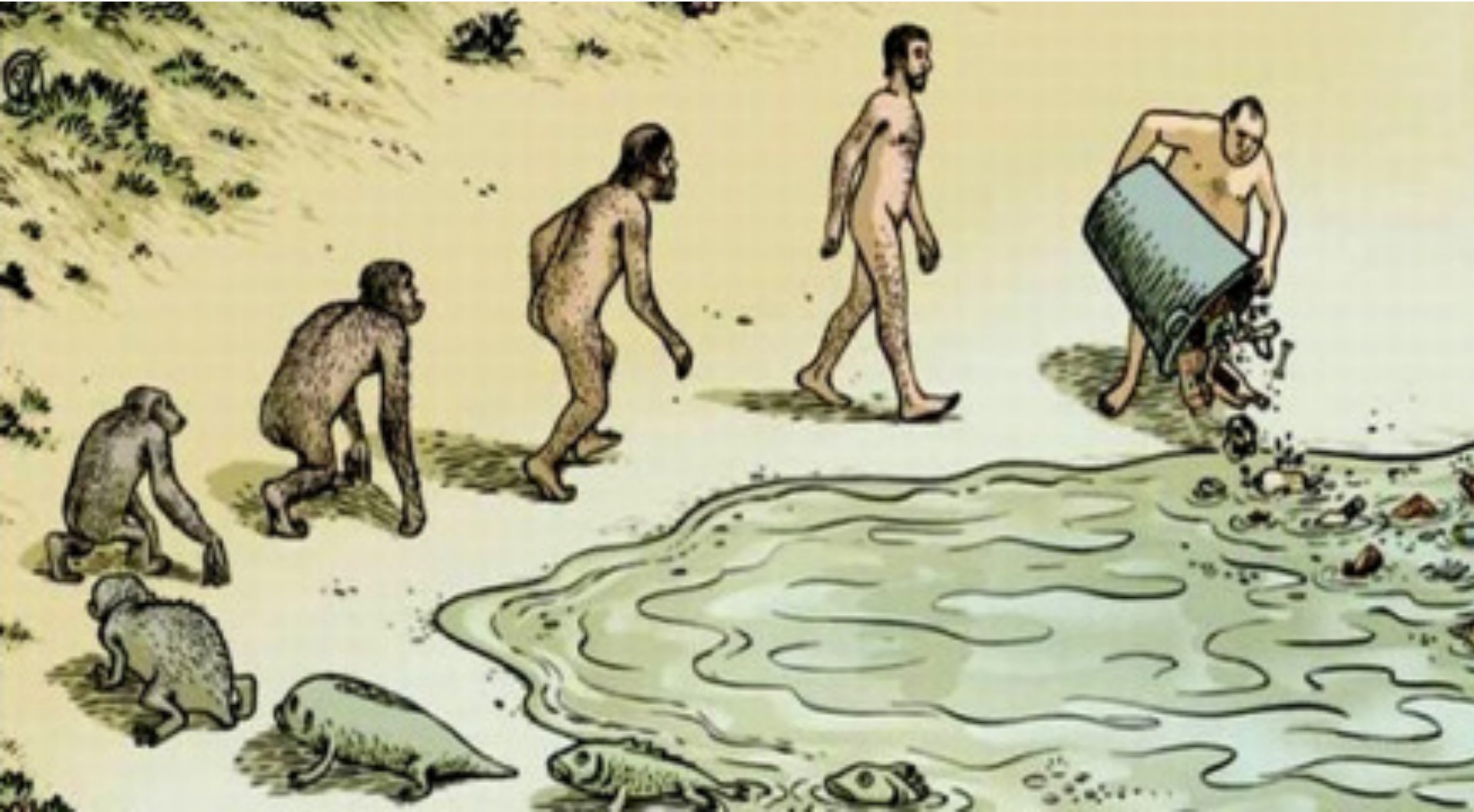


# Evolution & Adaptation

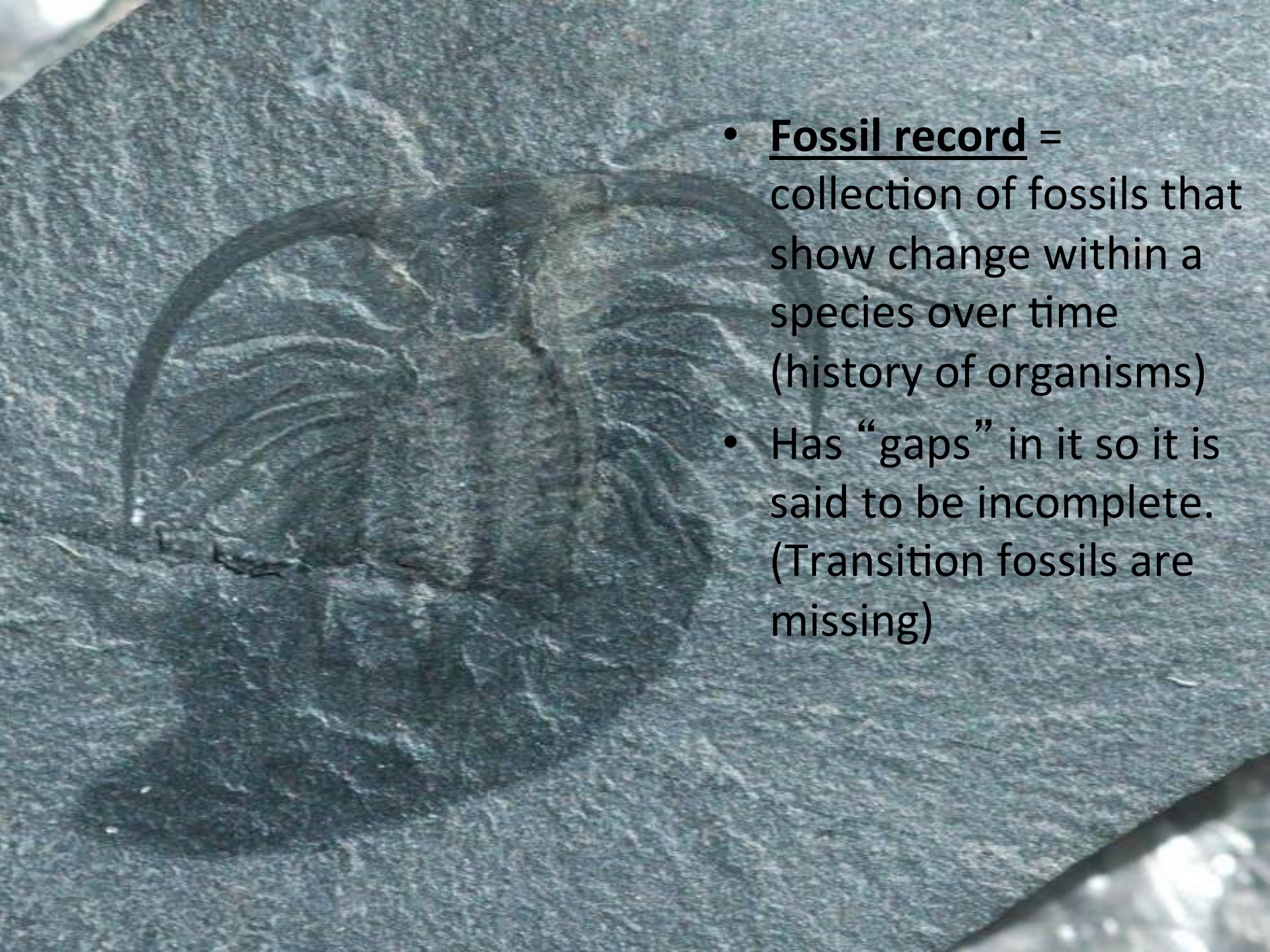


# Evidence for Evolution

# Fossils

- Fossils are preserved remains of ancient organisms
- best evidence of evolution
- formed when plant or animal matter is changed to stone or the “imprint” is solidified.





- **Fossil record** = collection of fossils that show change within a species over time (history of organisms)
- Has “gaps” in it so it is said to be incomplete. (Transition fossils are missing)

# Tarpits

- teeth and bones have been found where animals were trapped in thick mud.
  - Later, became tarpits.



