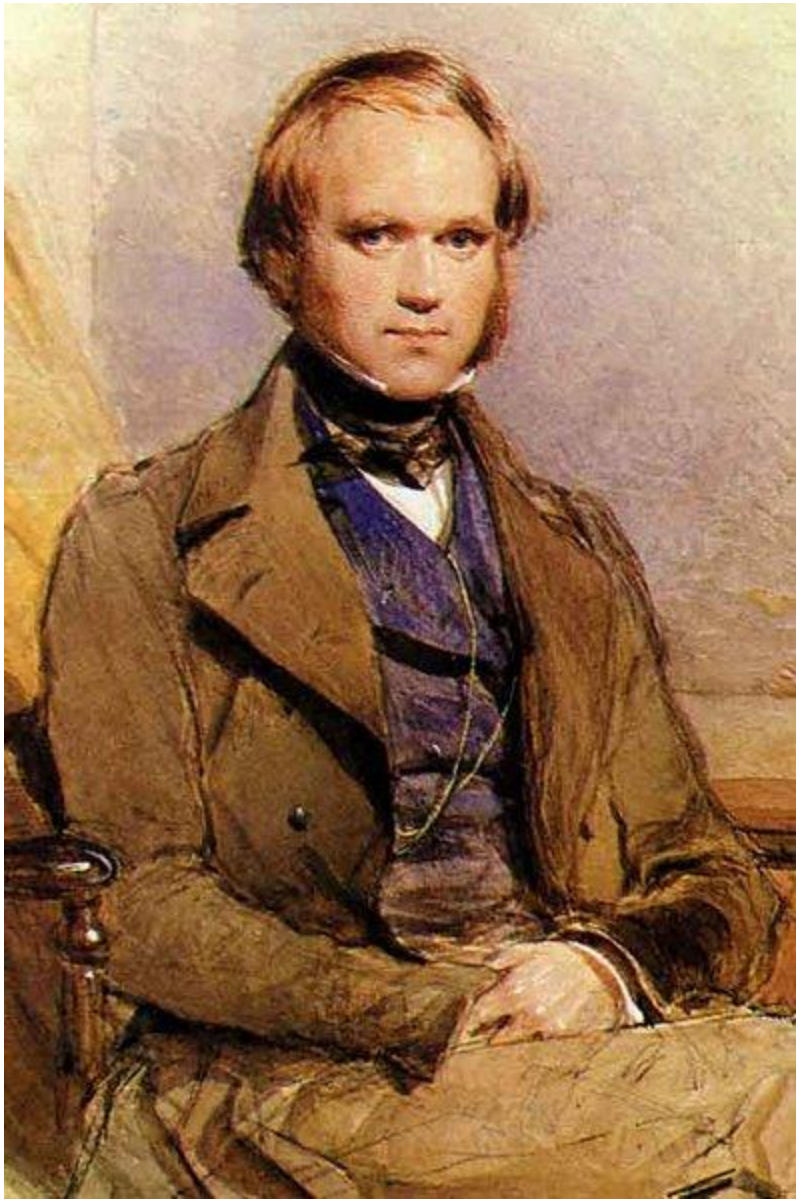
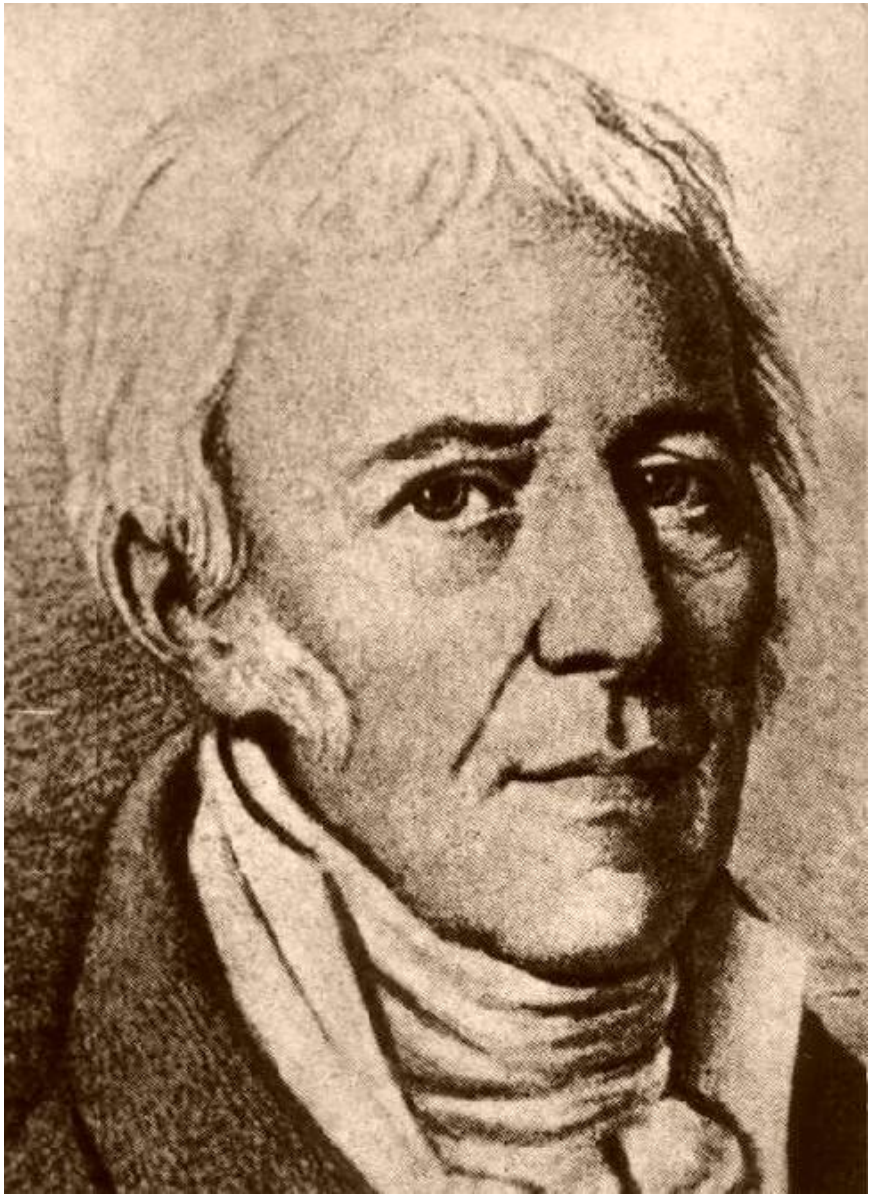
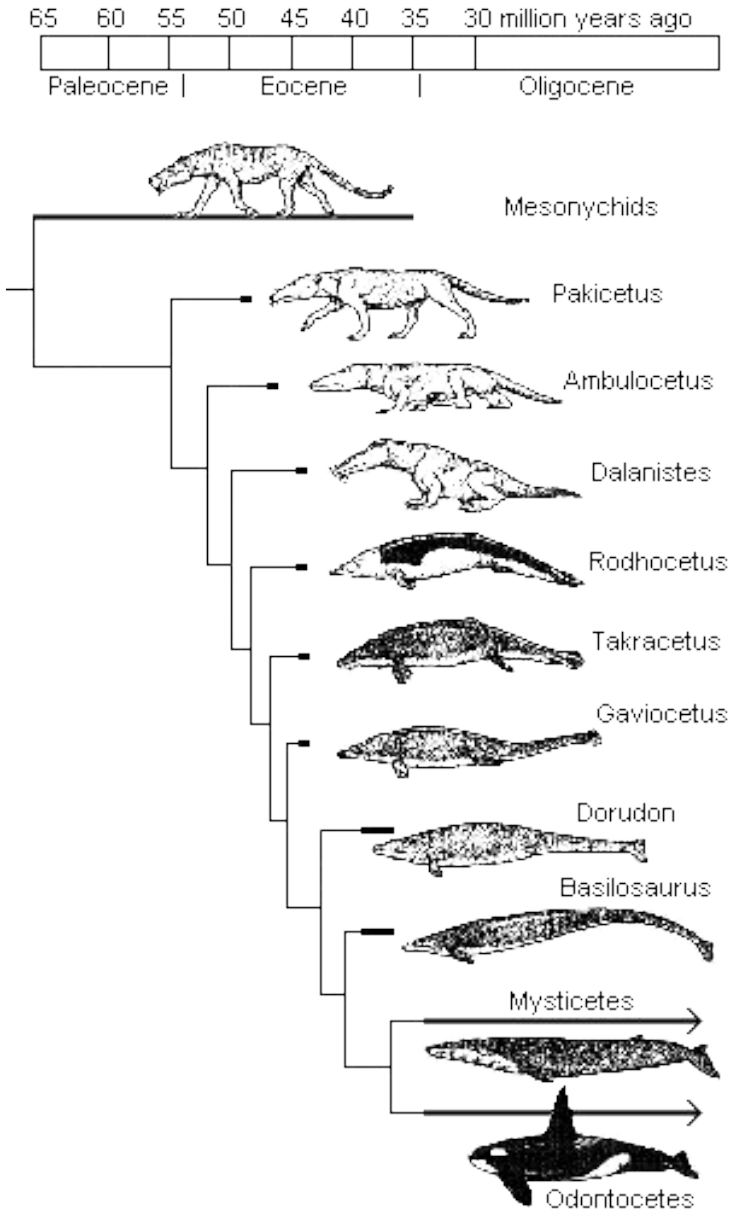
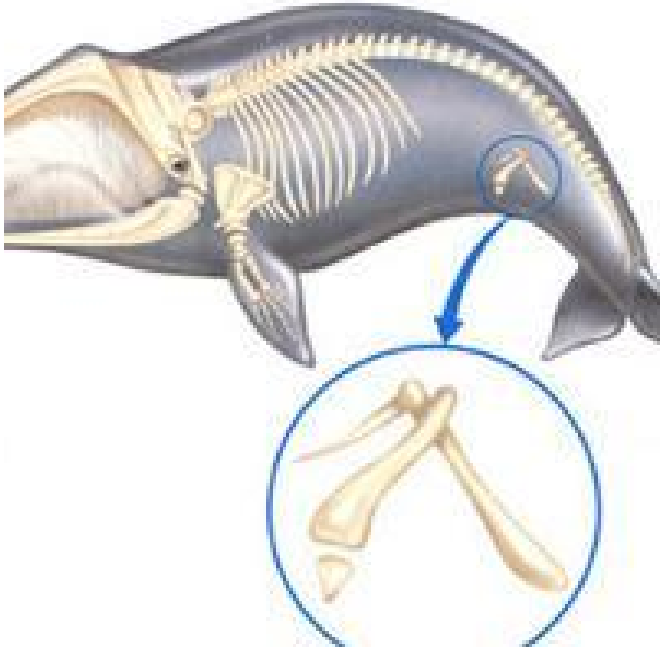




Evolution

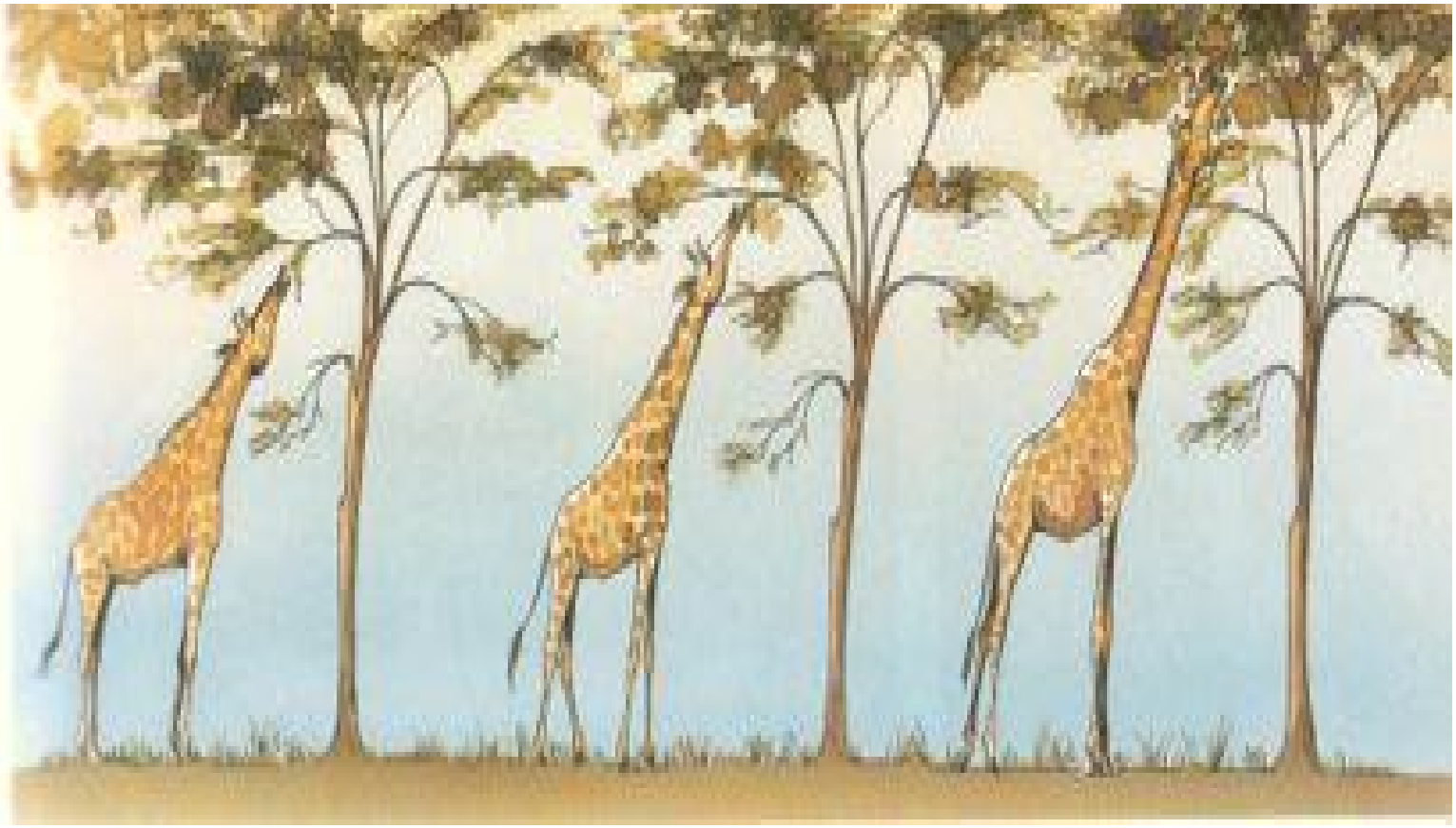
- “The change that has occurred in a species of organism with the passage of time”
- Passage of time = millions of years!
- Resulted in diversity today


65
60
55
50
45
40
35
30 million years ago
Paleocene
Eocene
Oligocene
Mesonychids
Pakicetus
Ambulocetus
Dalanistes
Rodhocetus
Takracetus
Gaviocetus
Dorudon
Basilosaurus
Mysticetes
Odontocetes



Lamarck's Theory 1809

- Lamarck is best known for his *Theory of Inheritance of Acquired Characteristics*:
  - If an organism changes during life in order to adapt to its environment, those changes are passed on to its offspring.
  - Change is made by what the organisms want or need



What Darwin Believed 1831

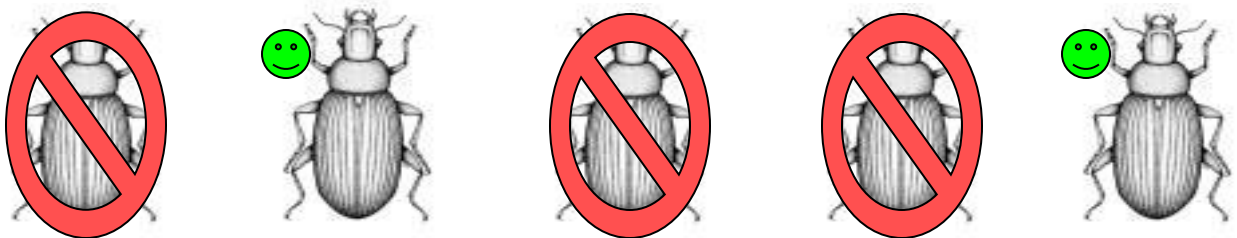
- Darwin believed that organisms, even of the same species, are all different (VARIATIONS)
- These variations help populations survive in their environments to have more offspring with favorable variations

