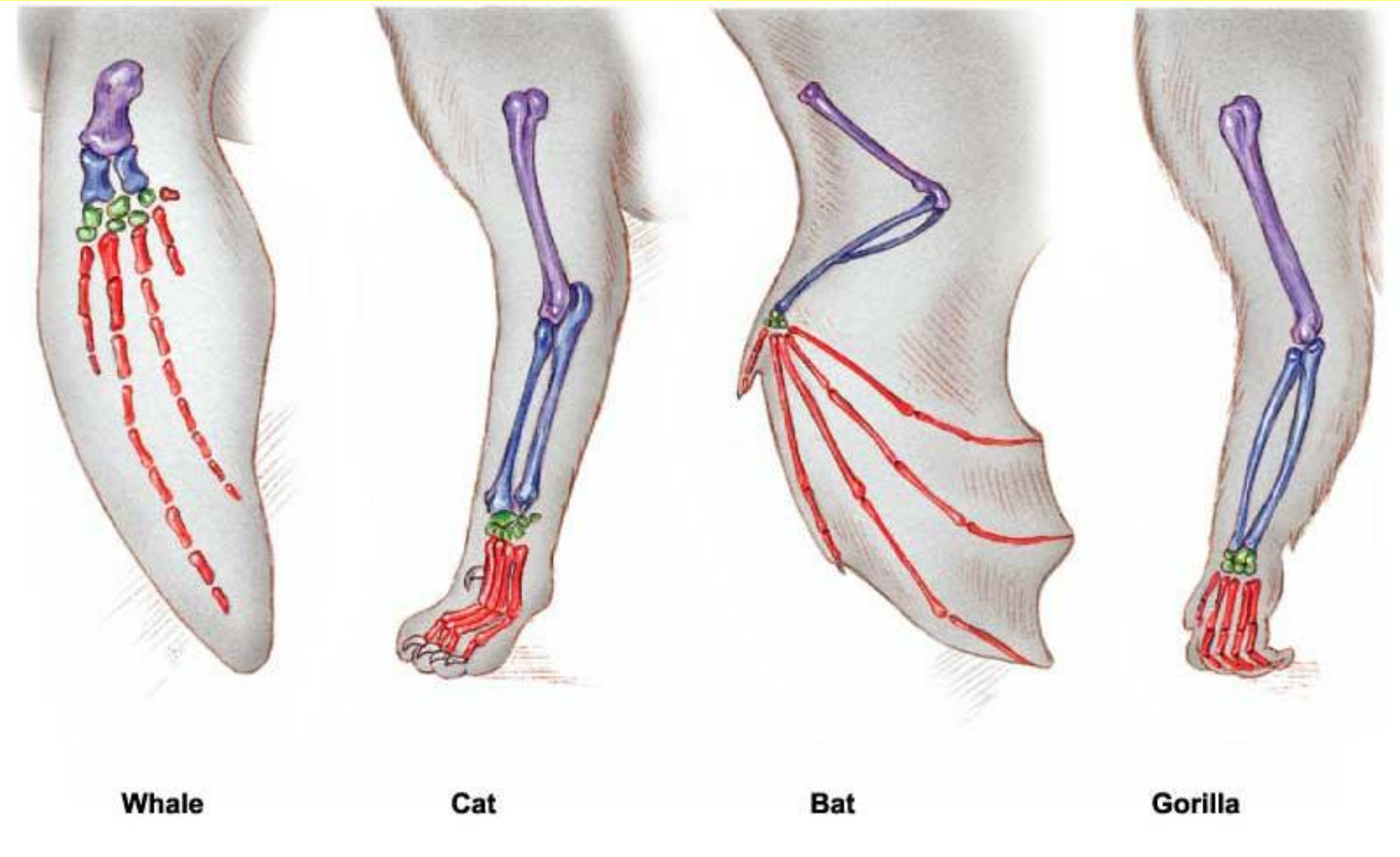
Geographic Distribution of Living Species

Darwin proposed that similar animals in different locations were the product of different lines of evolutionary descent.