# Amber

- Hardened gum/ sap of a tree
  - Usually insects are trapped



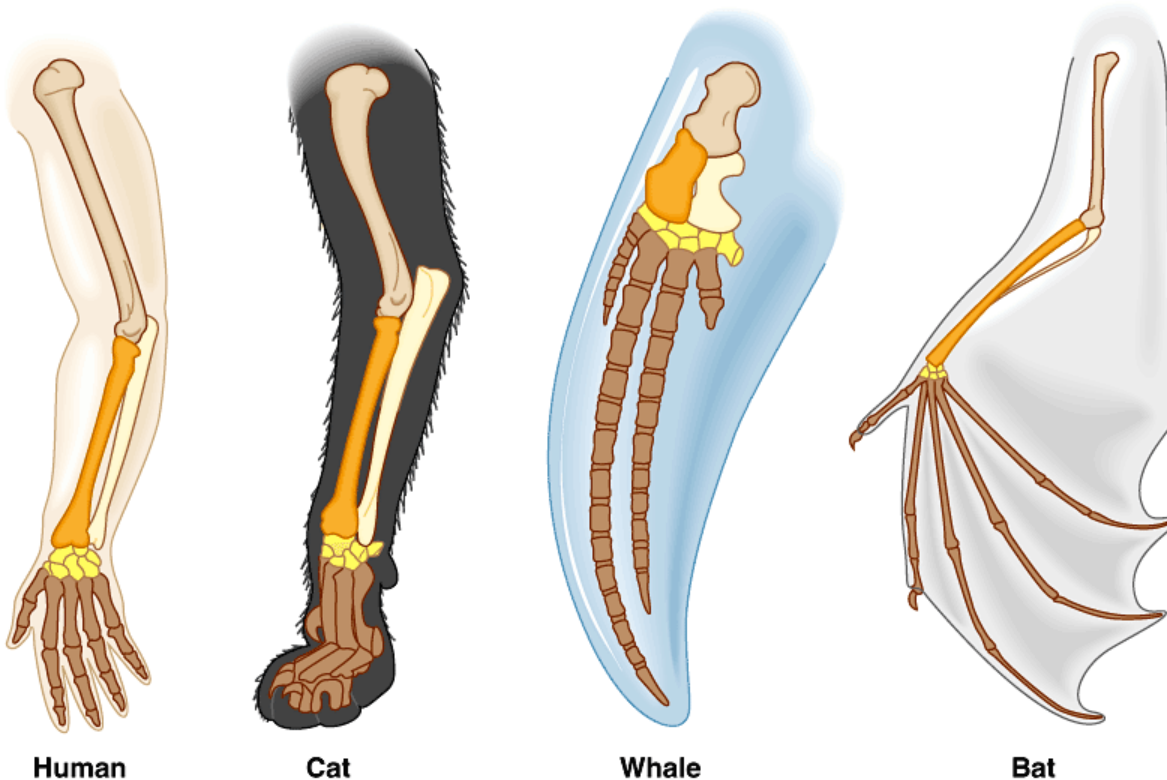
# Flash Frozen

- Organism quickly frozen in ice
  - Woolly Mammoth found nearly intact



# Comparative Anatomy

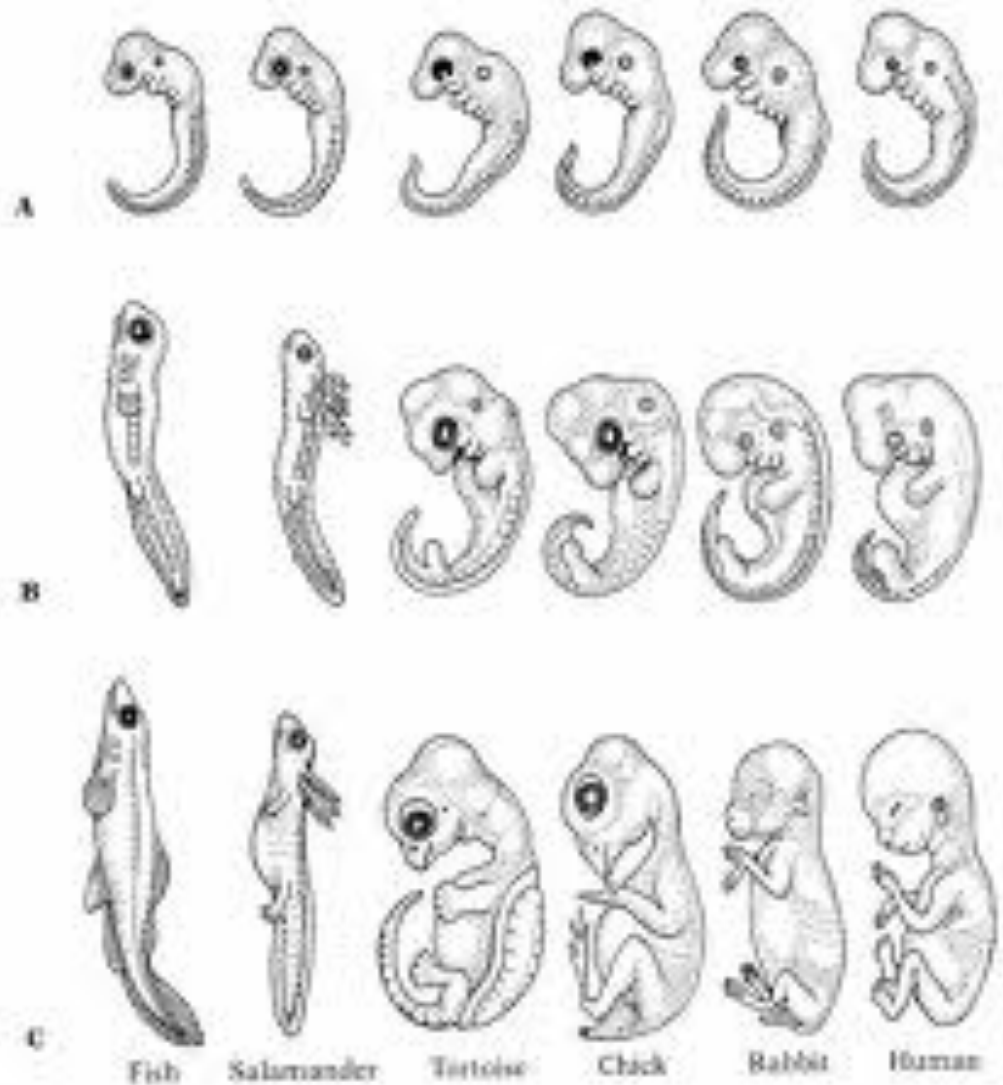
- What similar structures did the animals have, then lose or gain, compared to animals of today:
  - skeletal, nervous, circulatory systems





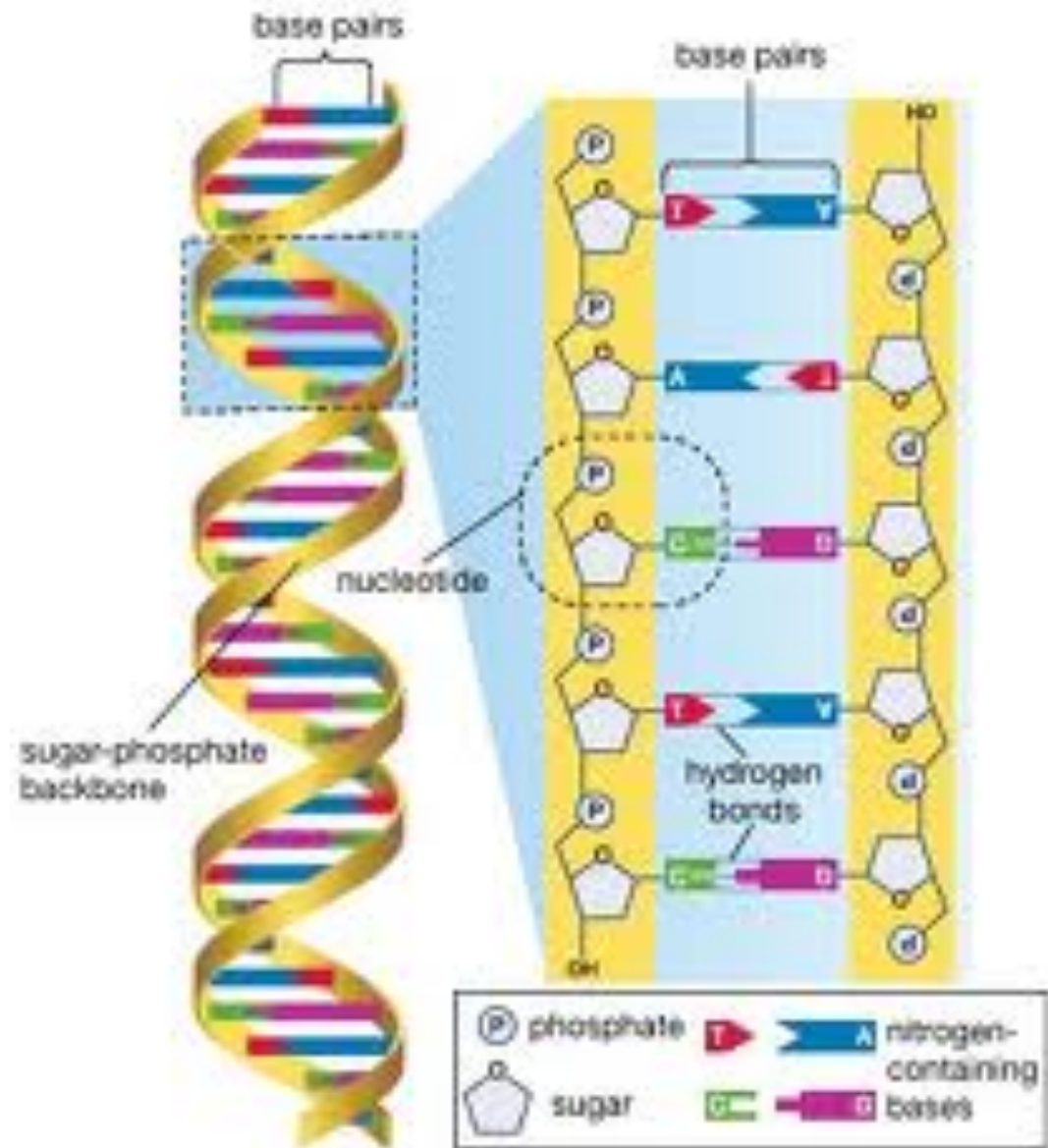
# Embryology

- In vertebrates, the early stages of development look very similar with tails and gill slits
- Therefore, similar ancestors – embryology traces evolutionary pathway