Theory of Natural Selection

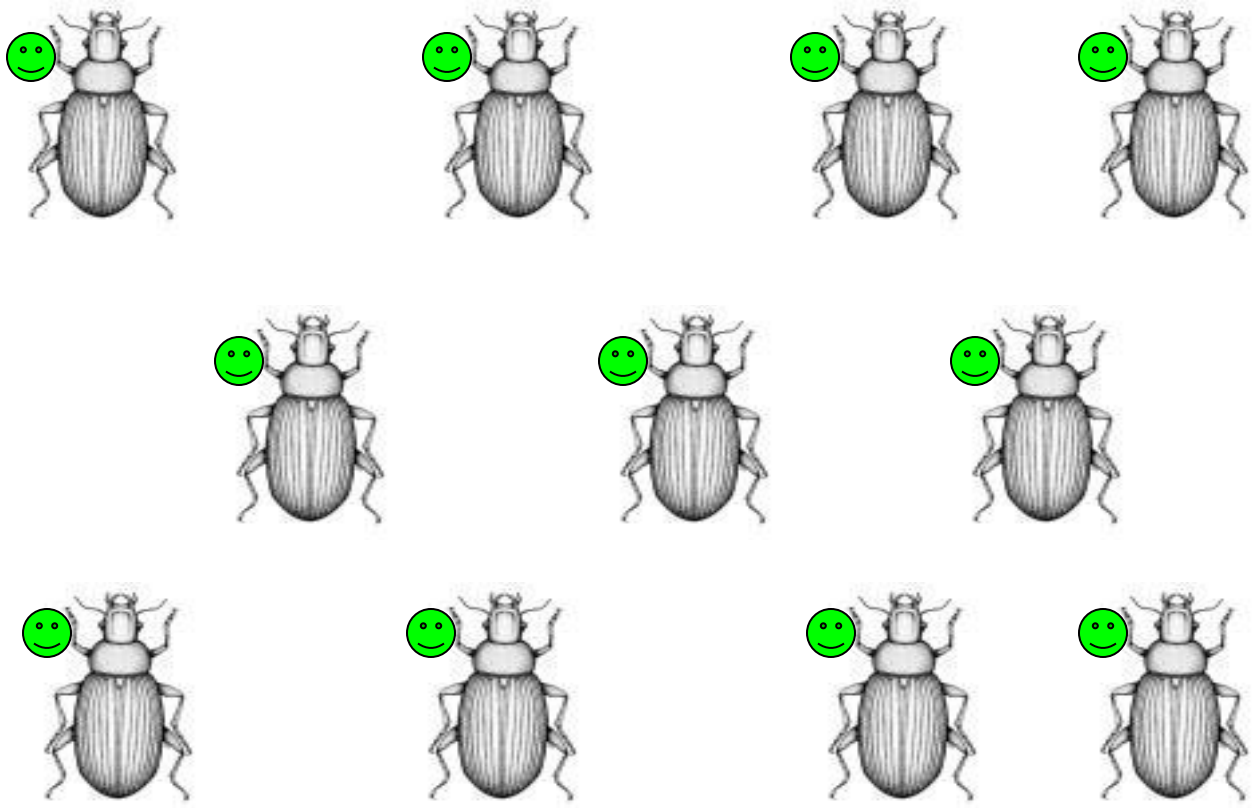
- The environment selects a variation that helps an organism survive and have more offspring.
- In order for natural selection to work there must be variation in a population

Example of Natural Selection

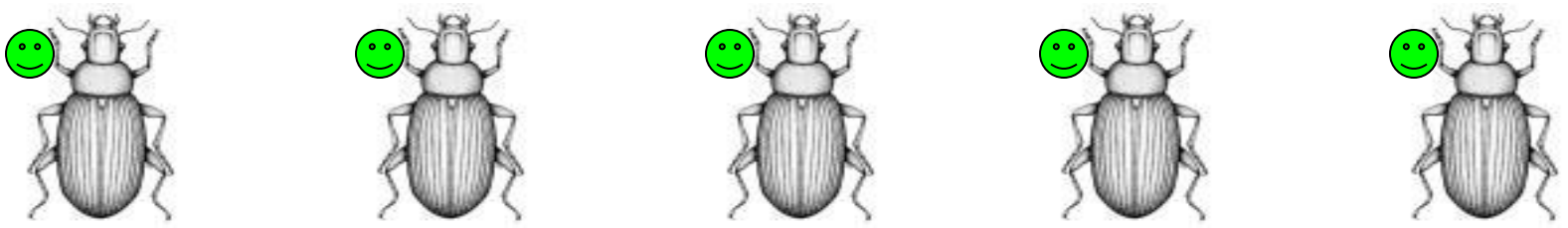
- Step one: application is made to a population where some individuals have natural resistant genes



Resistant individuals reproduce – pass on genes



Next application – no effect



pHET Simulation Post-Questions

If only one species is considered the “fittest”, why do we still have so many variations among species. Why do some birds have very long pointy beaks, while other birds have short flat beaks?

How do you think diseases can affect natural selection?

In what ways does this simulation fail to represent the process of natural selection? Give a specific example.

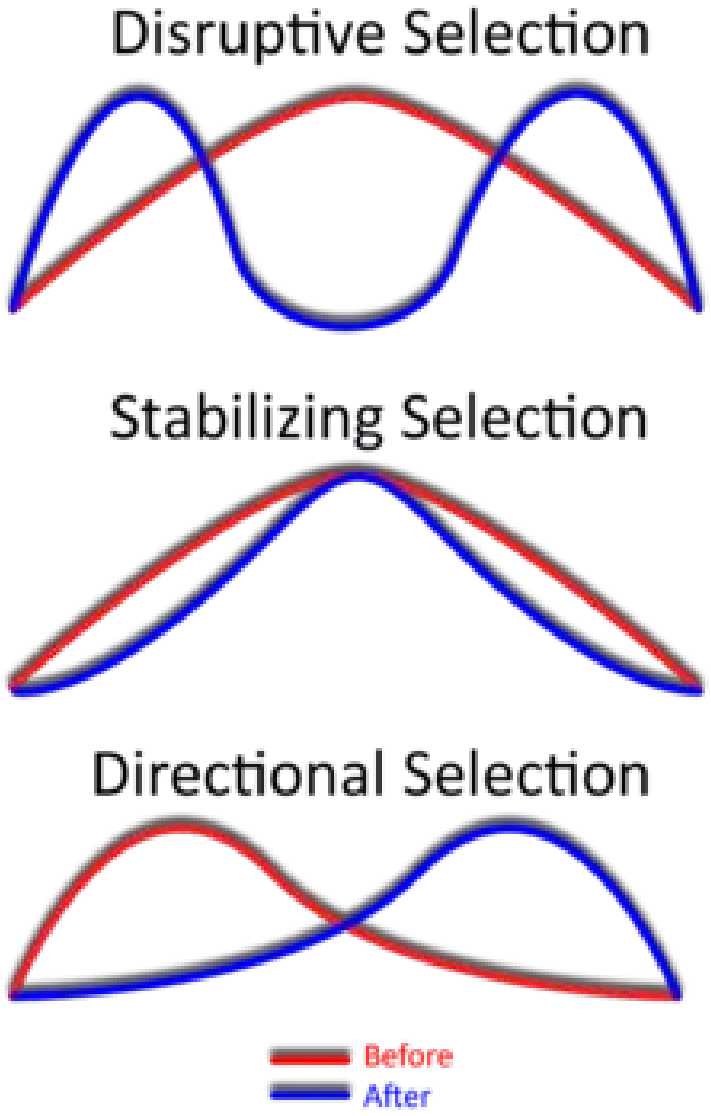
Natural Selection

- Heritable
- Genetic variation
- Variants that offer greater survival

Genetic Sources of Variation

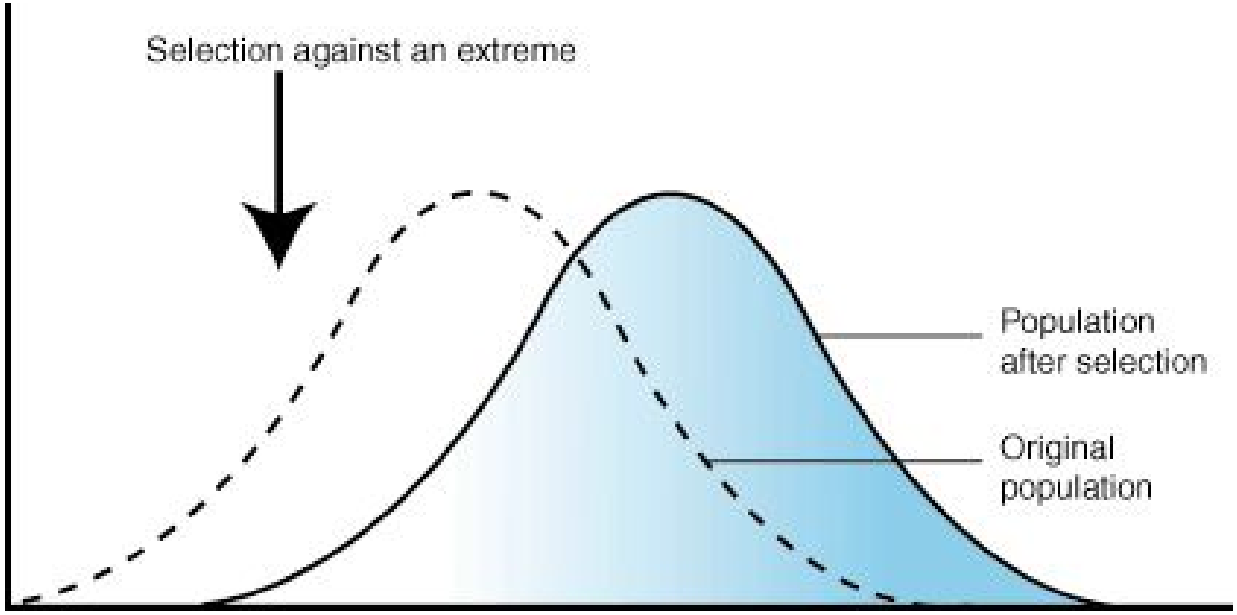
- Mutations 1:10,000 not all are bad
- Genetic recombination (sex gametes)
- Migration – move into and out of a population
- Genetic drift- small populations, change in the gene pool by chance.

3 Types of Natural Selection



Types of Natural Selection

- Directional- extreme phenotype becomes favorable

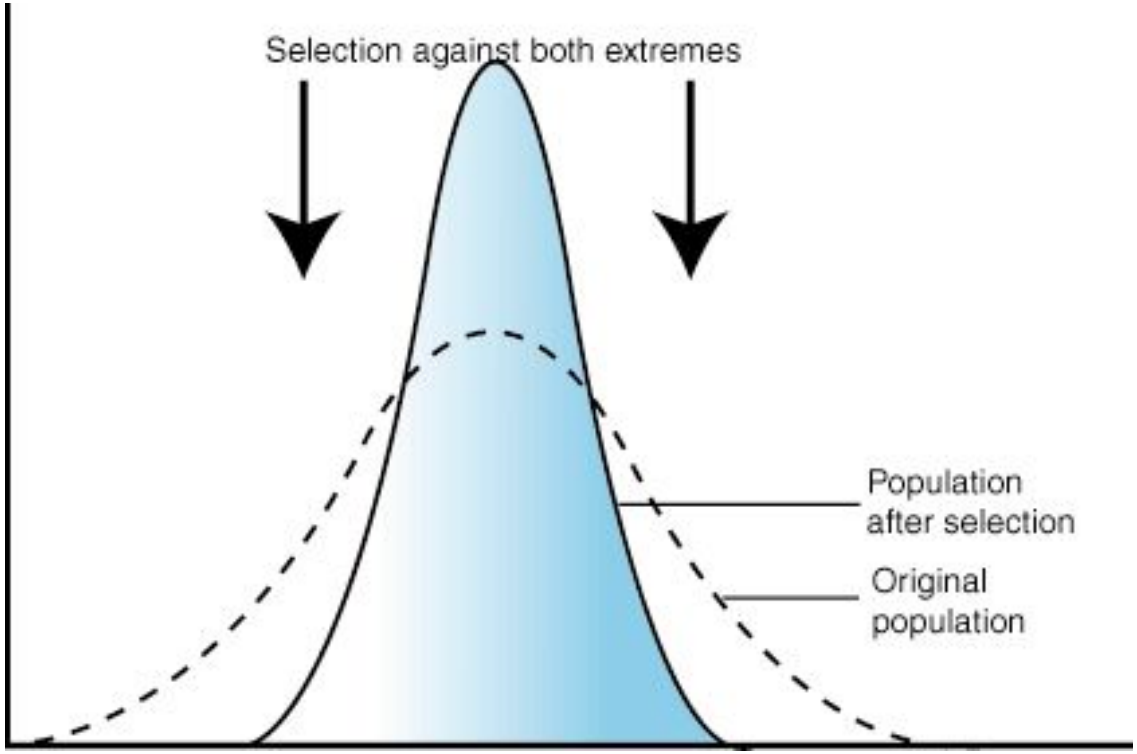


Example

- Selecting grey hounds that were the fastest to breed, which could make faster offspring
- These fast offspring would then breed to make even faster offspring
- End result = grey hounds are the fastest dog