Because the animals were living under similar ecological conditions they were exposed to similar pressures of natural selection and evolved common features.



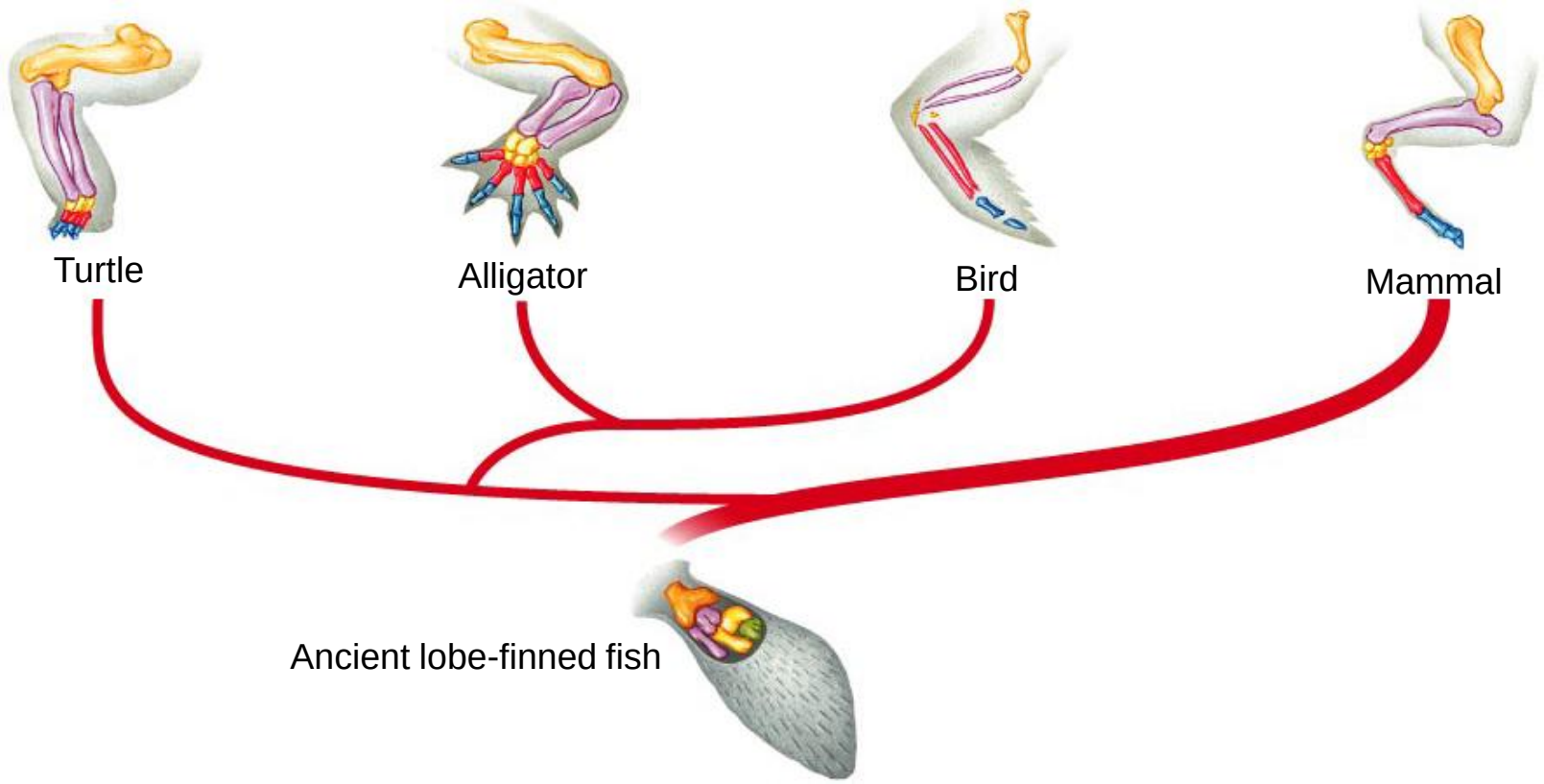
Evidence for Evolution - Comparative Morphology



Why use the same skeletal plan for these very different appendages?