# DNA

- DNA has the same structure for every living thing on Earth



# Natural Selection

**Diversity of Life**

# Charles Darwin the Naturalist

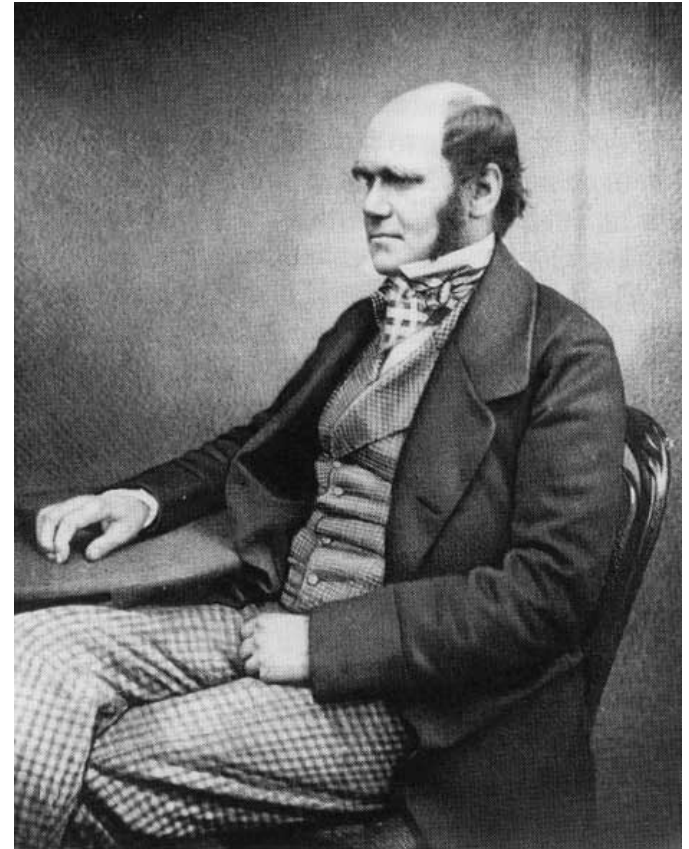


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# Voyage of the Beagle

## Charles Darwin

- born Feb. 12, 1809
- naturalist
- joined Crew of HMS Beagle, 1831 - hired for a 5 year voyage around world to observe plants and animals



# Darwin's Voyage of Discovery



**A reconstruction of the HMS Beagle sailing off Patagonia.**

# Darwin Left England in 1831

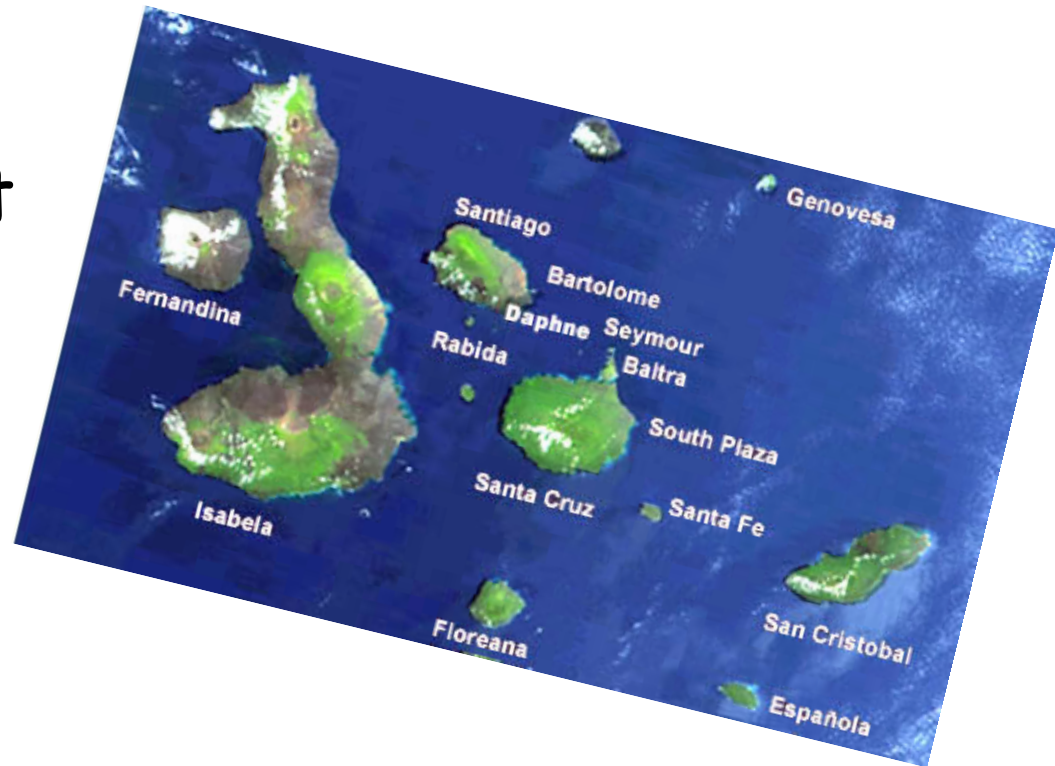


Darwin returned 5 years later in 1836

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# The Galapagos Islands

- **Volcanic islands** off the coast of South America
- Darwin noticed that animal species on the islands varied from mainland species & species from island-to-island also varied











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# The Galapagos Islands

- Darwin observed birds on the islands called Finches
- He noticed huge variation in the types of beaks the finches had
- The different types of beaks seemed to correlate with different food sources on each island (seeds, nuts, berries, insects...)
- Finches had different types of beaks adapted to their type of food gathering



## Galápagos Islands Finches

|                               |   |   |  |   |   |   |
|-------------------------------|---|---|--|---|---|---|
| <b>Shape of Head and Beak</b> |  |  |  |  |  |  |
| <b>Name</b>                   | Vegetarian tree finch   | Large insectivorous tree finch  | Woodpecker finch   | Cactus ground finch   | Sharp-beaked ground finch   | Large ground finch  |
| <b>Main Food</b>              | Fruit   | Insects   | Insects  | Cactus  | Seeds   | Seeds   |
| <b>Feeding Adaptation</b>     | Parrotlike beak   | Grasping beak   | Uses cactus spines   | Large crushing beak   | Pointed crushing beak   | Large crushing beak   |
| <b>Habitat</b>                | Trees   | Trees   | Trees  | Ground  | Ground  | Ground  |

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# Voyage of the Beagle

In addition to the finches, Darwin made numerous other observations and collected evidence that led him to propose a **Revolutionary Hypothesis** about the way life changes over time

# Natural Selection

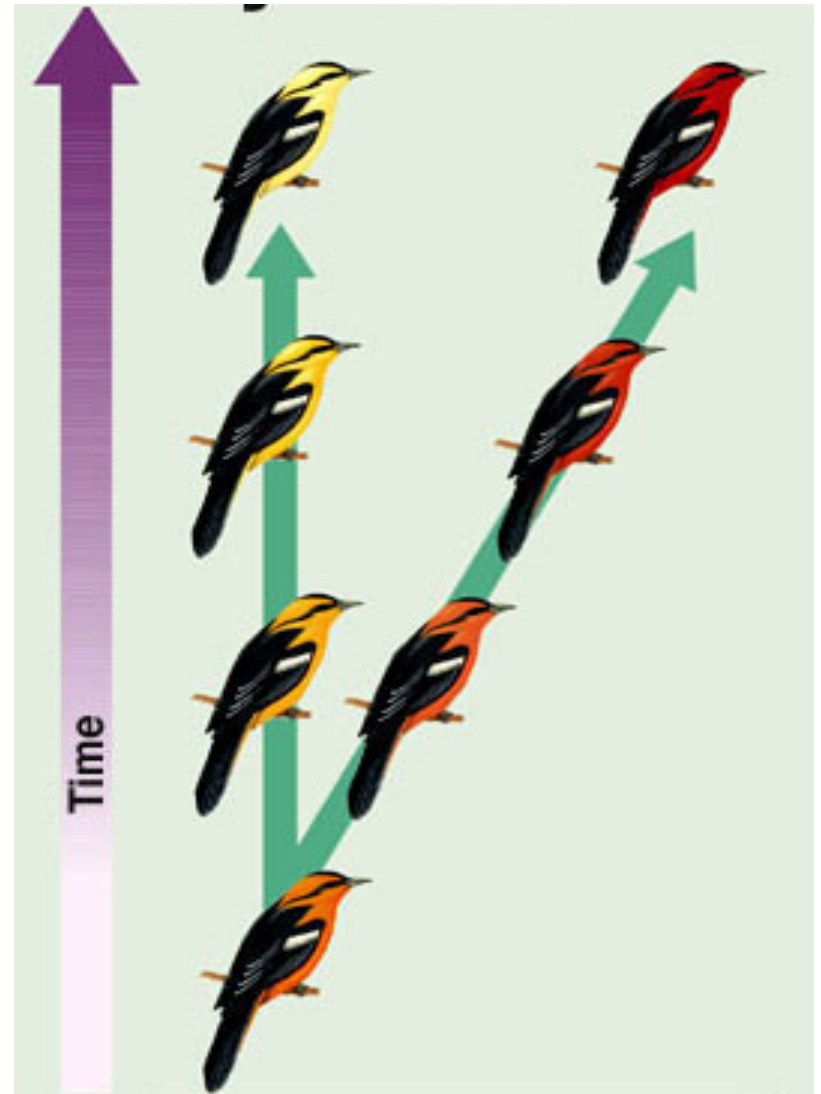
Nature determines  
("selects") the organisms  
that will survive