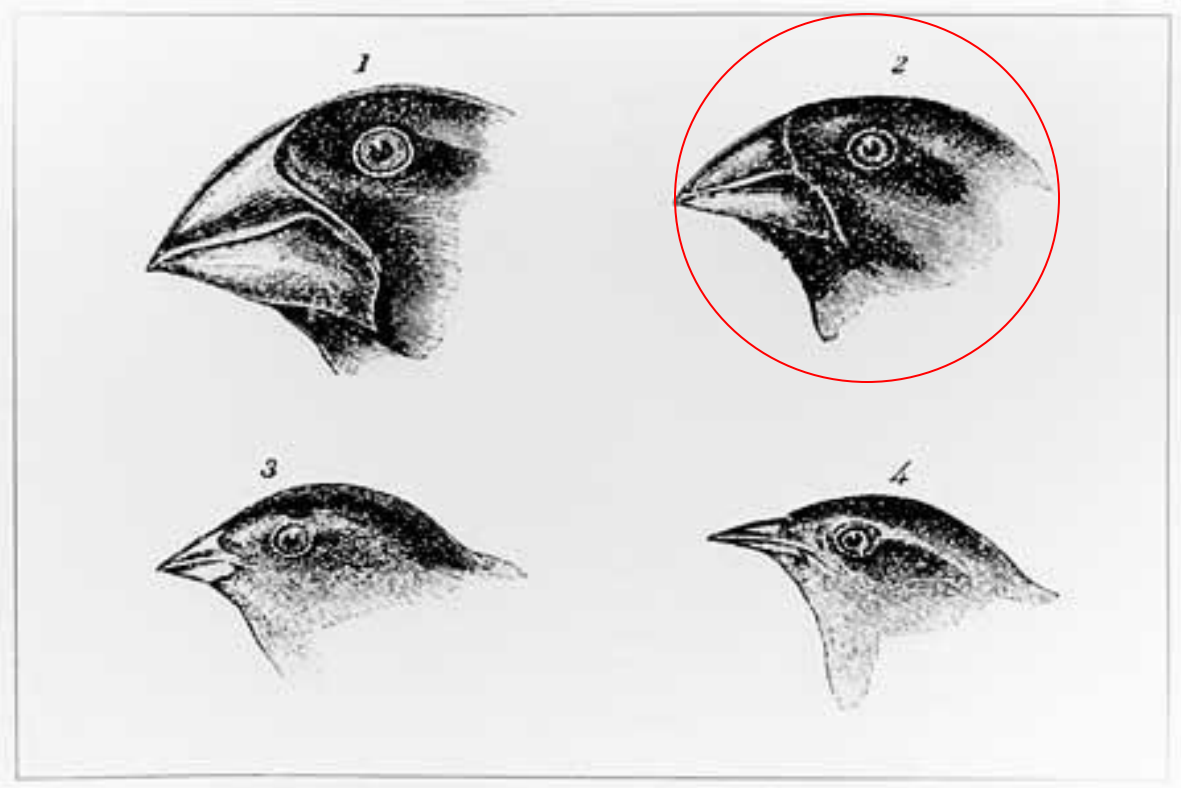
Stabilizing Selection

- Average phenotype becomes favorable extreme phenotypes are unfavorable



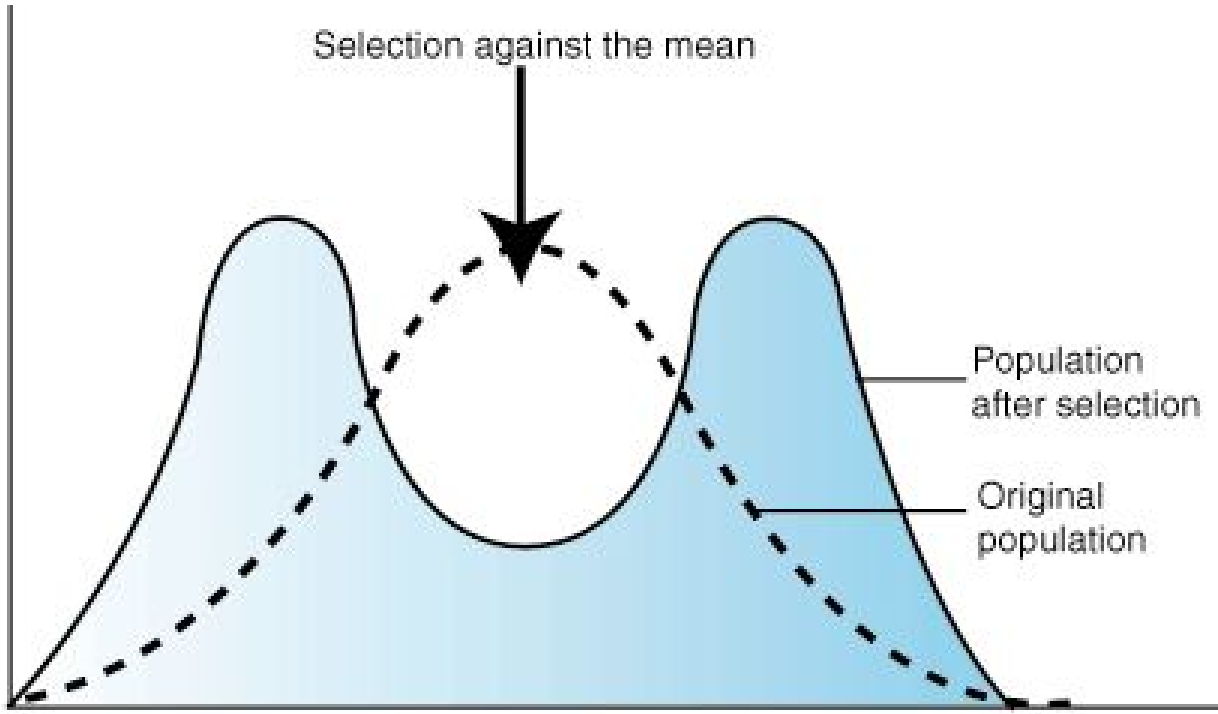
Example

- Finches had small and large beaks only
- Its environment now only has medium-sized seeds to eat
- Over centuries, nature selects bir with medium-sized beaks



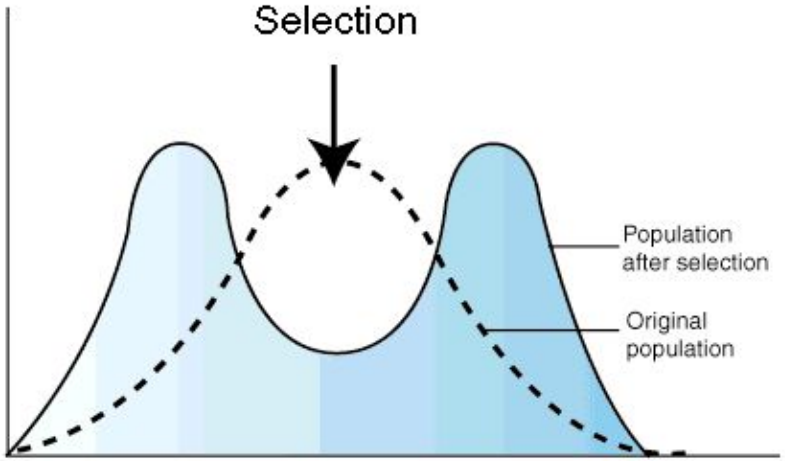
Disruptive selection

- Two opposites phenotypes are favorable
- The middle is not the most suitable for that environment



Example

African Swallowtail
(Papilio dardanus)



Female mimics an unpalatable species

Male or Female is palatable and does not mimic any unpalatable species

Female mimics a different unpalatable species

Steps needed for Evolution

- Overproduction
- Competition
- Variation
- Adaptations
- Speciation

Overproduction

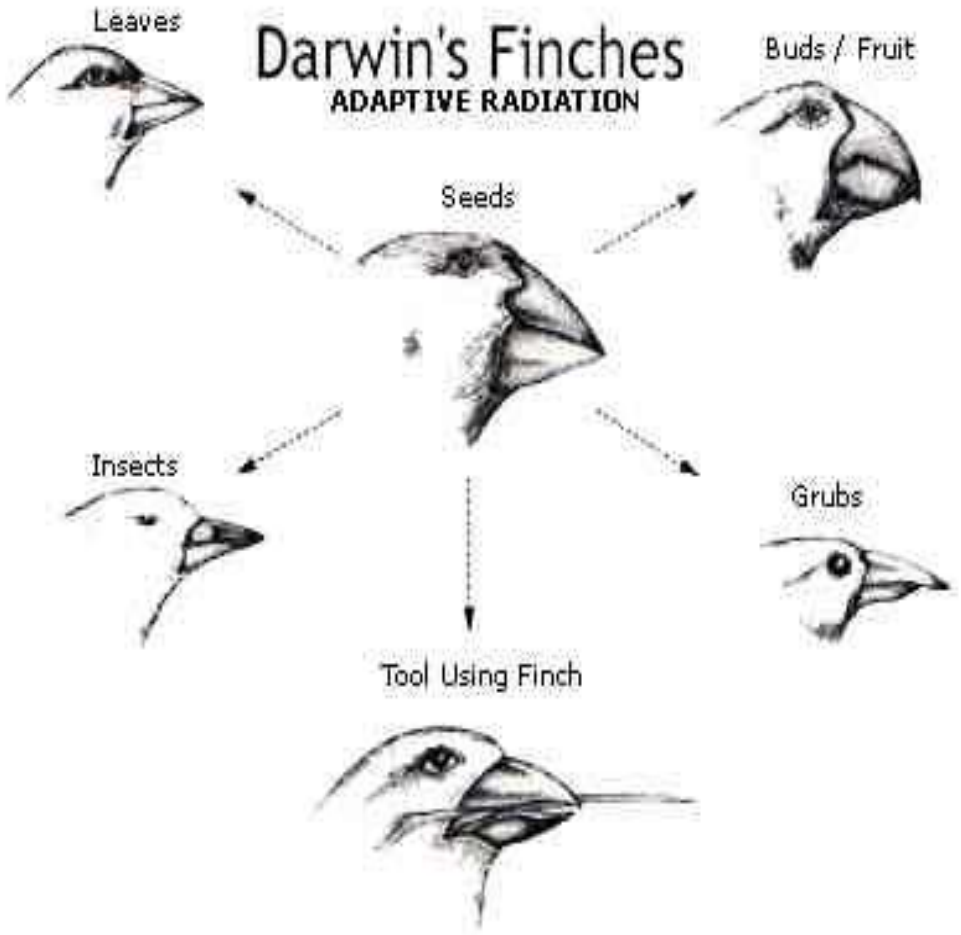
- Most species produce far more offspring than are needed to maintain the population
- Ensures some survive at least to carry on the species

Competition

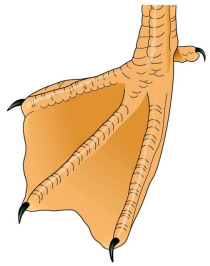
- **Competition for resources**
- **Some are better adapted to obtain resources**

Variation

- **Individuals are slightly diff. from each other**
- **Some variations are better adapted for a specific area.**



Which population has more chance of survival?

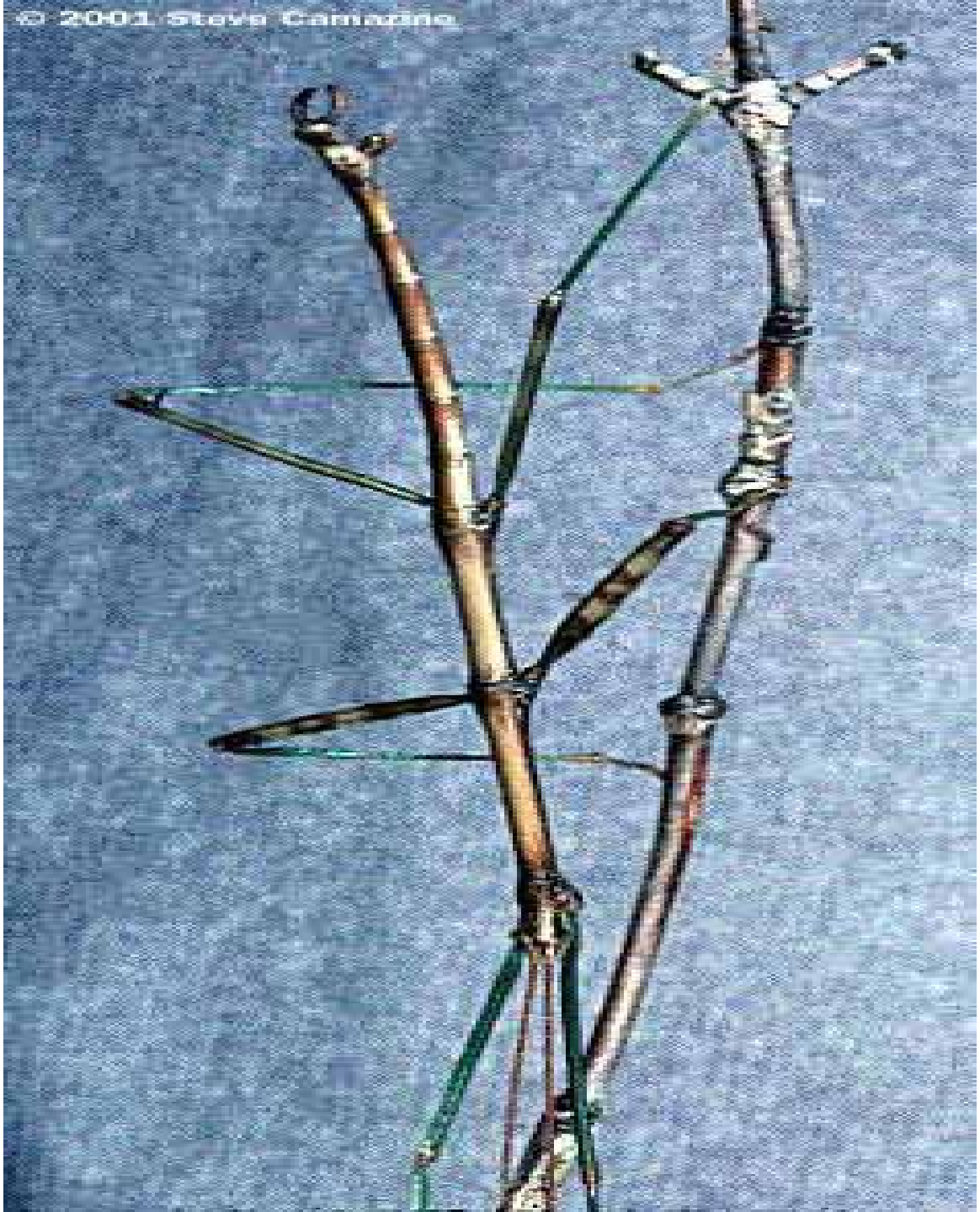


What about reproducing sexually or asexually?

Adaptations

- Adaptation is an inherited trait that is present in a population because that trait helps the individual survive.
- Physiological adaptations (poison by snakes)
- Structural adaptations (camouflage, warning colors, mimicry)


© Carl Roessler

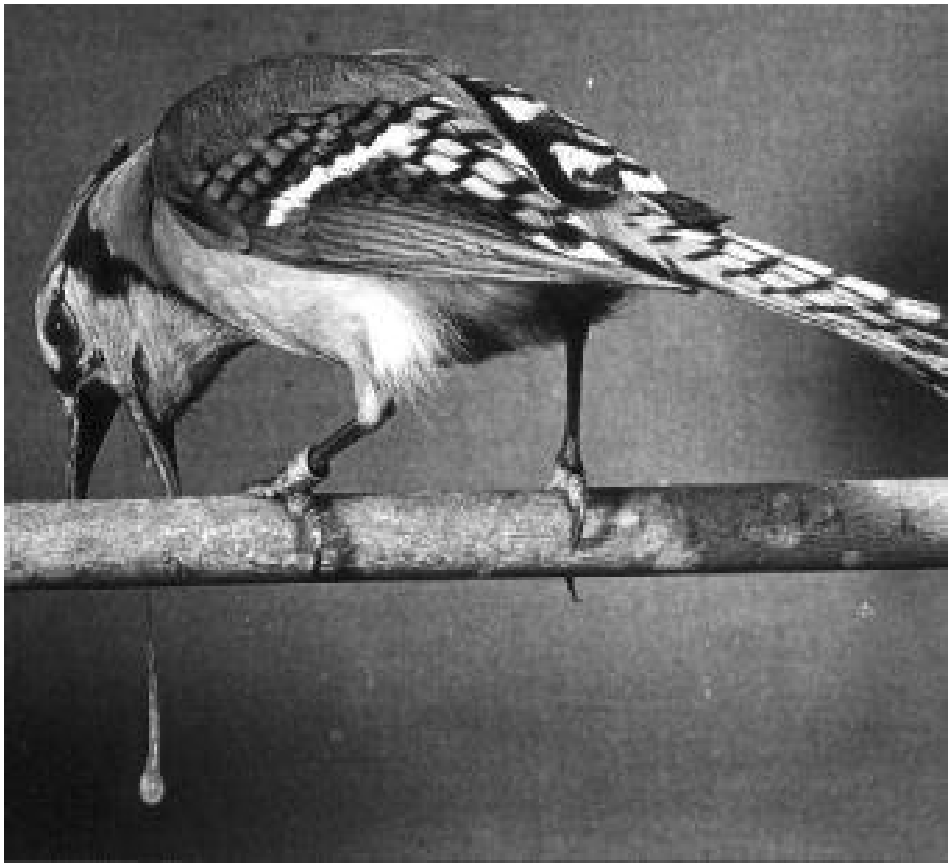

© 2001 Steve Camazine


6 6:47PM

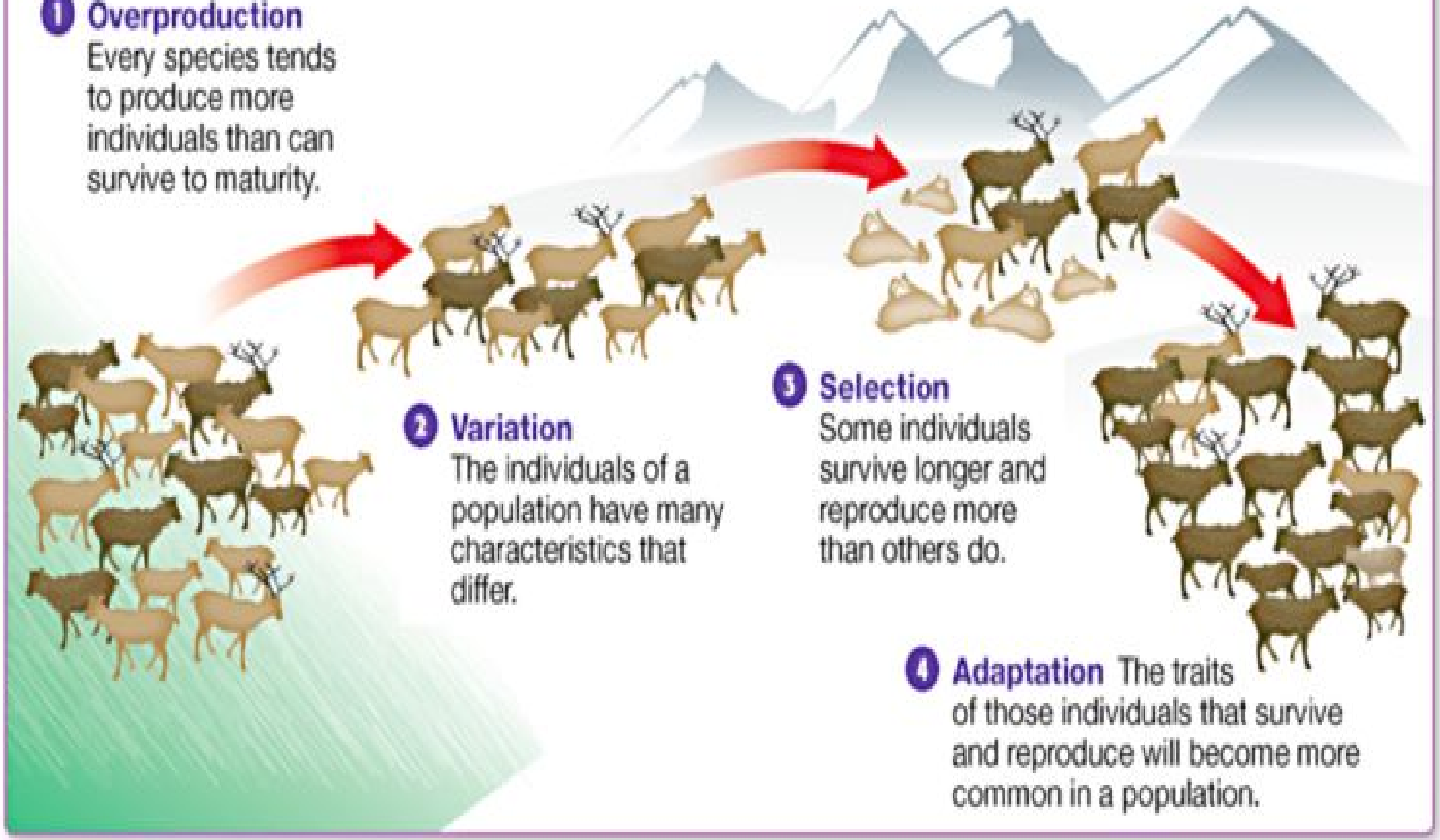
Warning Colors


©W.P. Armstrong 2000

MIMICS



The Theory of Evolution by Natural Selection



Speciation

- One species can evolve into two or more species
- Range where a species lives

Types of Speciation

- Geographic isolation
- Reproductive isolation
- Adaptive radiation (darwins finches)

Rate of Evolution

- Gradualism- evolution occurs slowly and continuously over millions of years
- Punctuated equilibrium- species remains the same for extended periods of time. Changes occur in short periods of time to form new species.