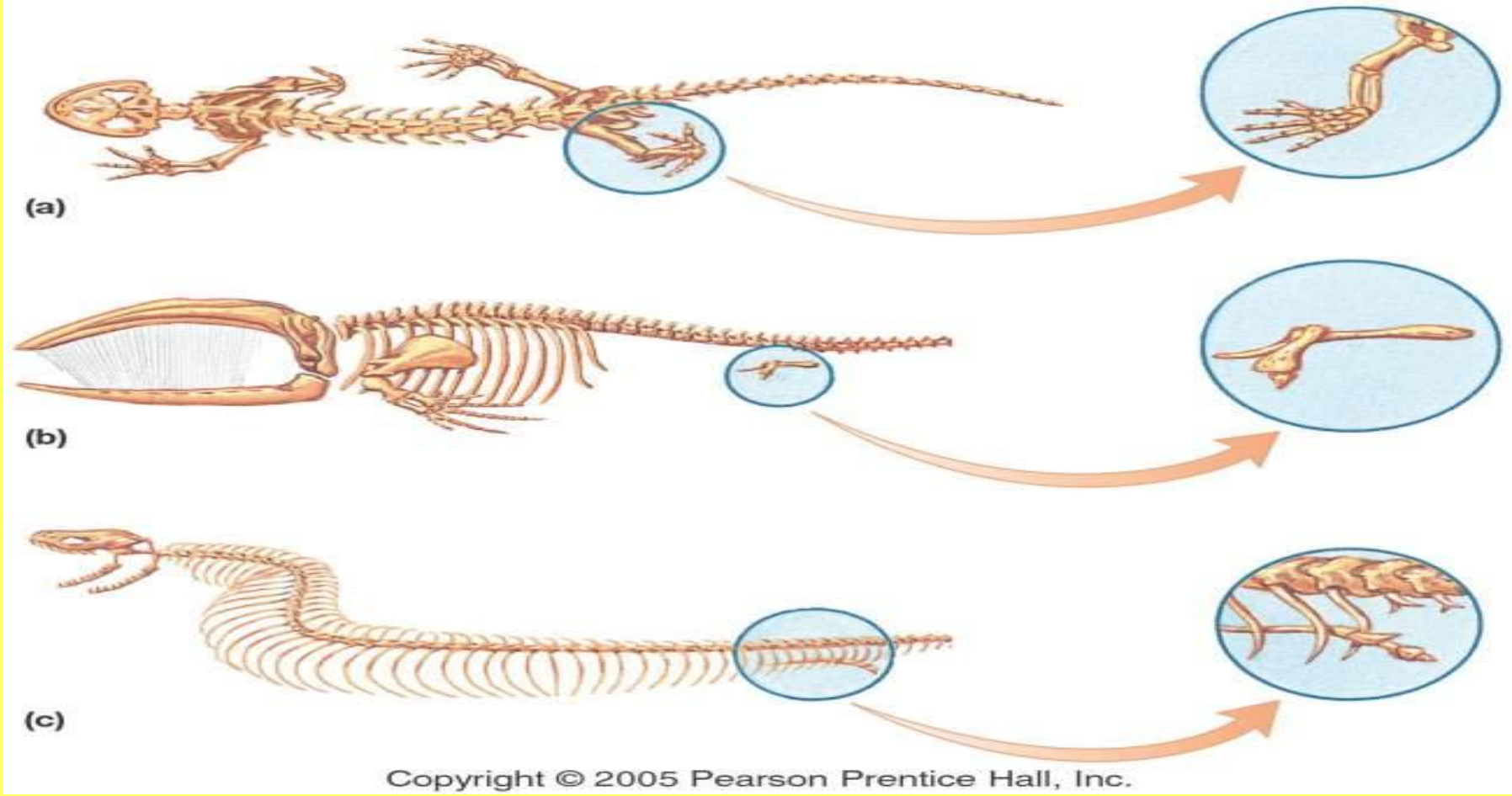
Figure 15–15 Homologous Body Structures

Section 15-3



Homologous structures = have different mature forms but develop from the same embryonic tissues.