# Natural selection

- selection for traits that are most successful in the current environment
- a constant process – environments are changing and so does success

# Common Descent with Modification

- Darwin proposed that organisms descend from common ancestors and change with time, diverging from the original common form
- This causes the **evolution of new species**



# Darwin's 5 Ideas

1. Overpopulation
2. Competition
3. Variation
4. Survival of the Fittest
5. New Species



# 1. OVERPOPULATION

- Organisms tend to produce many offspring - more than the environment can support
- Organisms will reproduce until something stops them (usually food)



## 2. COMPETITION

- Because of overpopulation, individuals compete with one another over limited resources → food, water, shelter, mates
- Competition occurs both within and between species



# 3. VARIATION

- Individuals of a population vary in their traits and characteristics
- this variation is passed on to offspring.



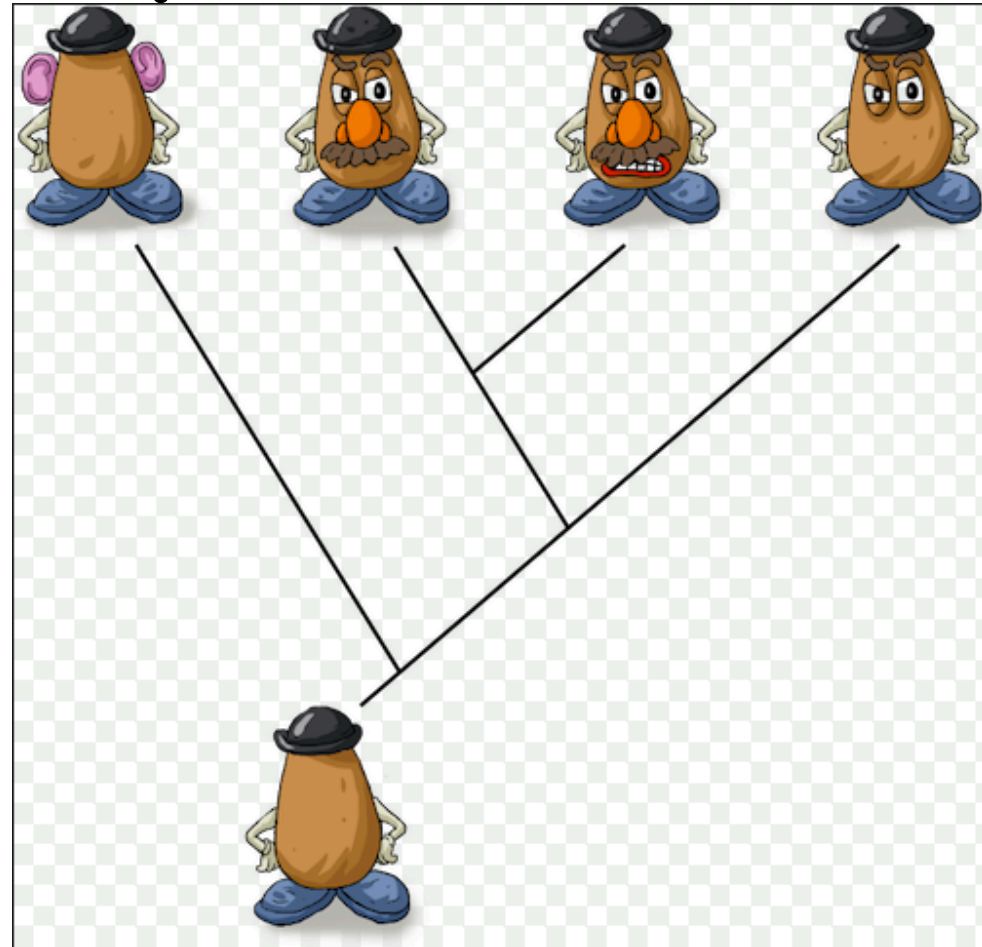
# 4. SURVIVAL OF THE FITTEST

- individuals with advantageous genetic traits are better adapted to their environment
- This increases their chance of survival
  - This is called survival of the fittest



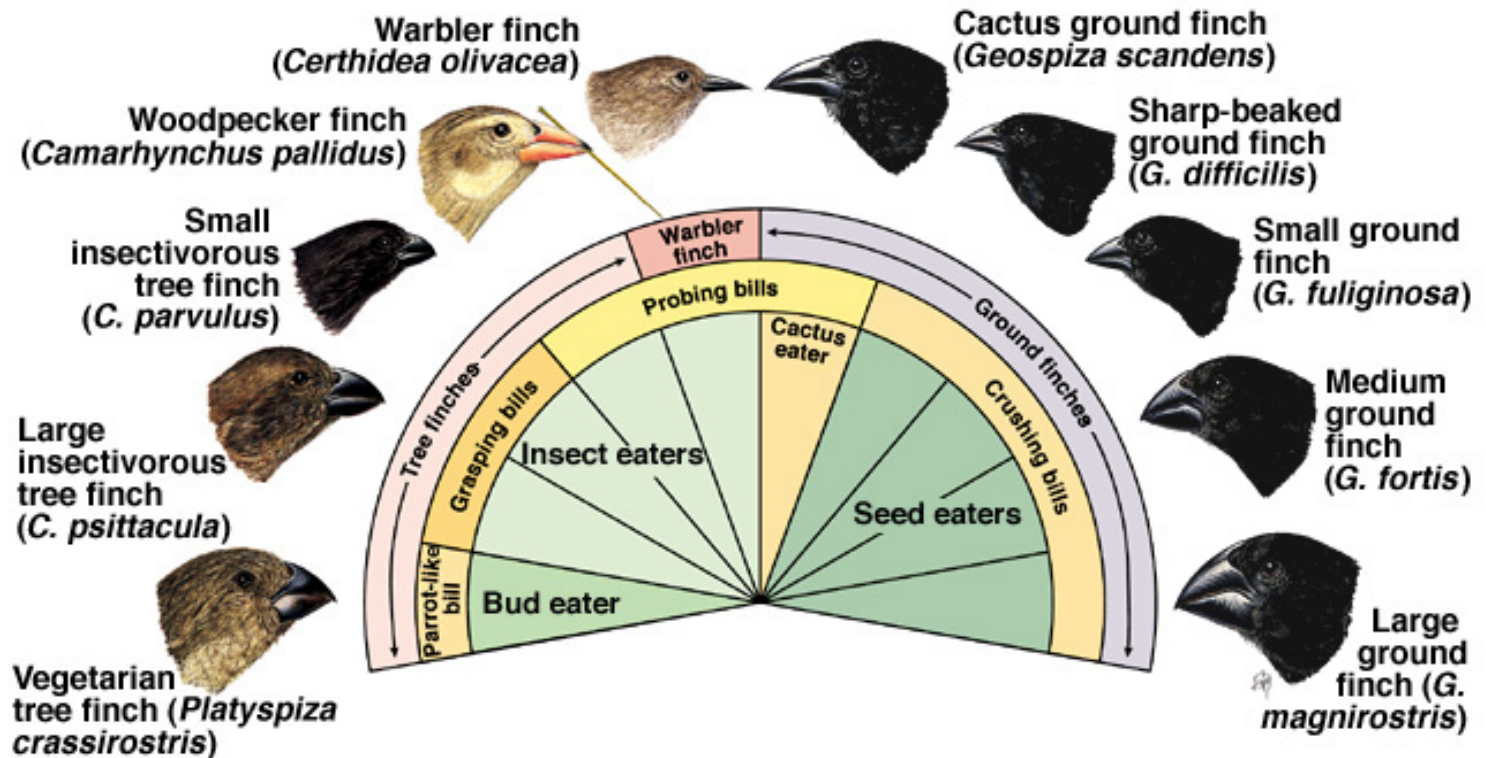
# 5. New Species

- New species results by inheritance of trait(s), on genes, that give them an advantage over others.
- **New species evolve**



# SPECIATION

- Where one species evolves into one or more other species
- Also called **adaptive radiation**

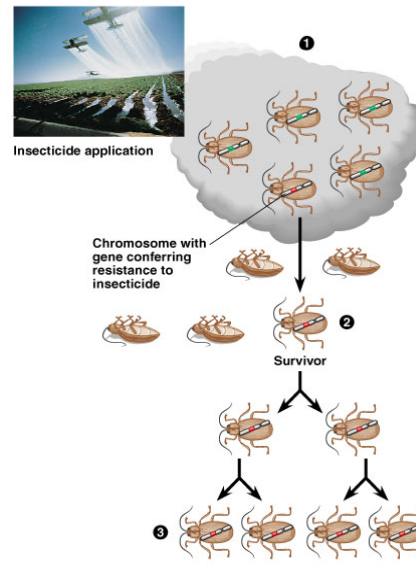


# ADAPTATION

- A inheritable characteristic that provides an advantage for survival and reproduction
- **Adaptations Can Be:**
  - **Structural** – a part organism has to help
    - Speed, Camouflage, Claws, Quills, etc.
  - **Physiological** – physical or chemical part inside the organism
    - Maintain internal temp., or use less water for photosynthesis
  - **Behavioural** – something organism does
    - Solitary, Migration, Herds, Packs etc.