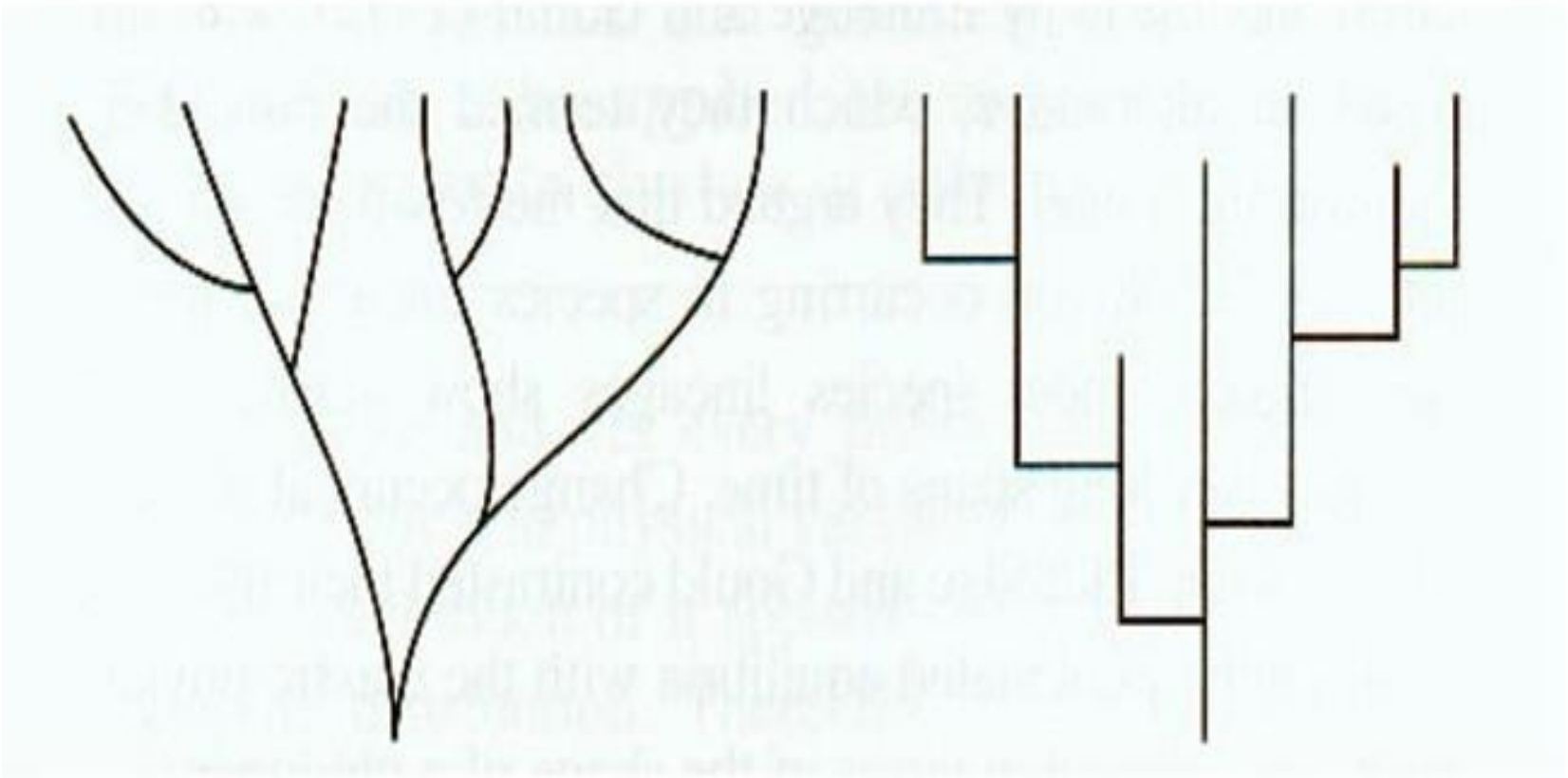
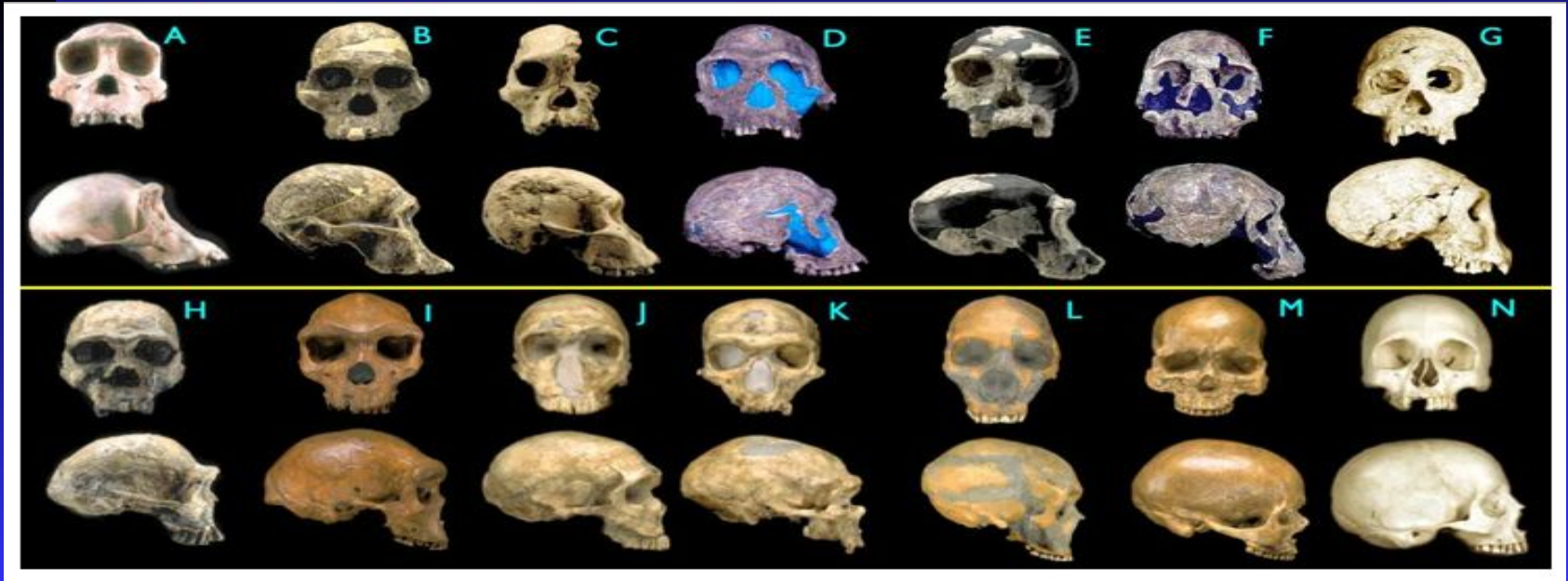


Fig. 3. Contrasting expectations of species-level evolution, the classic phyletic gradualism model (A), and the punctuated equilibrium model (B). Modified from various sources.

Descent

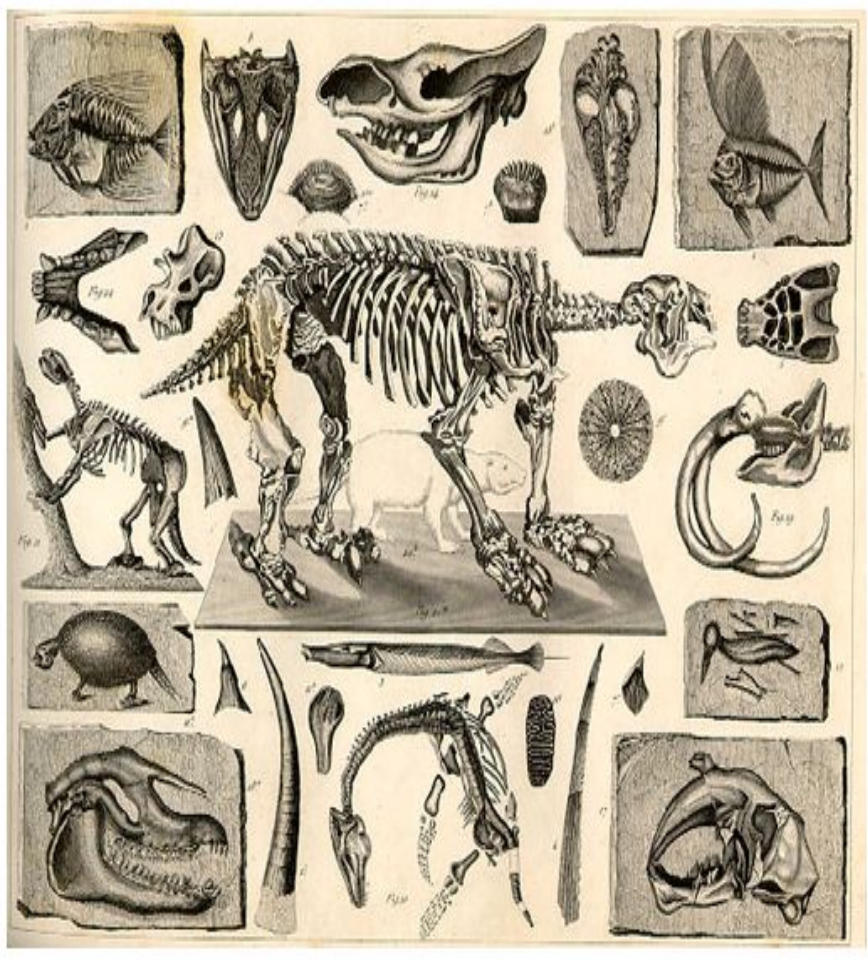
- **Descent with Modification (Darwin coined this!)**-Each living organism has descended, with changes from other species over time
- **Common Descent**- were derived from common ancestors



Evidence of Evolution

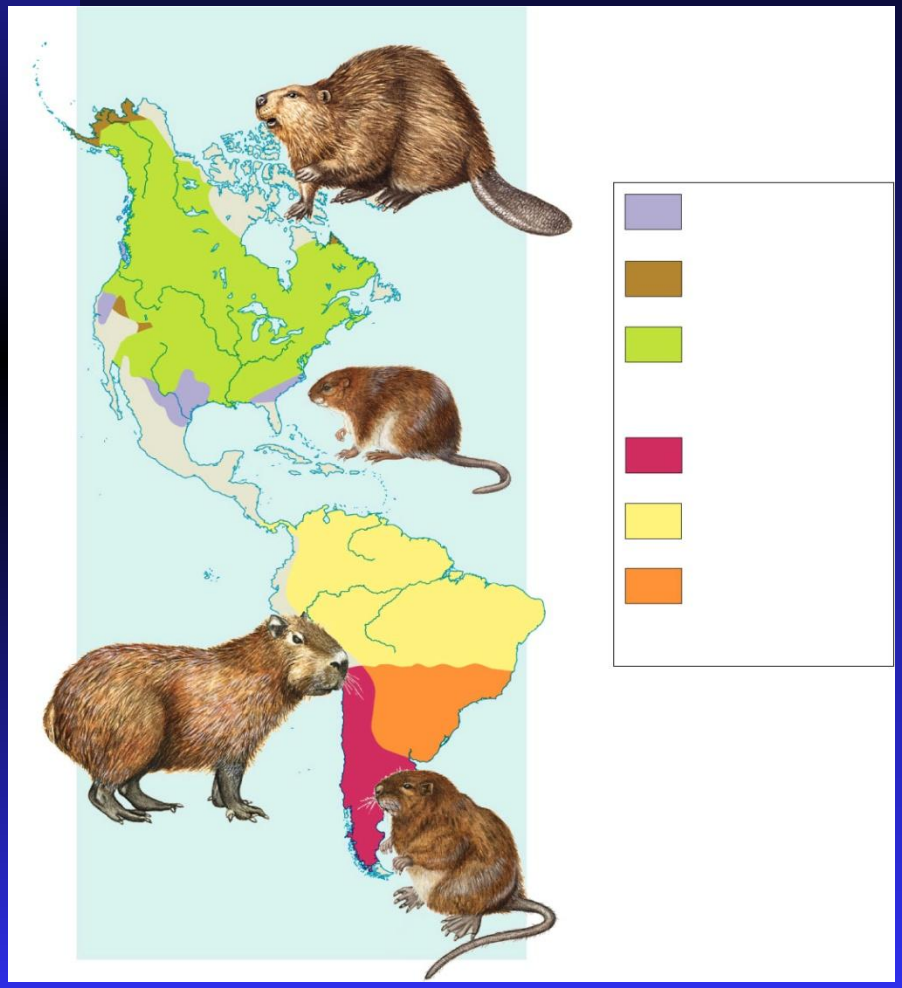
- The Fossil Record
- Geographic Distribution of Living Things
- Anatomy
- Embryology