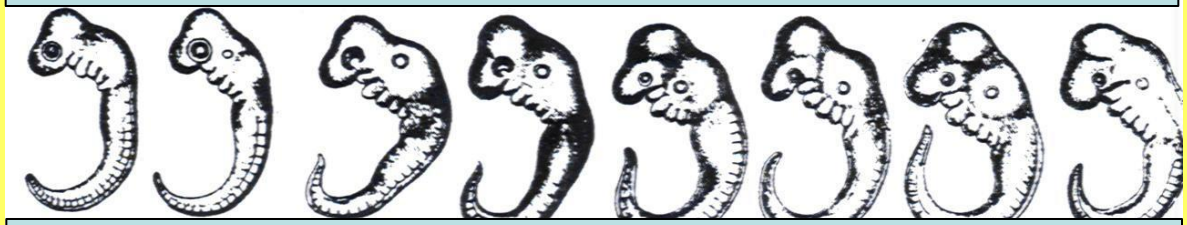
Vestigial organs = organ that serves no useful function in an organism.



- Many organisms have vestigial structures that serve no apparent function. The (a) salamander, (b) whale, and (c) snake all inherited hindlimb bones from a common ancestor; the bones remain functional in the salamander but are vestigial in the whale and snake.

Similarities in Embryology

In their early stages of development, the embryos of many animals are very similar.



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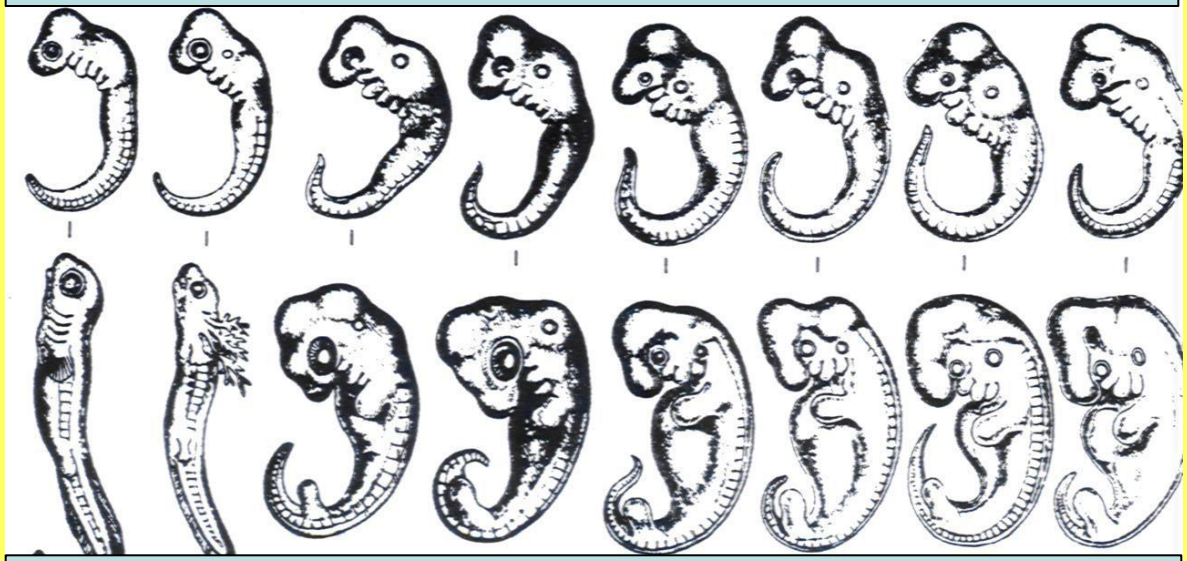