# Examples of Natural Selection

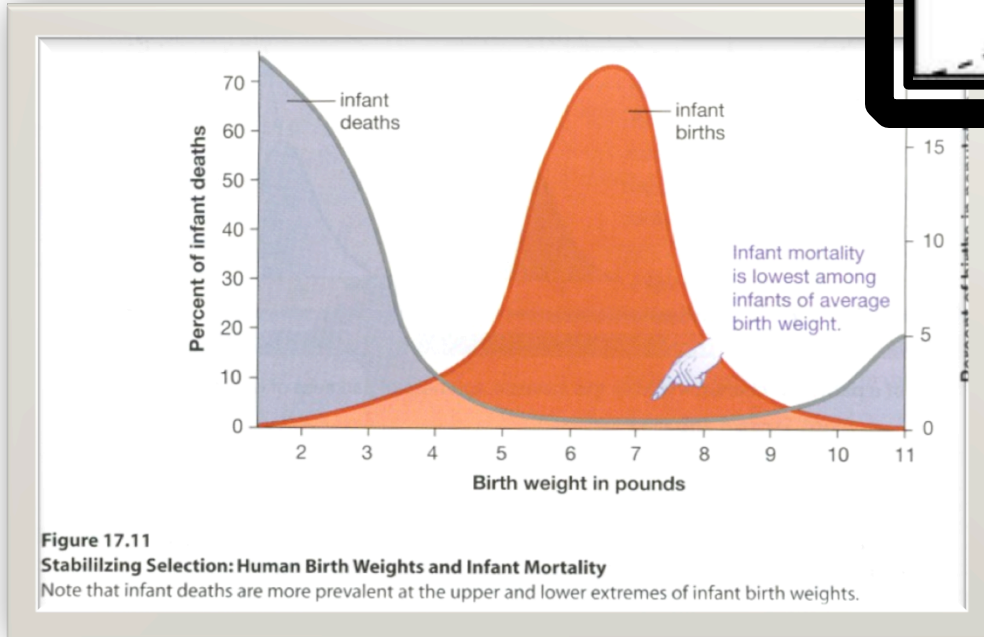
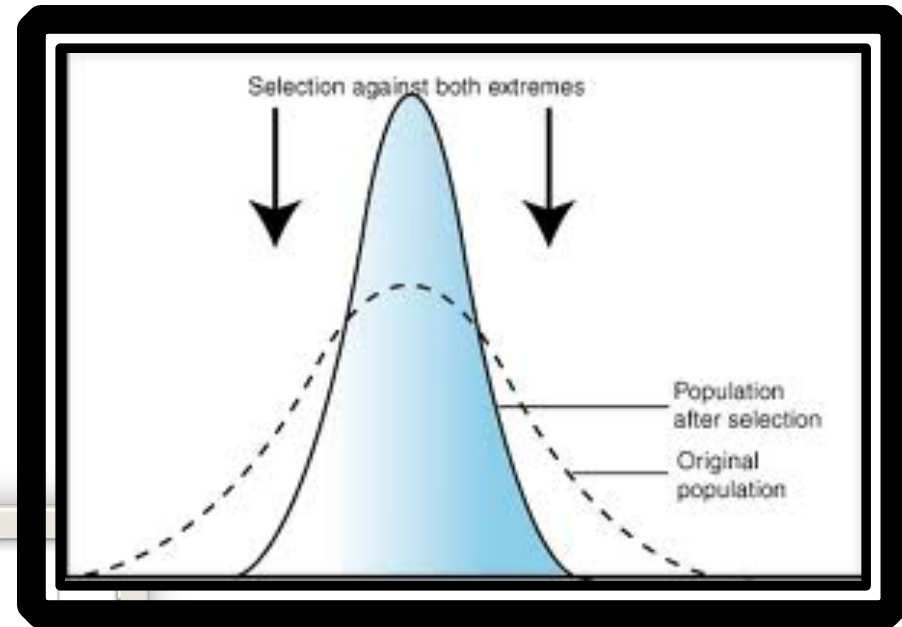
1. Darwin's finches
2. Peppered moth
3. Antibiotic Resistant bacteria
4. Pesticide resistant mosquitoes