Evidence for Evolution

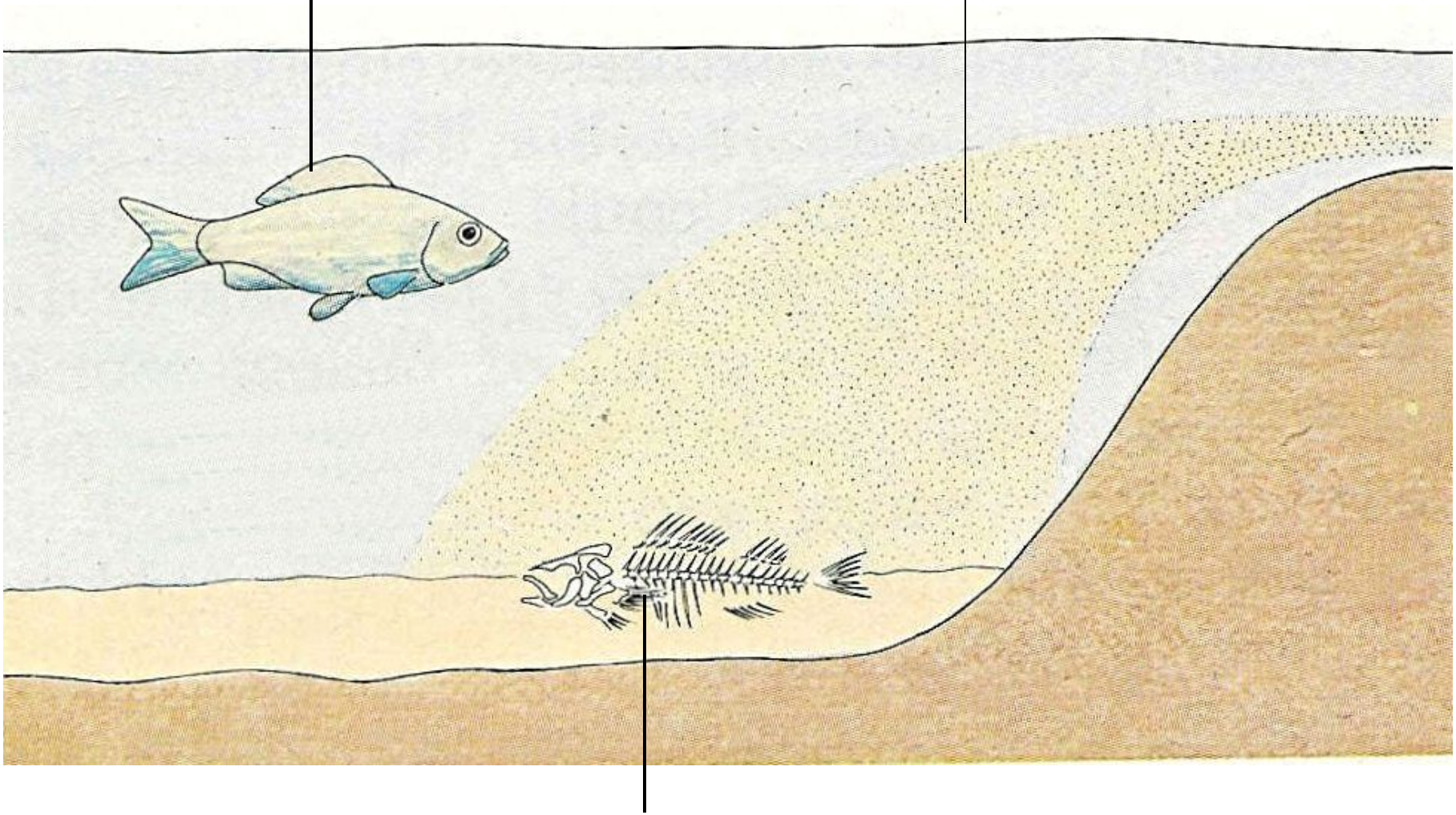


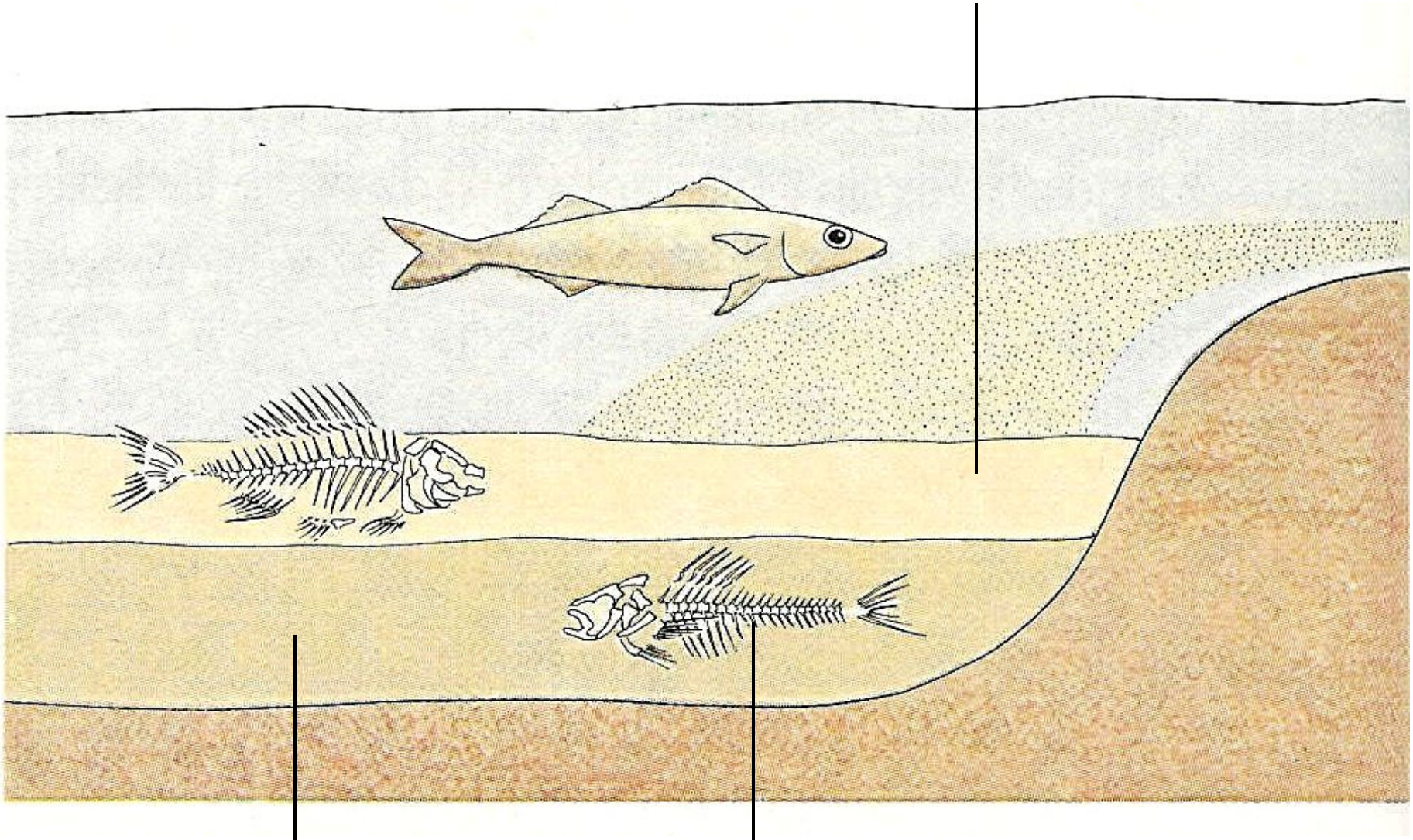
- **The Fossil Record**-Layer show change
- Geographic Distribution of Living Things
- Homologous Body Structures
- Similarities in Early Development

Evidence of Evolution



- The Fossil Record
- **Geographic Distribution of Living Things-**similar environments have similar types of organisms
- Example: Darwin's Finches

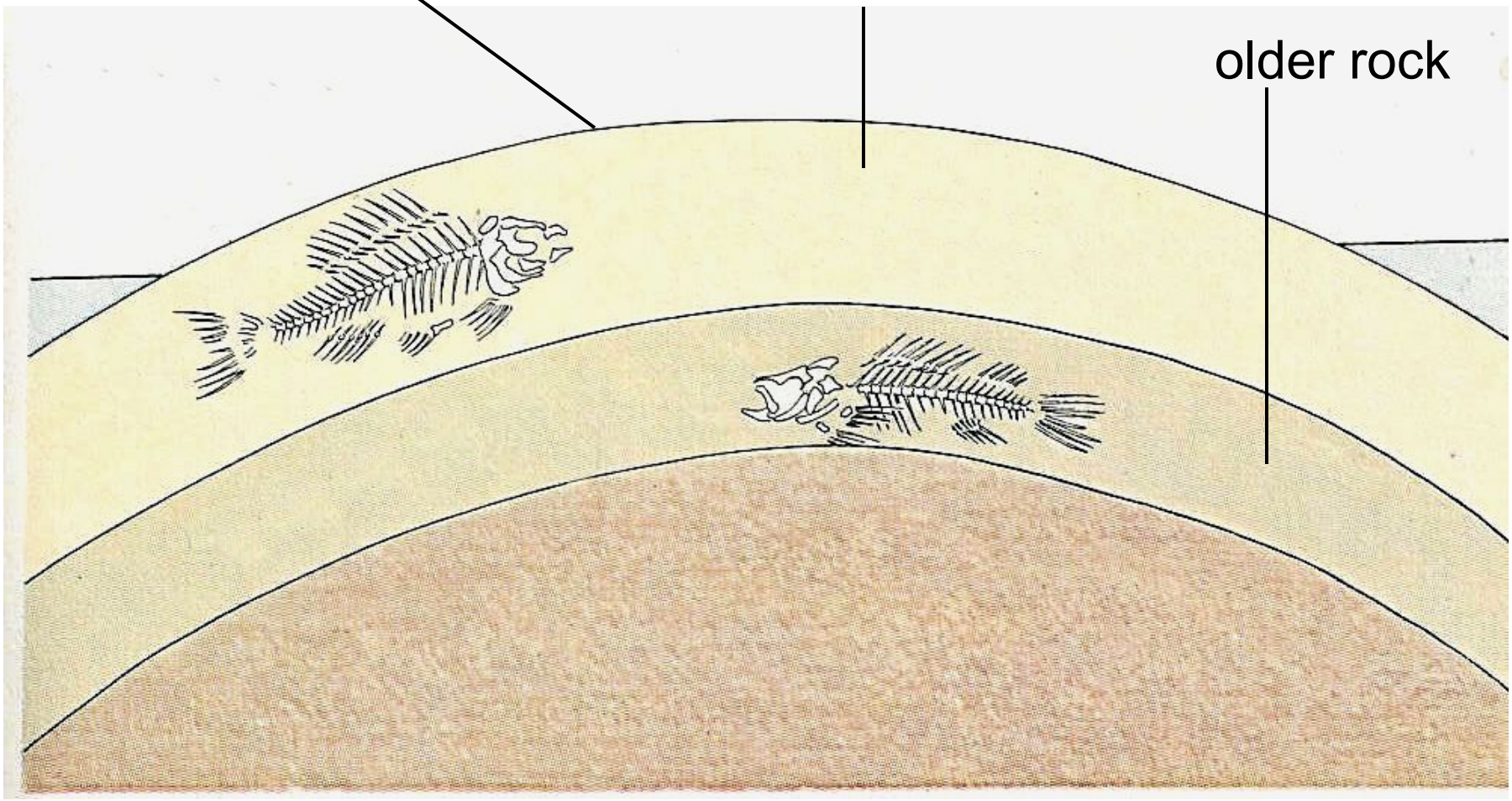

living fish
sediment from river
fish skeleton partly buried by sediment

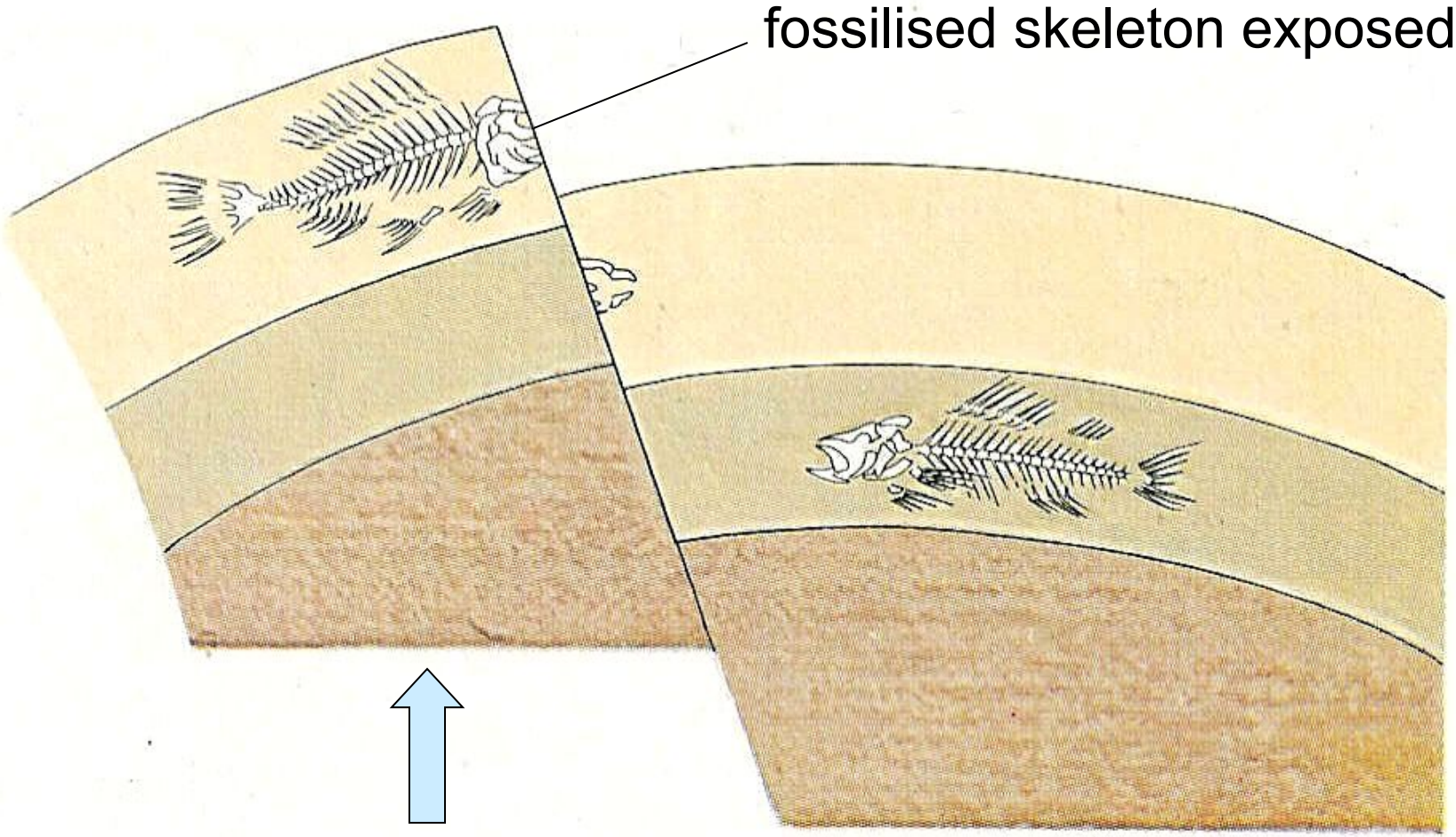

more recent sediment collects
older sediment becomes rock
fish skeleton fossilised

land raised above water level

recent rock

older rock




fossilised skeleton exposed
earth movements
fracture rock

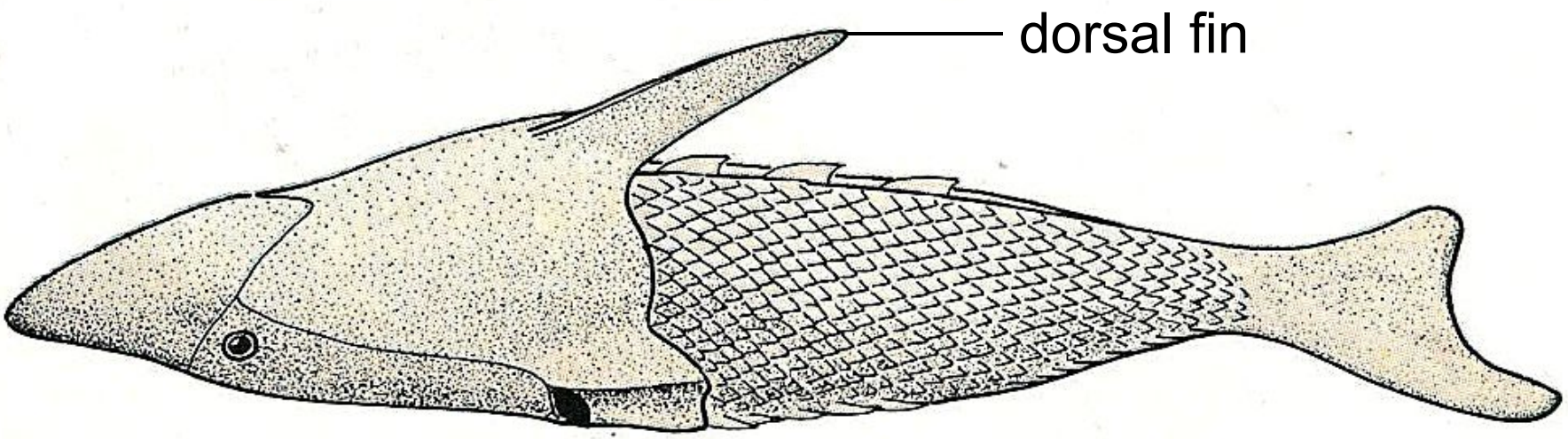
When rock strata become exposed, it can be assumed that, in most cases, the lowest layers are the oldest*

This means that the fossils of organisms preserved in the lowest layers represent animals and plants that lived many millions of years ago