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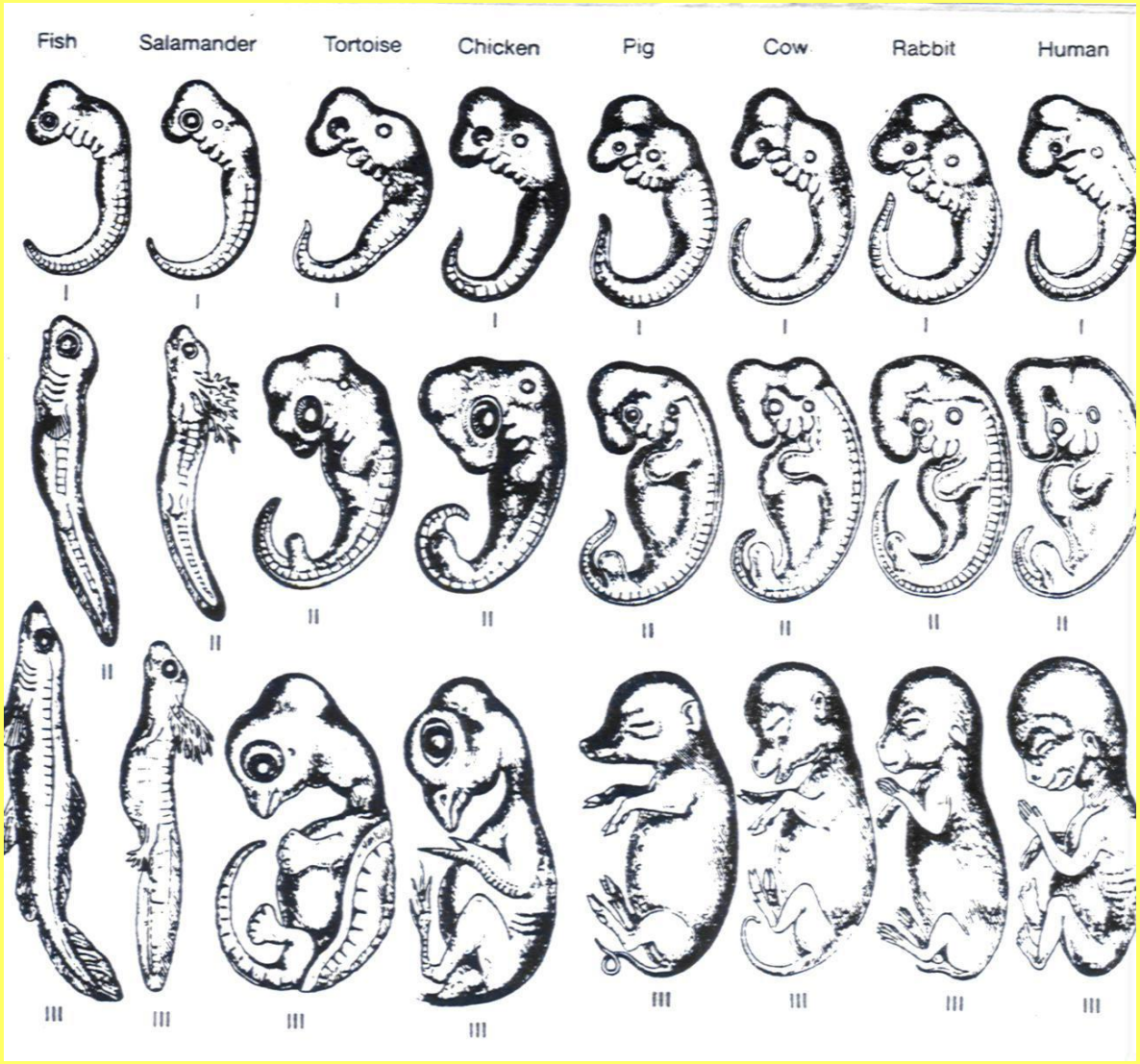
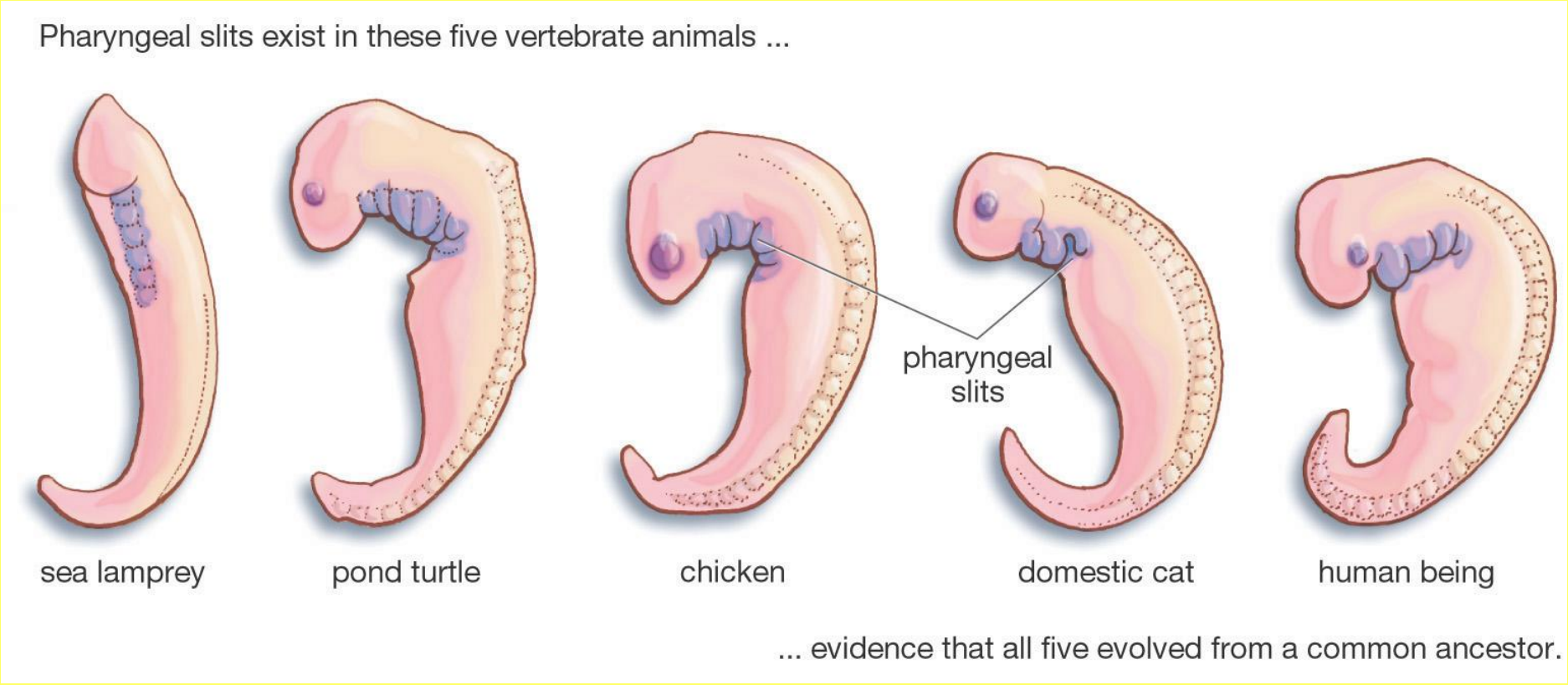