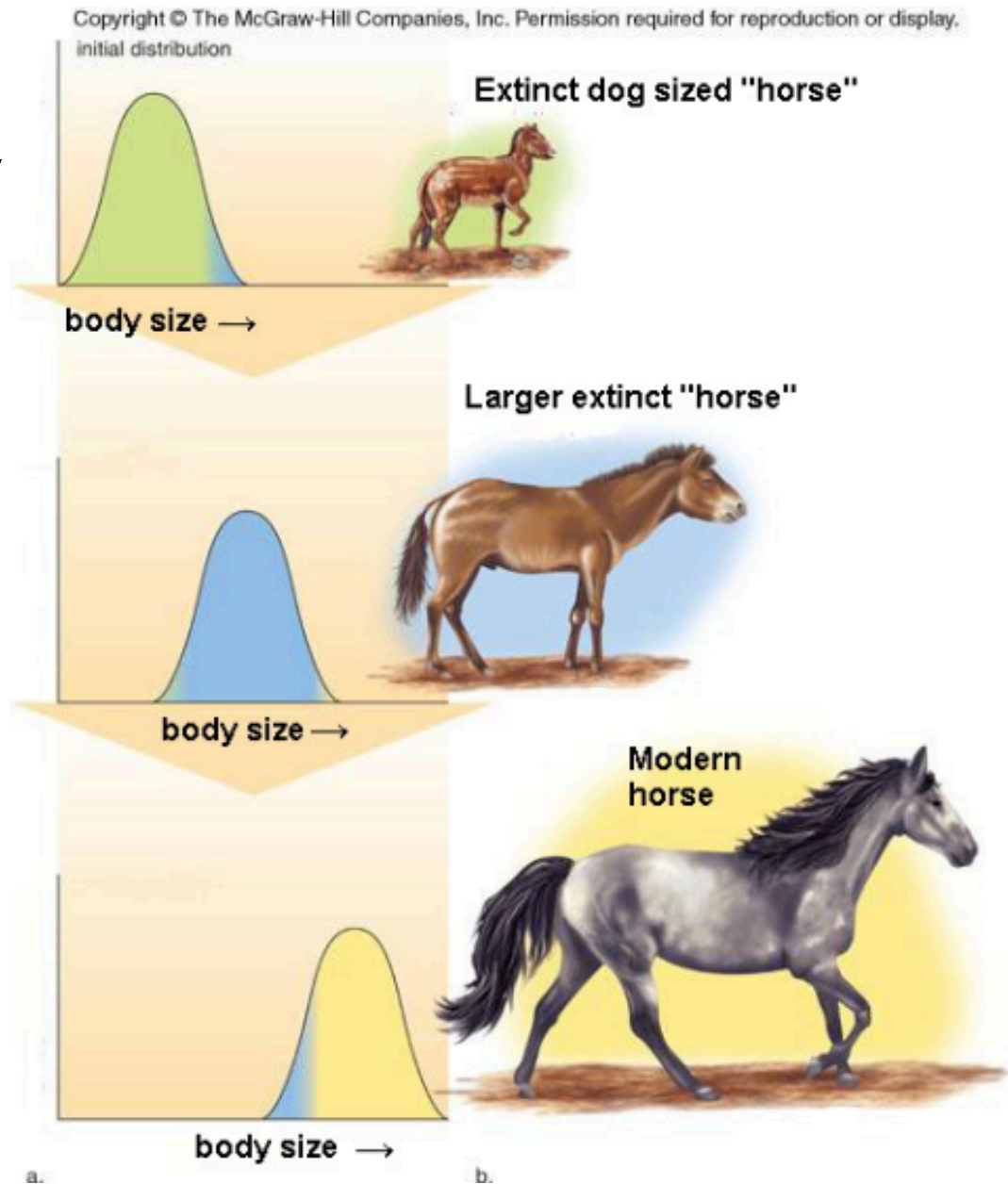


# Natural selection acts on a population in 3 ways:

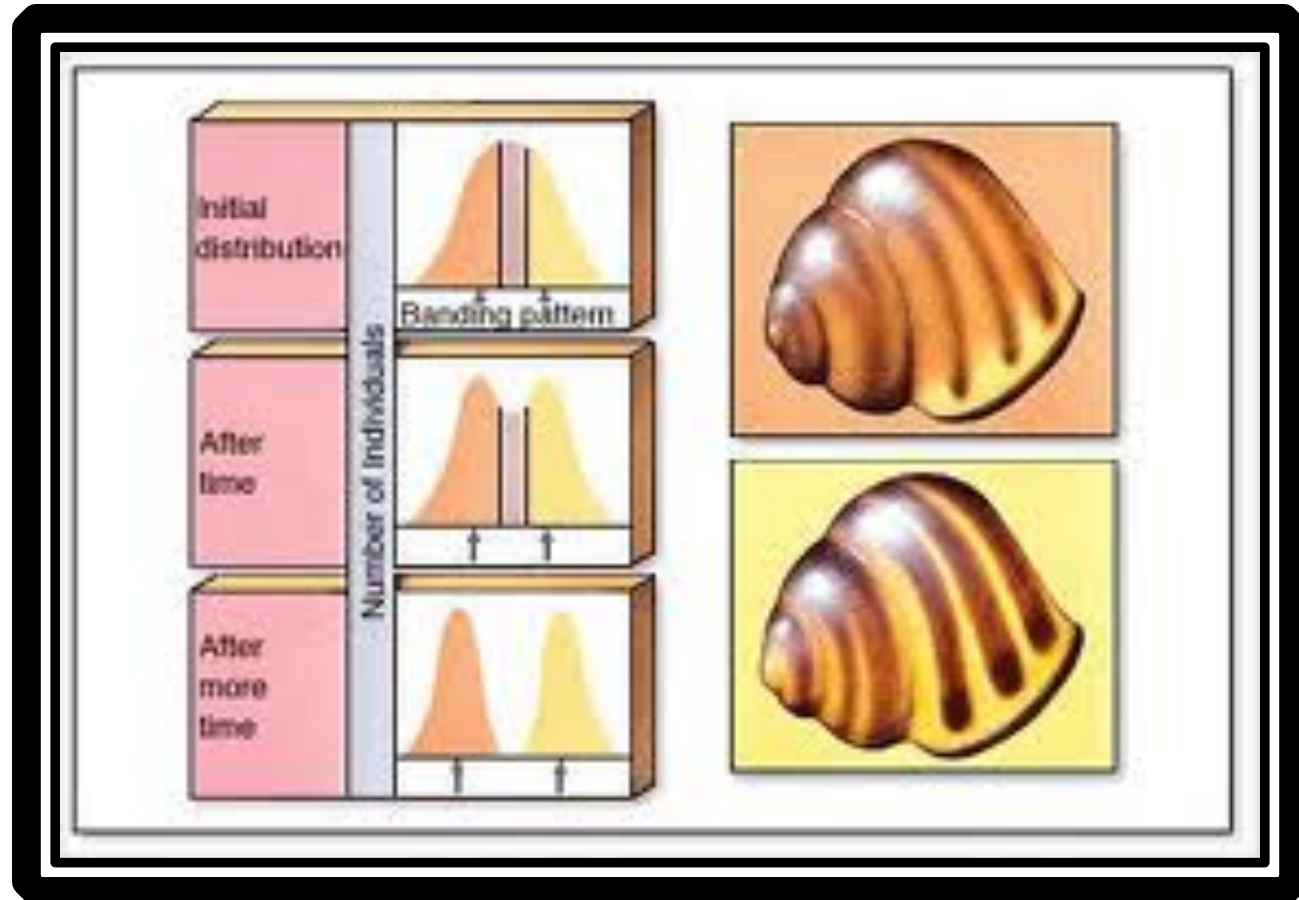
1. If the environment favours the **average** of the distribution, the selection is called **stabilizing selection**