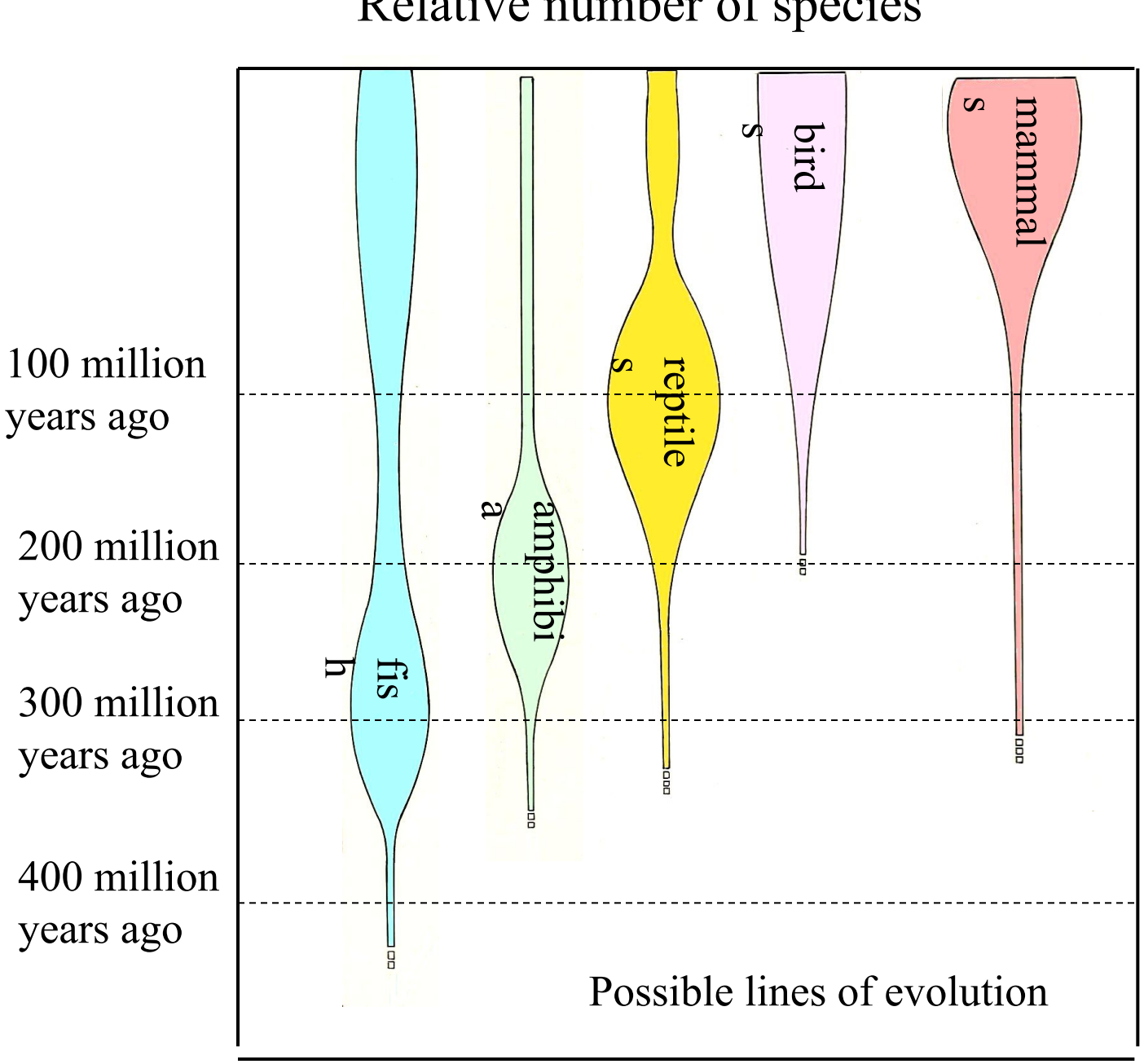
rock strata of increasing age

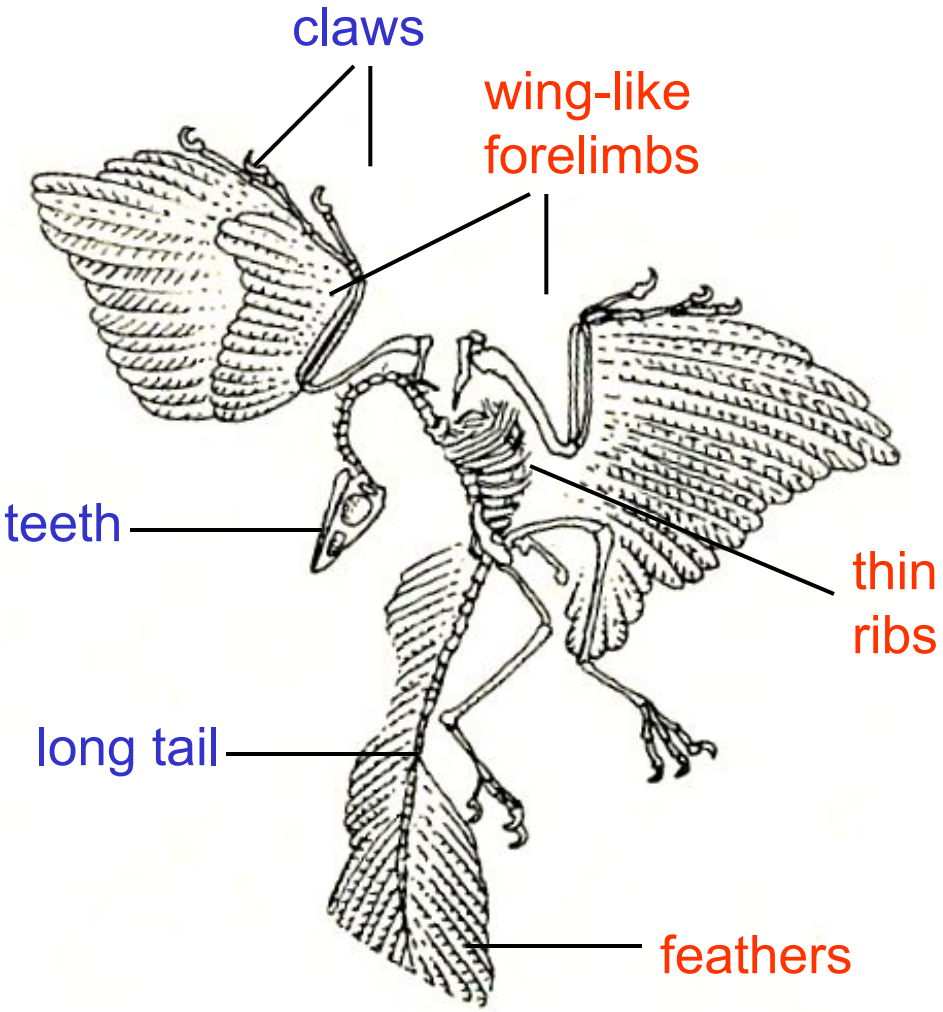
This is a fossil of a fish which lived 40 million years ago

This is a reconstruction, from fossil remains, of an ‘armour-plated’ fish which lived 350 million years ago



The fish which gave rise to fossils such as this, were very different from today’s fish


Relative number of species
100 million years ago
200 million years ago
300 million years ago
400 million years ago
fish
amphibians
reptiles
birds
mammals
Possible lines of evolution



Replica *of Archaeopteryx* fossil;
half bird half reptile

Reptile-like features

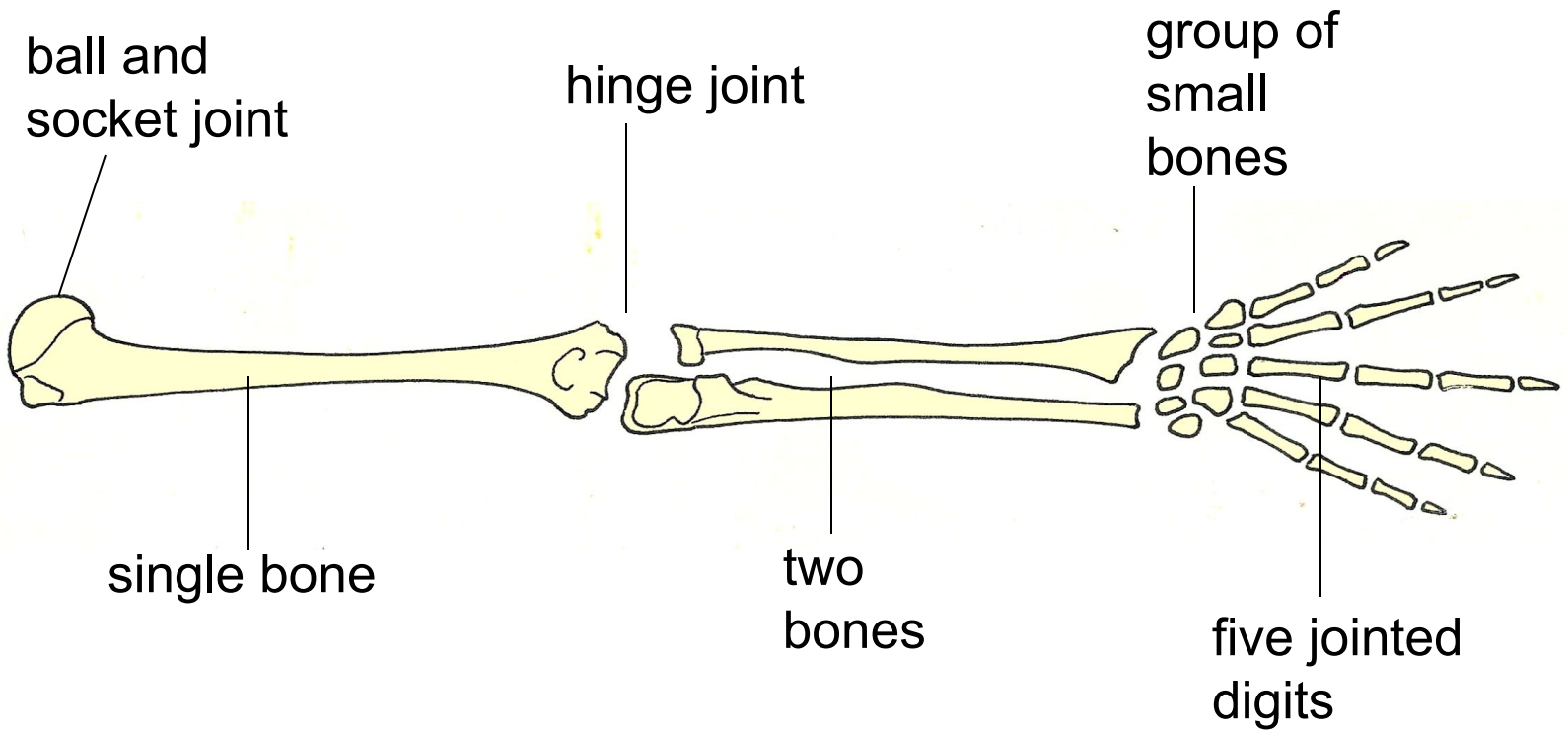
Bird-like features

Homologous Structures

- **Homologous Structures**-structures that have different mature forms in different organisms, but develop from the same embryonic tissue
- Means there was a common ancestry

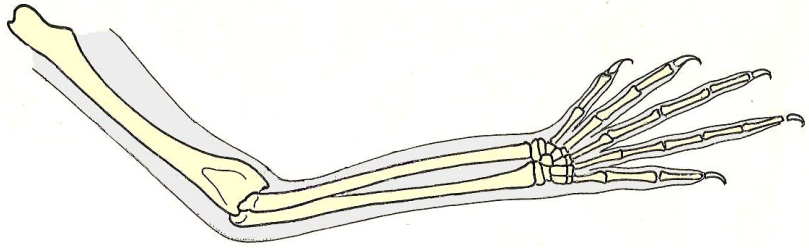
Vertebrate limbs

The basic pattern of the vertebrate limb is represented by the human arm skeleton shown below

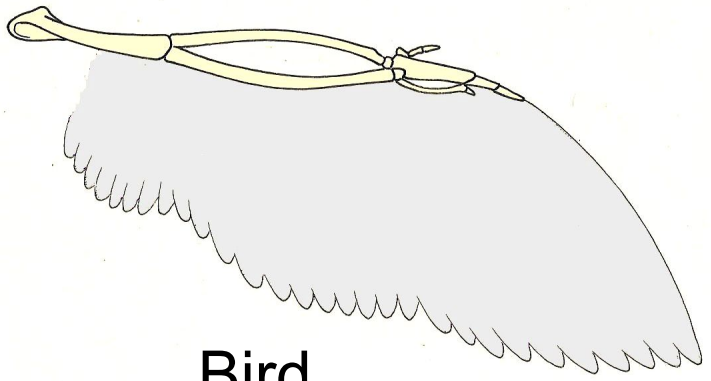


The forelimbs of the following vertebrates show the basic pattern of limb bones with modifications which are adapted to their methods of locomotion.

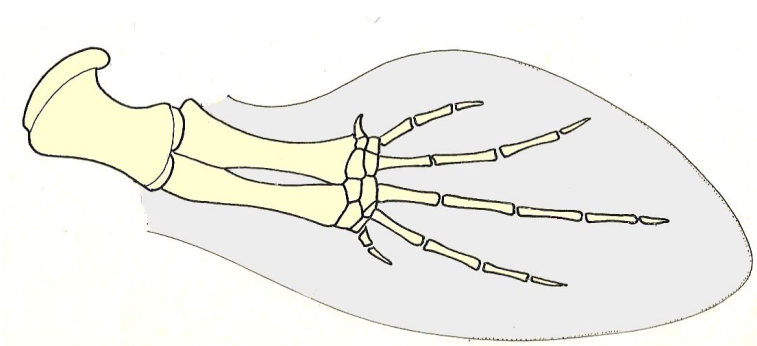
The basic pattern suggests they have evolved from a common ancestor