Evidence for Evolution - Comparative Embryology

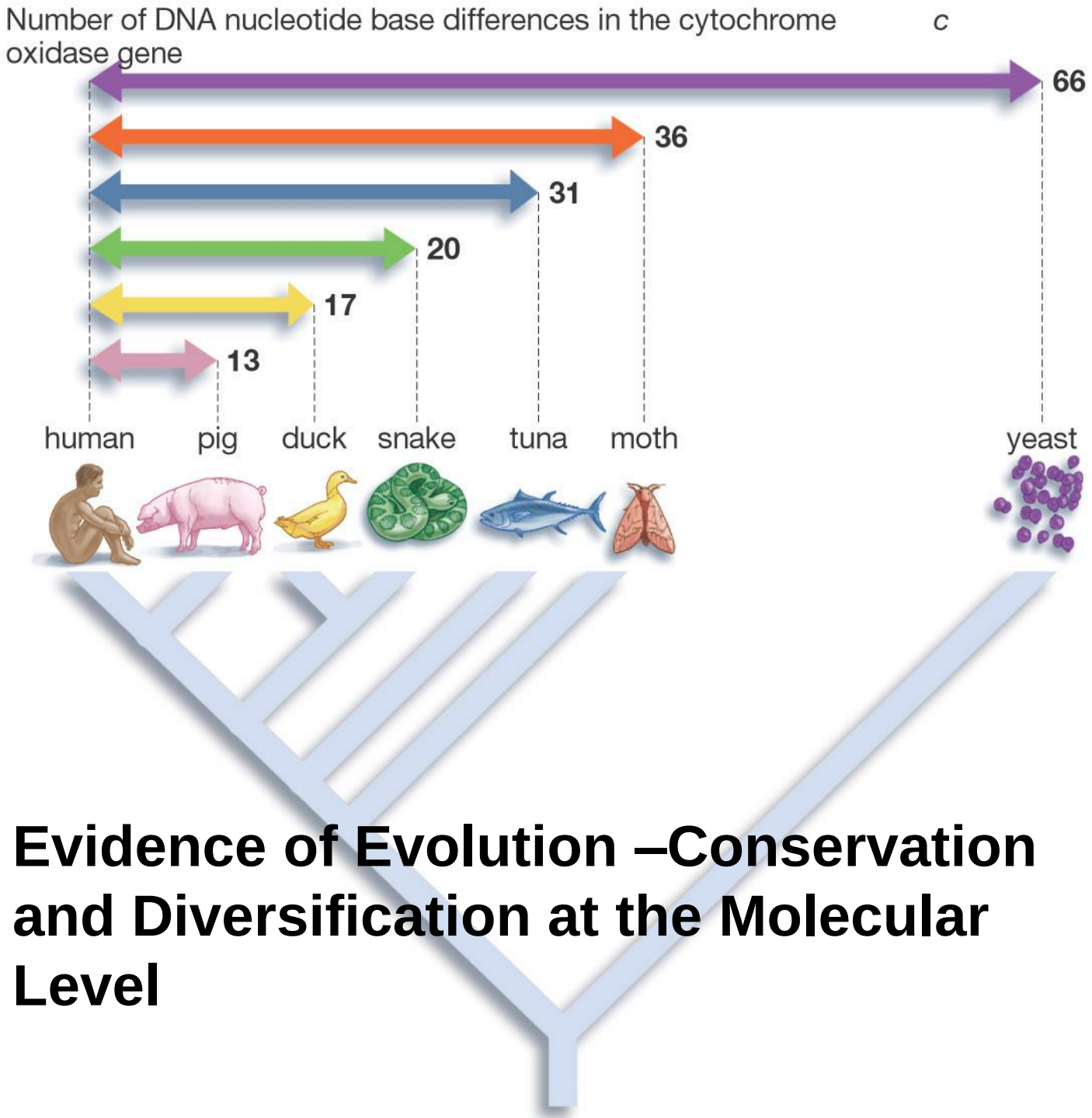


Why do embryos of different animals pass through a similar developmental stage?

Recent discoveries of the conservation of molecular mechanisms of development are even more compelling.

Why should different organisms possess related genes?

Why does the degree of relationship of genes match their degree of relationship established by other methods?



Evidence of Evolution –Conservation and Diversification at the Molecular Level