2. If the environment favours one extreme, the selection is directional



3. If the environment favours **both extremes**, the selection is **disruptive**

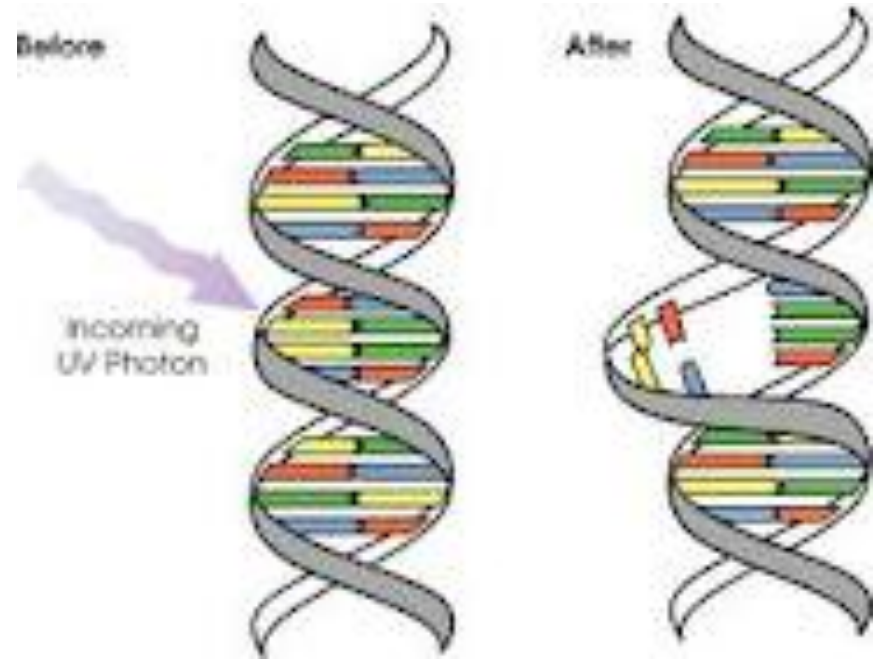


Factors which influence  
genetic variation

# Factors which **increase** genetic variation

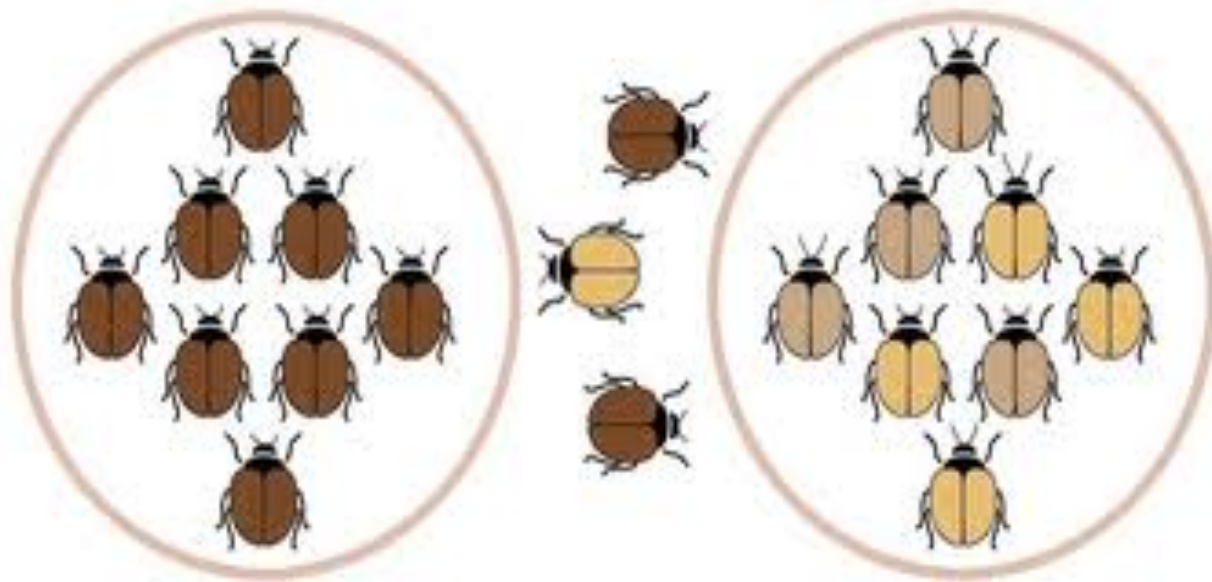
## 1. Mutations

- Permanent change in DNA
- Main source of new alleles



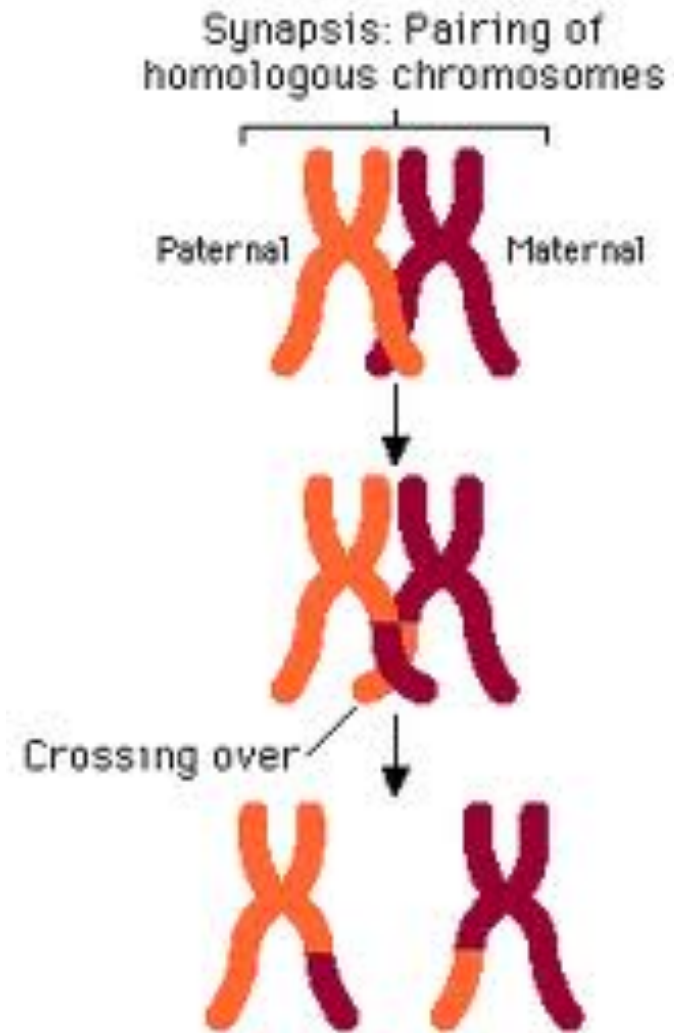
## 2. Gene flow

- Individuals of different populations immigrate or emigrate between populations of the same species
- Brings new genes into a population – adds variation to gene pool – new alleles
- Prevents specialization to environment



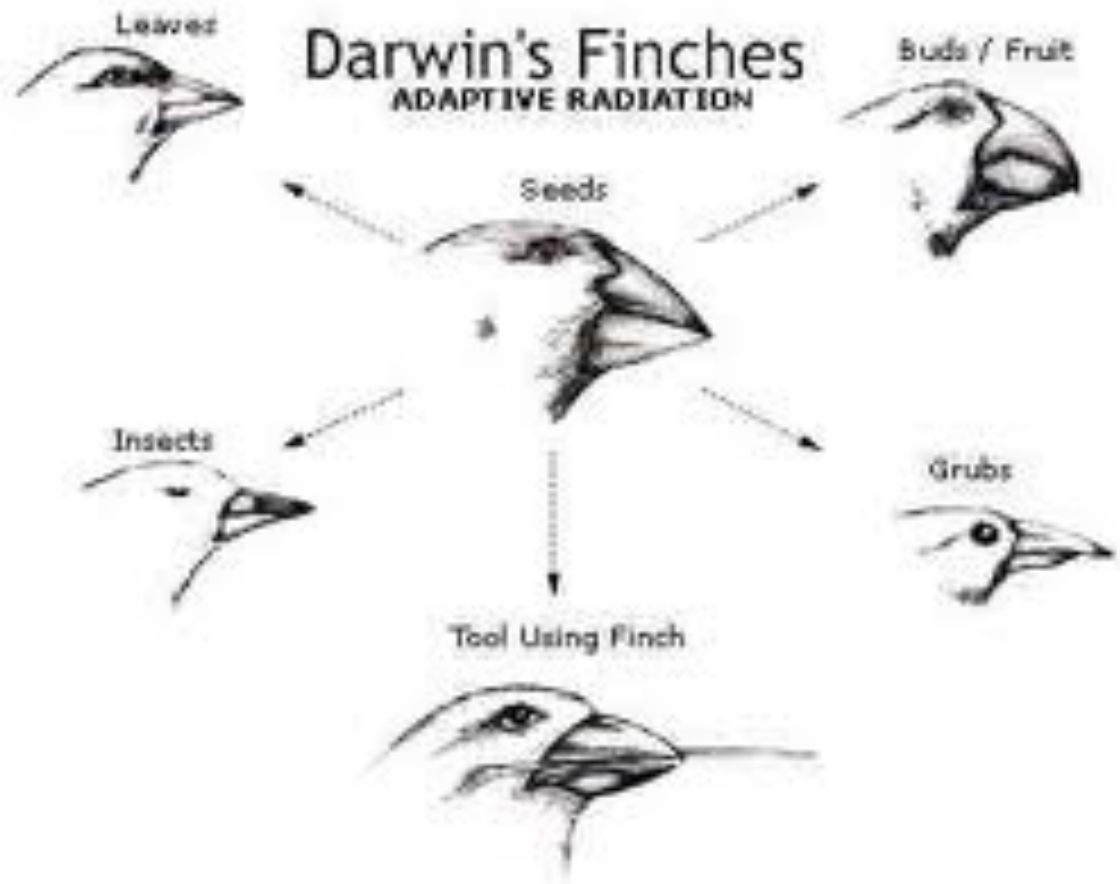
### 3. Recombination

- parts of chromosomes switch parts
- crossing over during meiosis



# Factors which decrease genetic variation:

## 1. Natural selection covered already





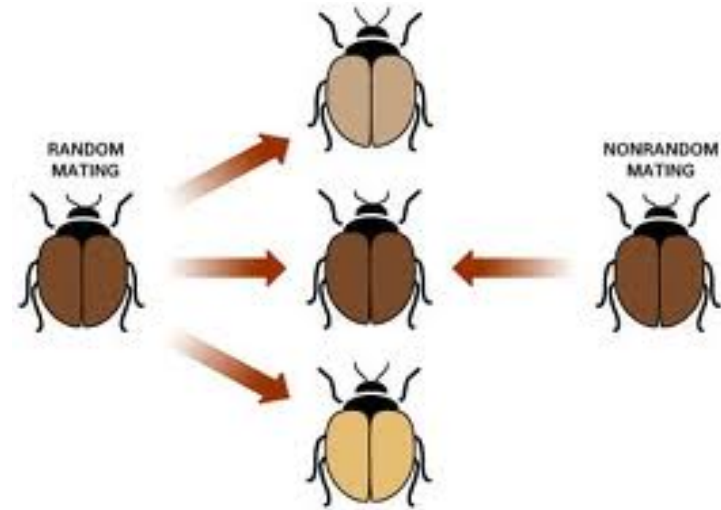
## 2. Genetic Drift

- Random or chance change in the frequency of a gene
- A change in allelic frequency over time due to chance
- Eg. a natural disaster could wipe out a large number of animals of a species. Those that survived are able to reproduce – not necessarily the strongest / fittest - luck



### 3. Non-random mating

- Some organisms have more opportunity to mate than others & therefore produce more offspring (& more copies of their genes).
- **Has more desirable trait**
- **2 reasons for non-random mating**
  - Simply easier to mate with a nearby individual (rather than one far away).
  - Competition for mates occurs among animals = active selection of mating partner (not random)



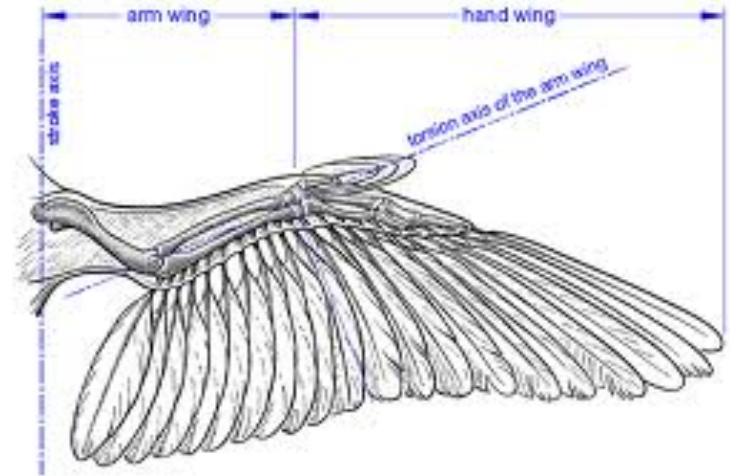
# Convergent vs. Divergent Evolution

# Convergent evolution

- = evolution toward the SAME type of adaptation among different groups of organisms
- Produces analogous structures which have the SAME FUNCTION but different structure

## Example of convergent evolution

- Wing of an insect and wing of a bird:
  - Both are used for flying but each has a very different structure
    - Bird = muscle, bone, feathers, skin, tissue
    - Insect = cartilage rods with membrane