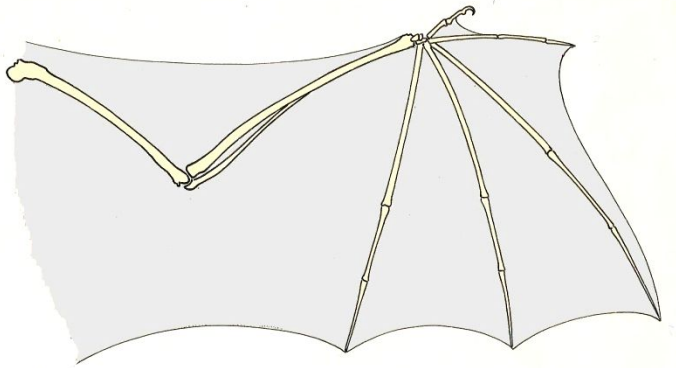
Lizard



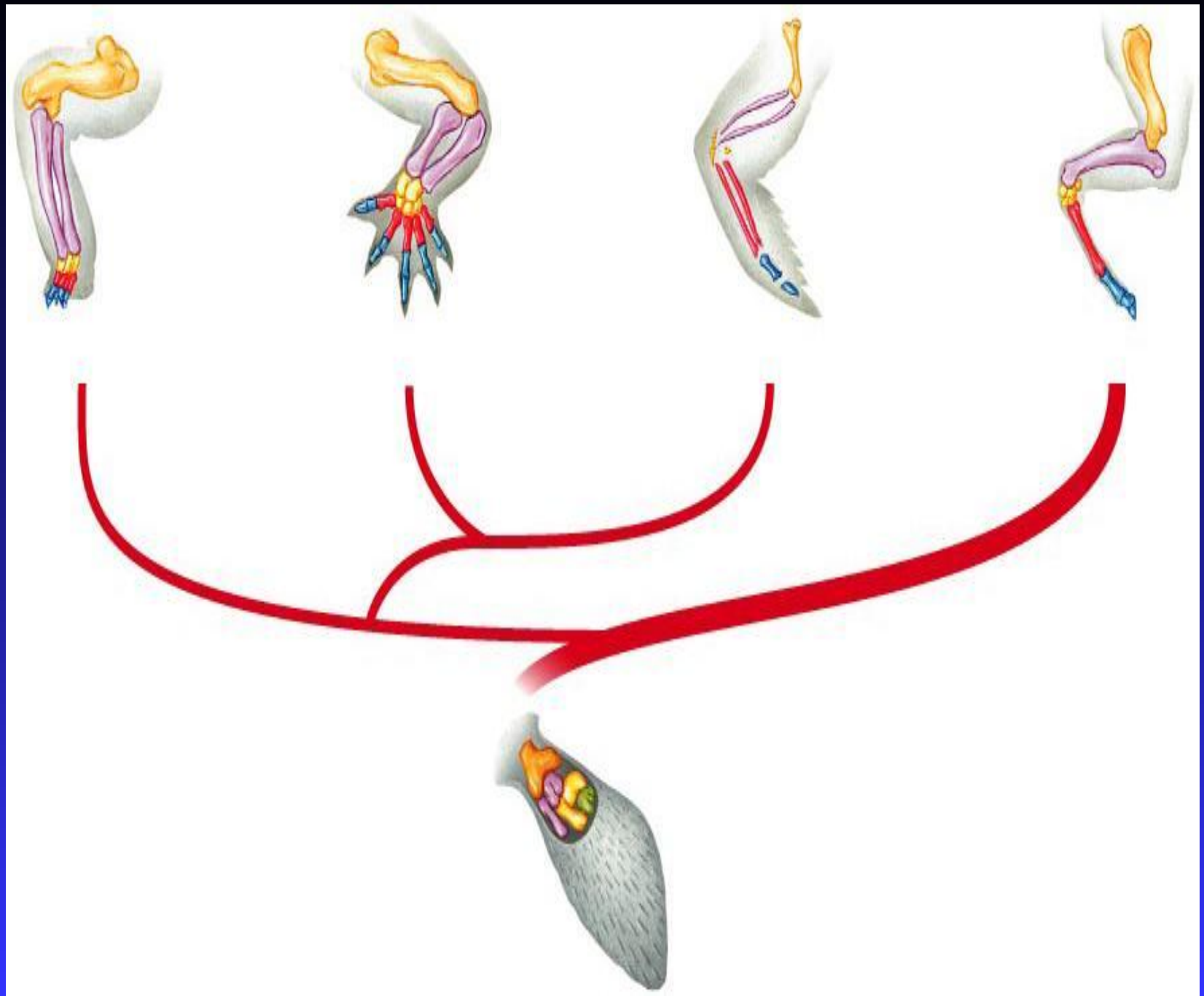
Bird



Dolphin

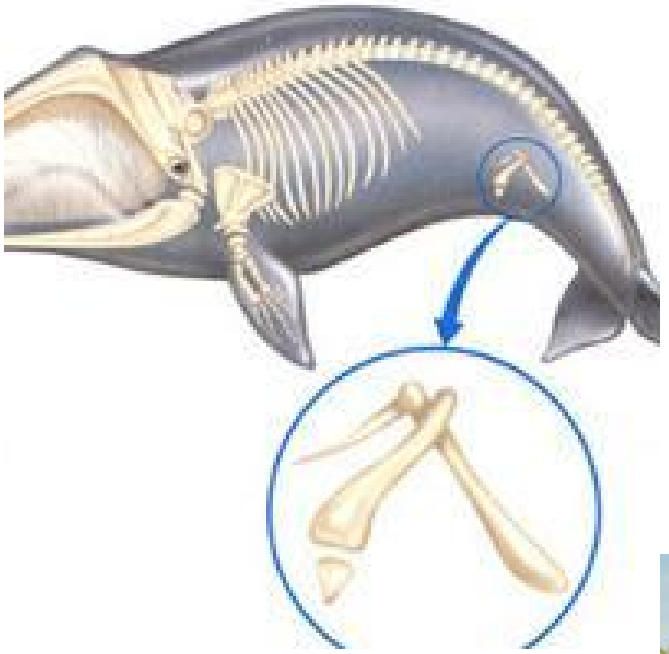


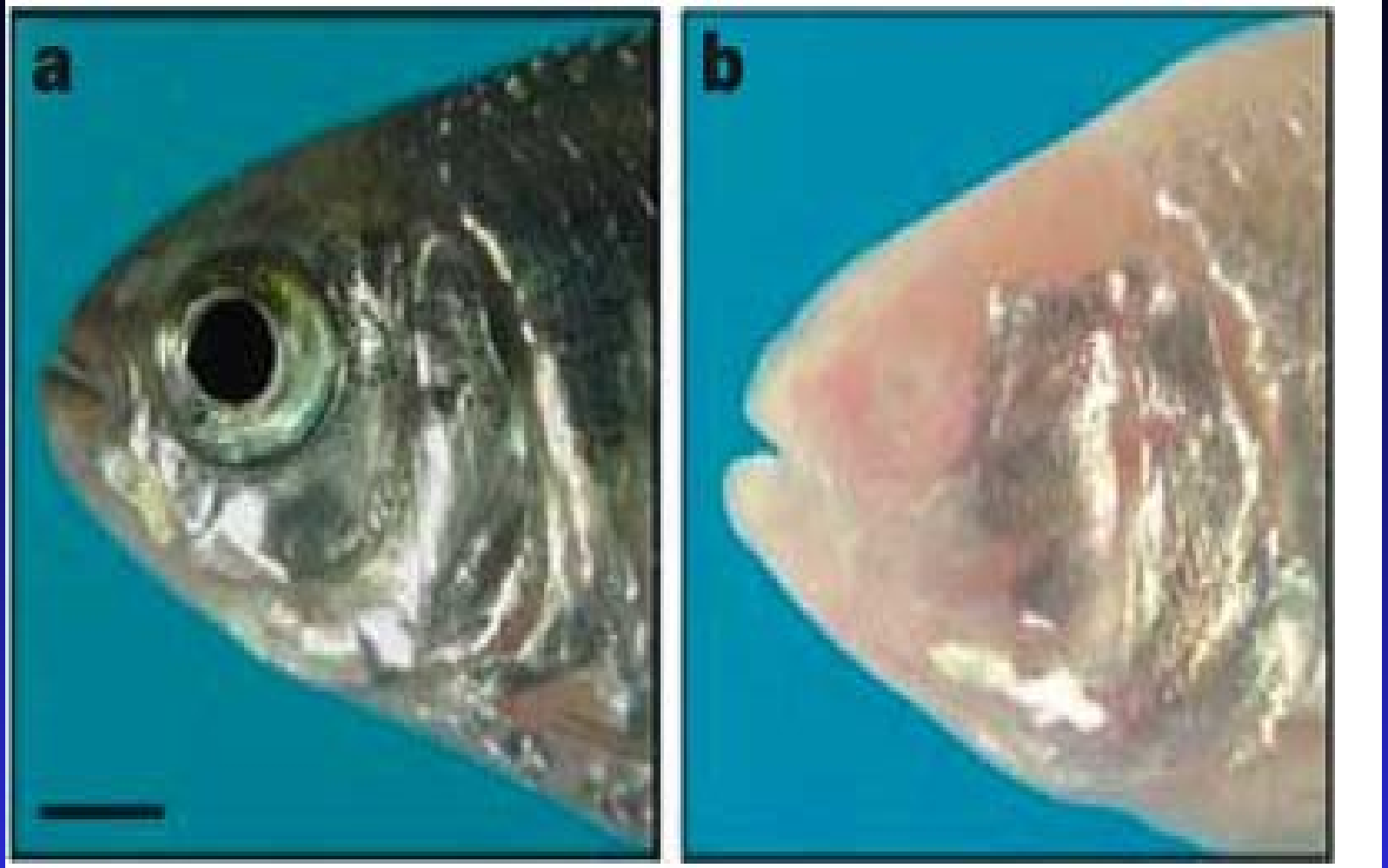
Bat



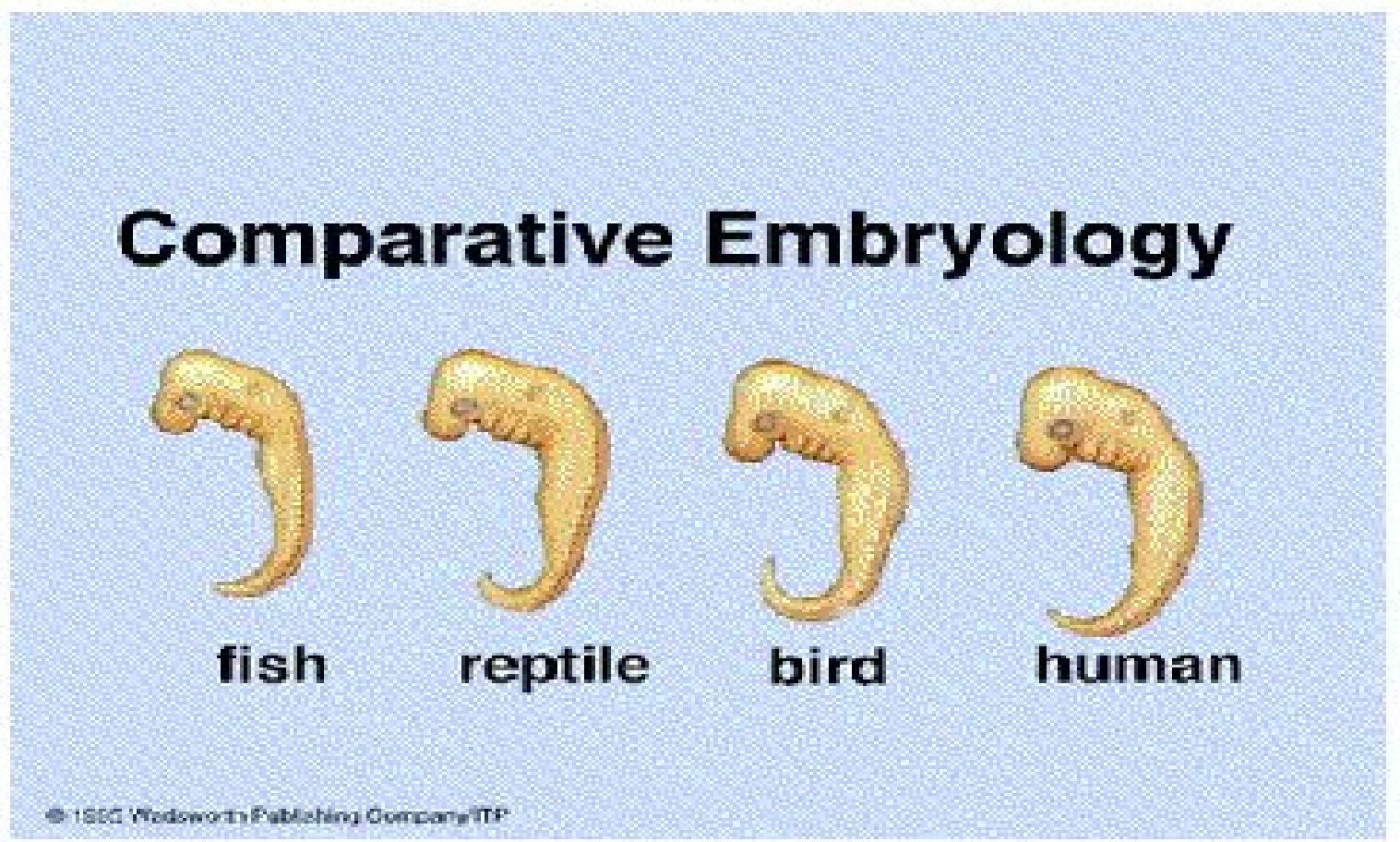
Evidence for Evolution

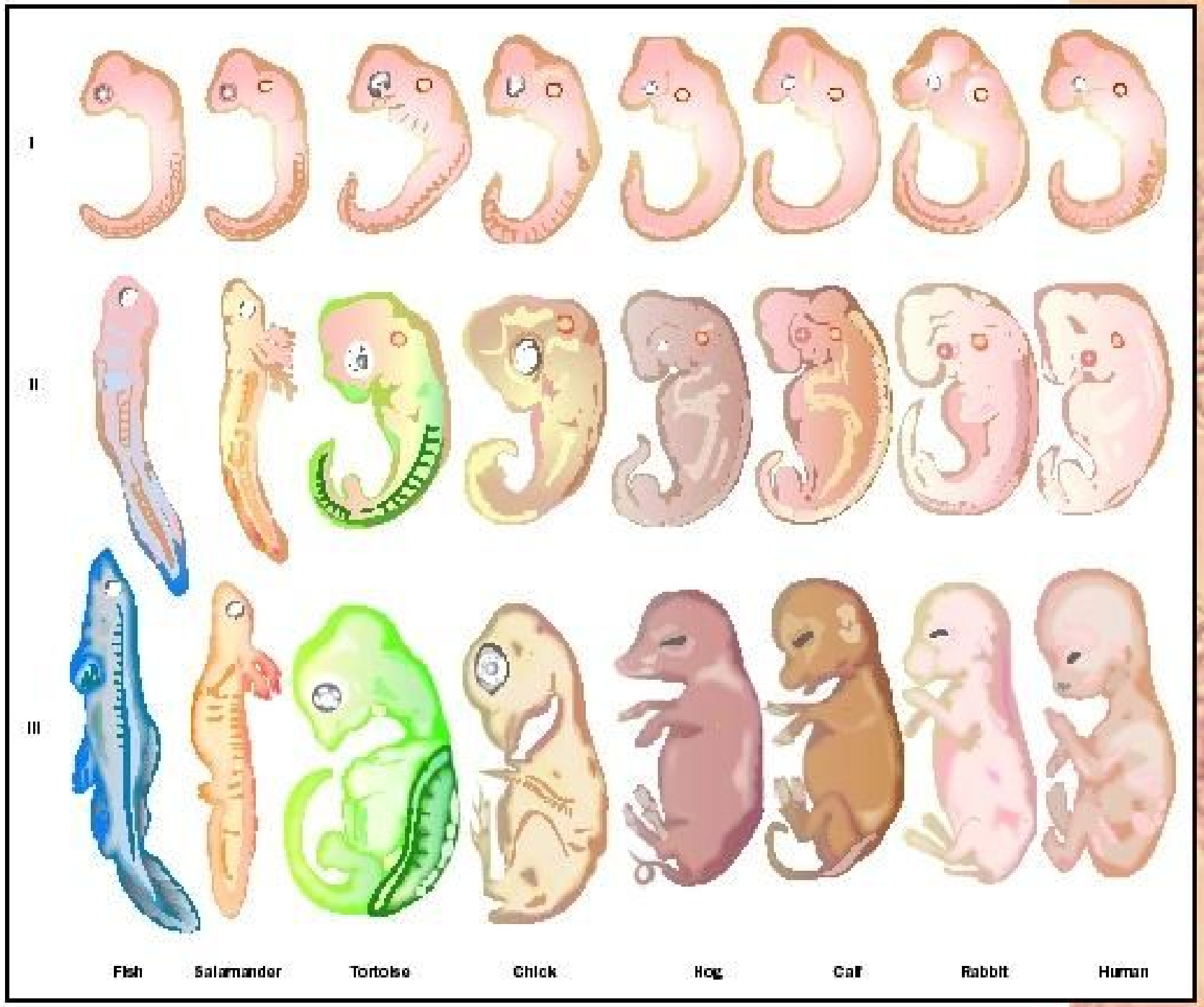
- **Vestigial organs**-organs that serve no useful function in an organism
- i.e.) appendix, miniature legs, arms




a
b

Similarities in Early Development




I
II
III
Fish
Salamander
Tortoise
Chick
Hog
Calf
Rabbit
Human

Biochemistry

Another important line of evidence for evolution comes from ***DNA*** analysis

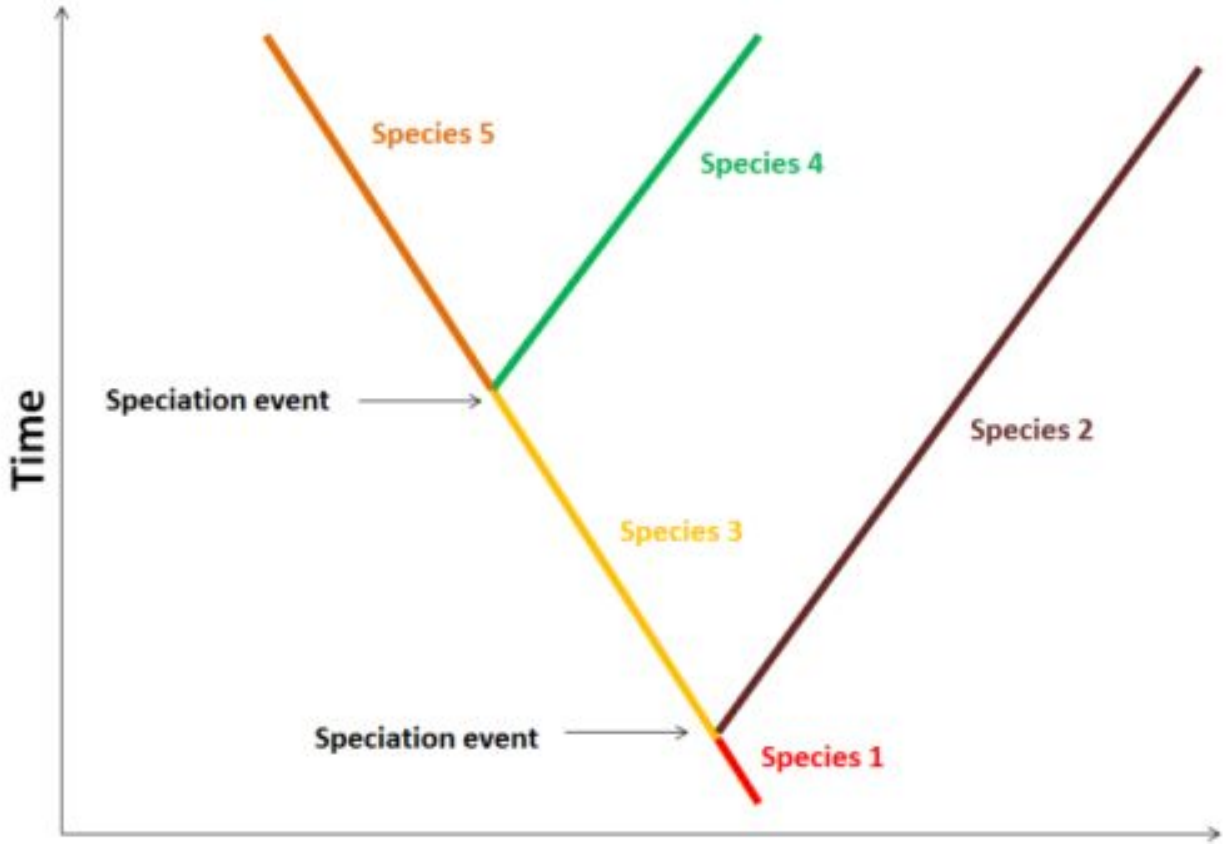
Any permanent change in form or function of an organism must be preceded by a change in its DNA

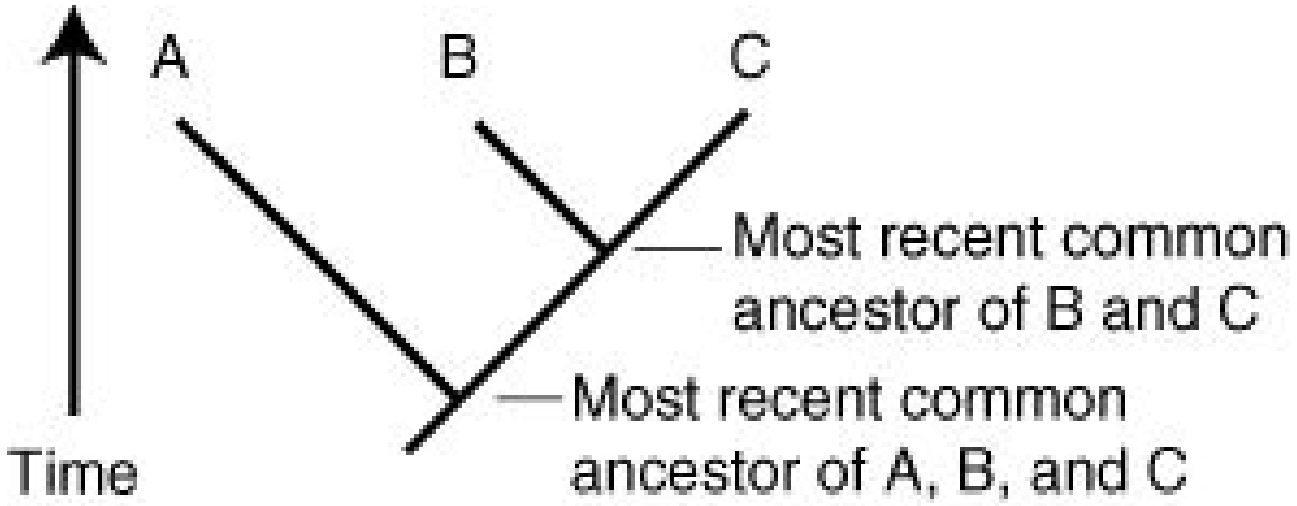
Organisms which have much of their DNA in common must be closely related, i.e. they have split from a common ancestor comparatively recently (in geological terms)

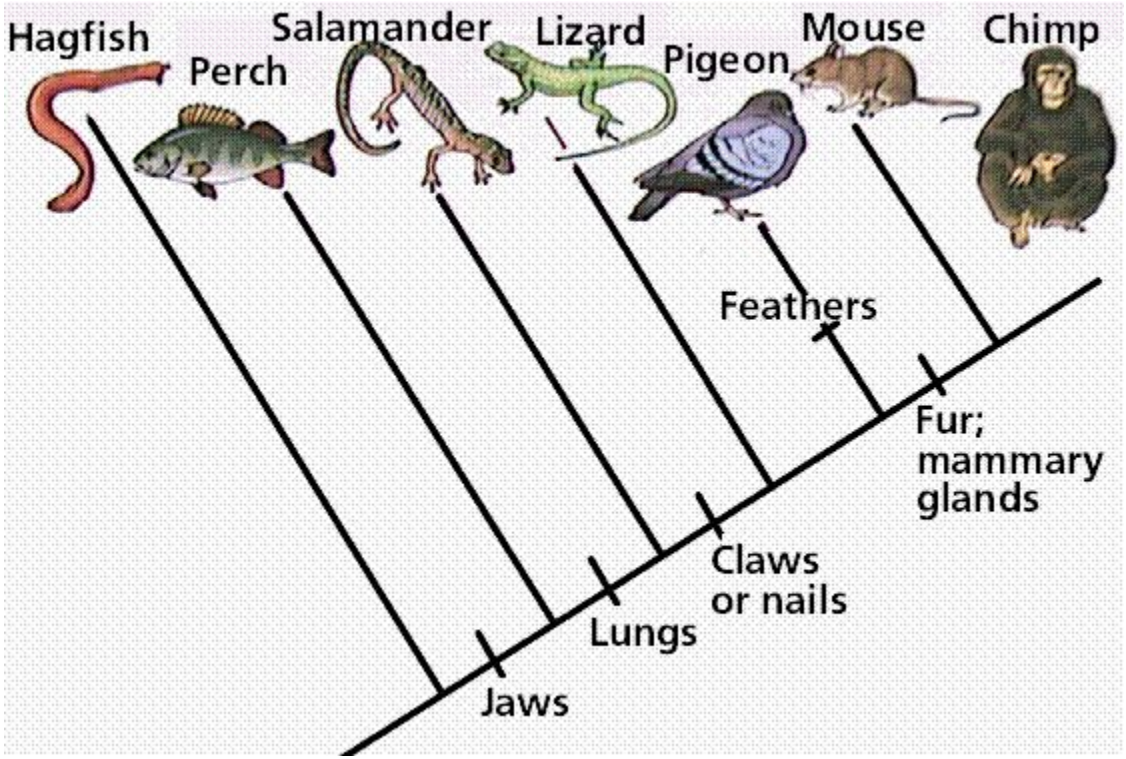
Ex: humans and chimpanzees have 99% of their DNA in common which suggests a close relationship and relatively 'recent' divergence from a common ancestor

Speciation

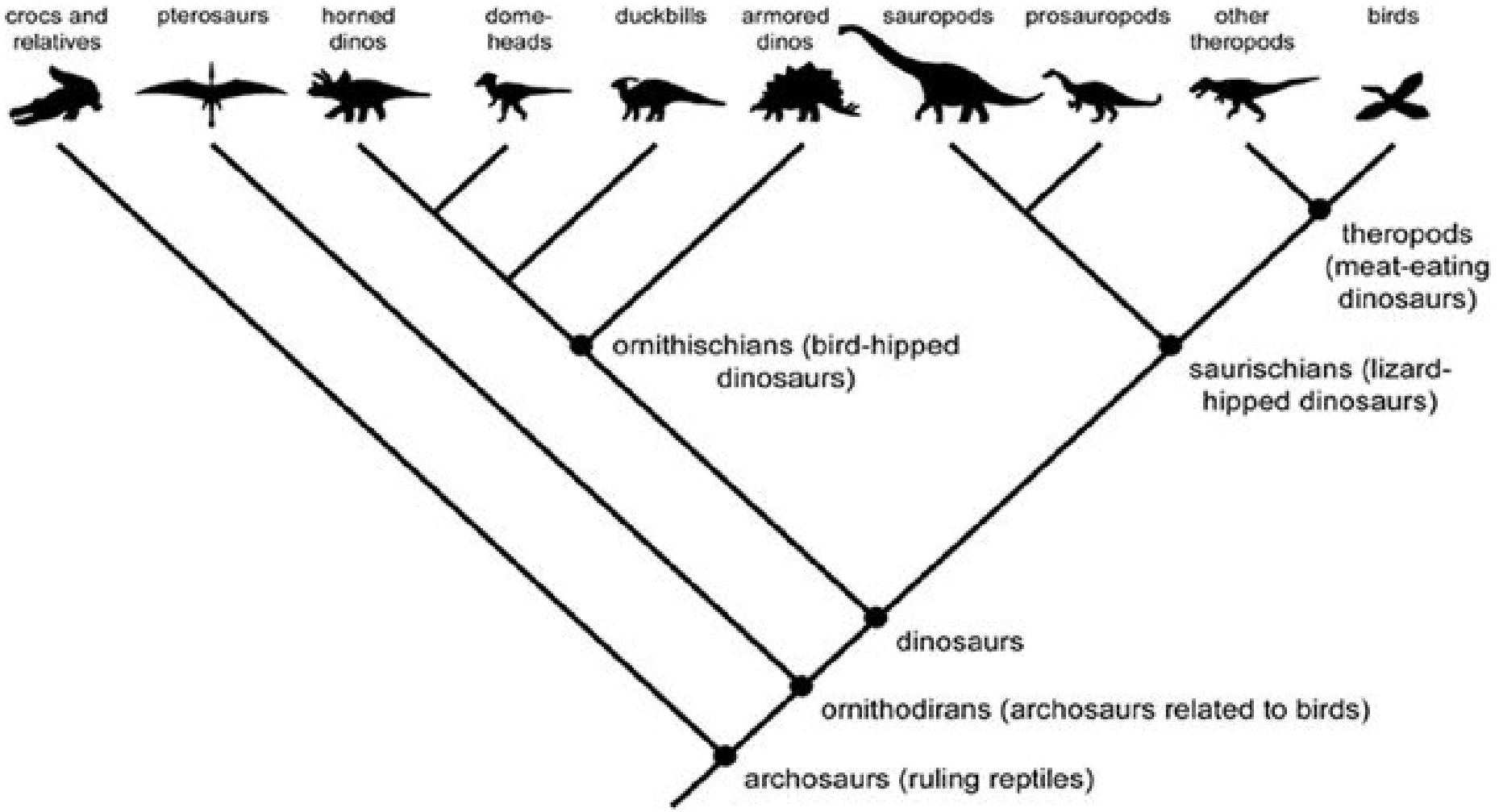
- Many factors can cause speciation
- Cladogram shows where speciation occurred because it shows a common ancestor




A
B
C
Most recent common ancestor of B and C
Most recent common ancestor of A, B, and C
Time

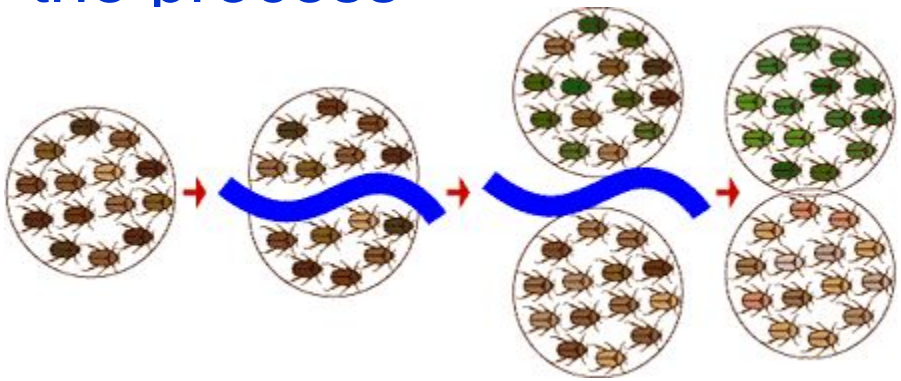

Hagfish
Perch
Salamander
Lizard
Pigeon
Mouse
Chimp
Feathers
Fur; mammary glands
Claws or nails
Lungs
Jaws

Can you tell where they diverged?



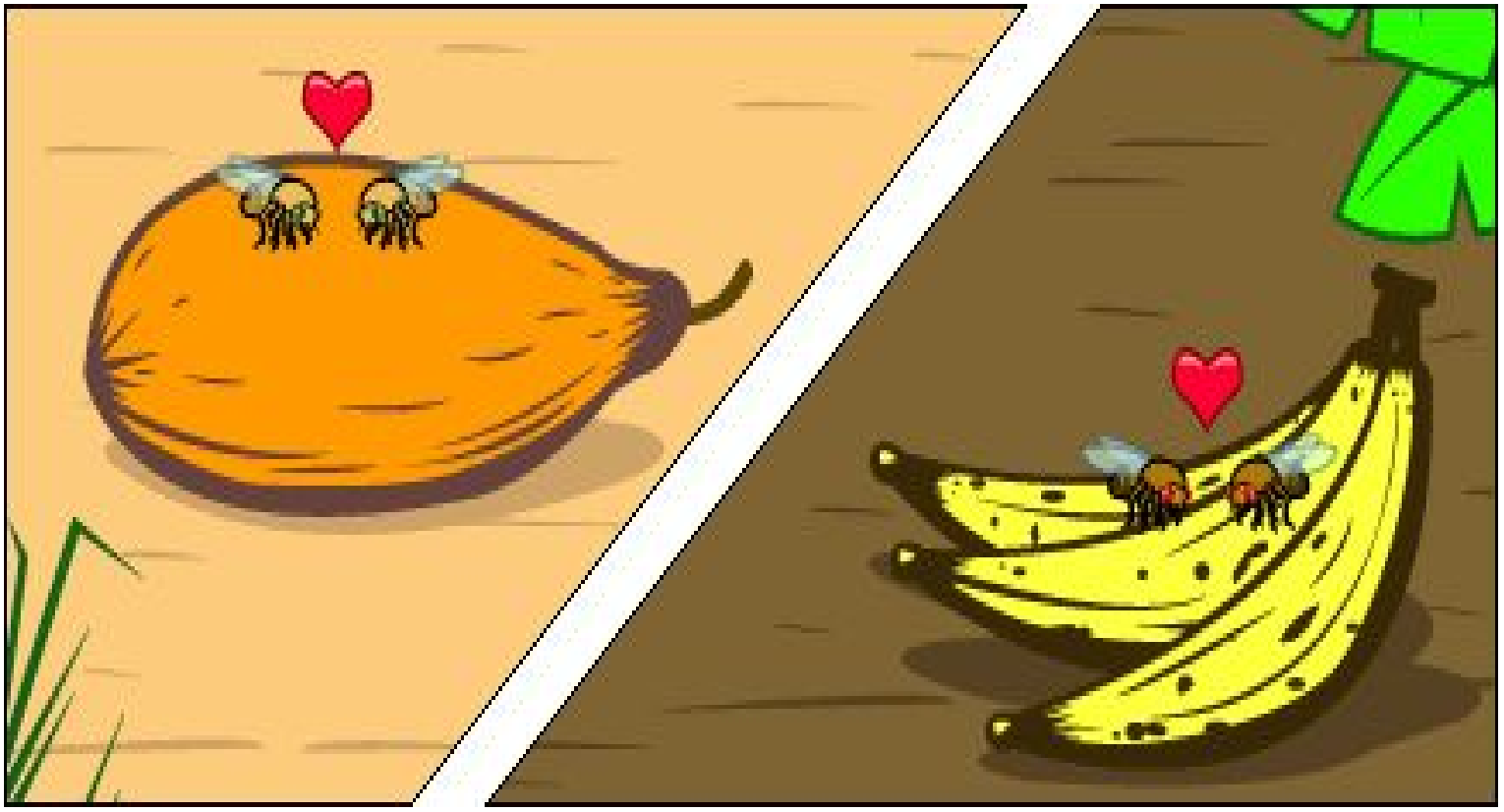
Geographic isolation

- A population is divided by a natural barrier
  - mountains
  - Deserts
  - Body of water
  - Landslide cause by an earthquake
  - Geographic isolation can instigate a speciation event—but genetic changes are necessary to complete the process



Reproductive isolation

- Differing selection pressures on the new environments can complete the differentiation of the new species.



- the differences between the isolated groups become so great that they can no longer interbreed

Let’s do some speciation activities!