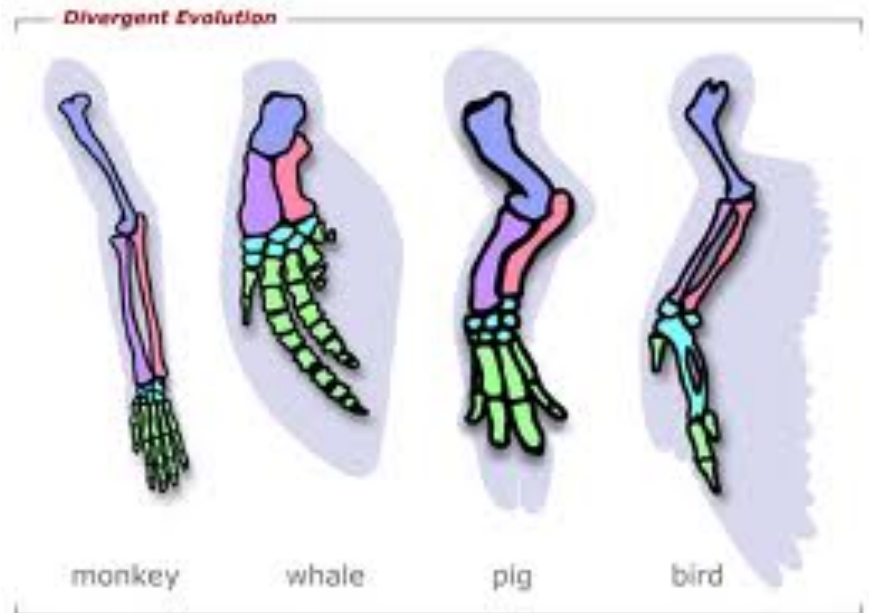


# Divergent Evolution

- = evolution which led to **DIFFERENT** structures developing from an original body plan.
- produces **homologous structures** = **DIFFERENT FUNCTION** but same structure due to a common ancestor

## Example of divergent evolution:

- Ex. Forelimb of mammals = same bone pattern but each limb is specialized / adapted to the animal's way of life.
  - Human: grasping (hand)
  - Whale / dolphin: swimming (flipper)
  - Bat: flying (wing)



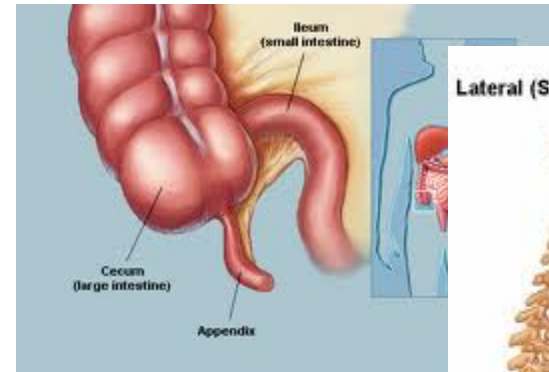
★ Leads to speciation

# Vestigial Structures

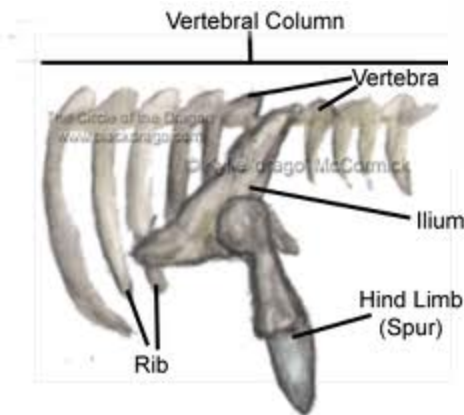
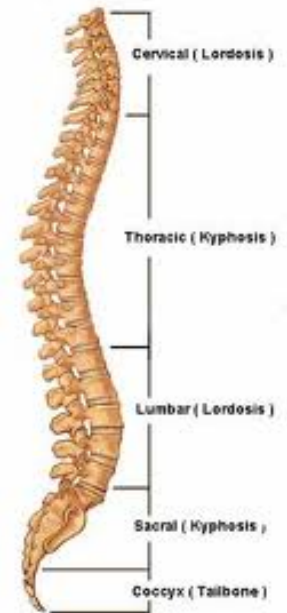
= remnants of a structure that had a function in an ancestor but no longer does in the evolved organism.

Ex. Appendix – used to be for digestion

- Tail bone
- Snake hips – pelvis bone but no legs
- Chickens have gene for teeth but no teeth



Lateral (Side) Spinal Column

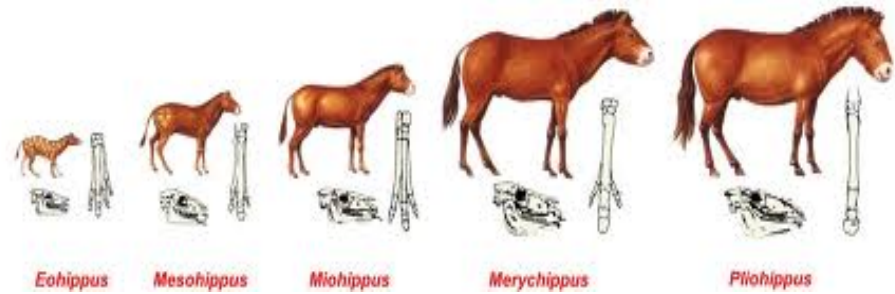




Rate of evolutionary  
change, extinction &  
factors involved in  
extinction

# Gradualism

- Evolutionary change that occurs slowly & constantly over time.
  - Based on evidence from the fossil record where some organisms have evolved slowly (in geological time)
- Ex. Sharks, crocodiles, cockroaches, horseshoe crabs

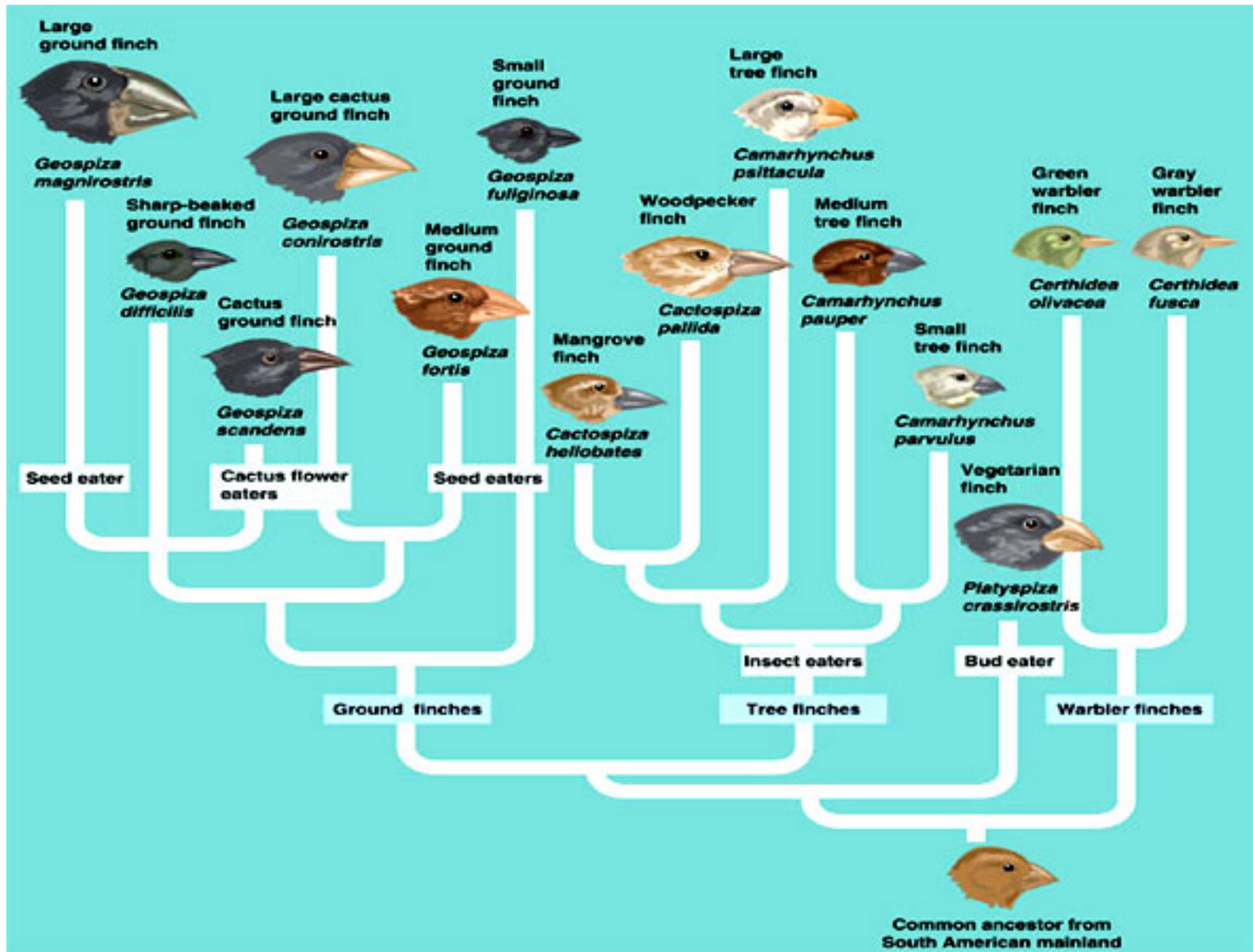


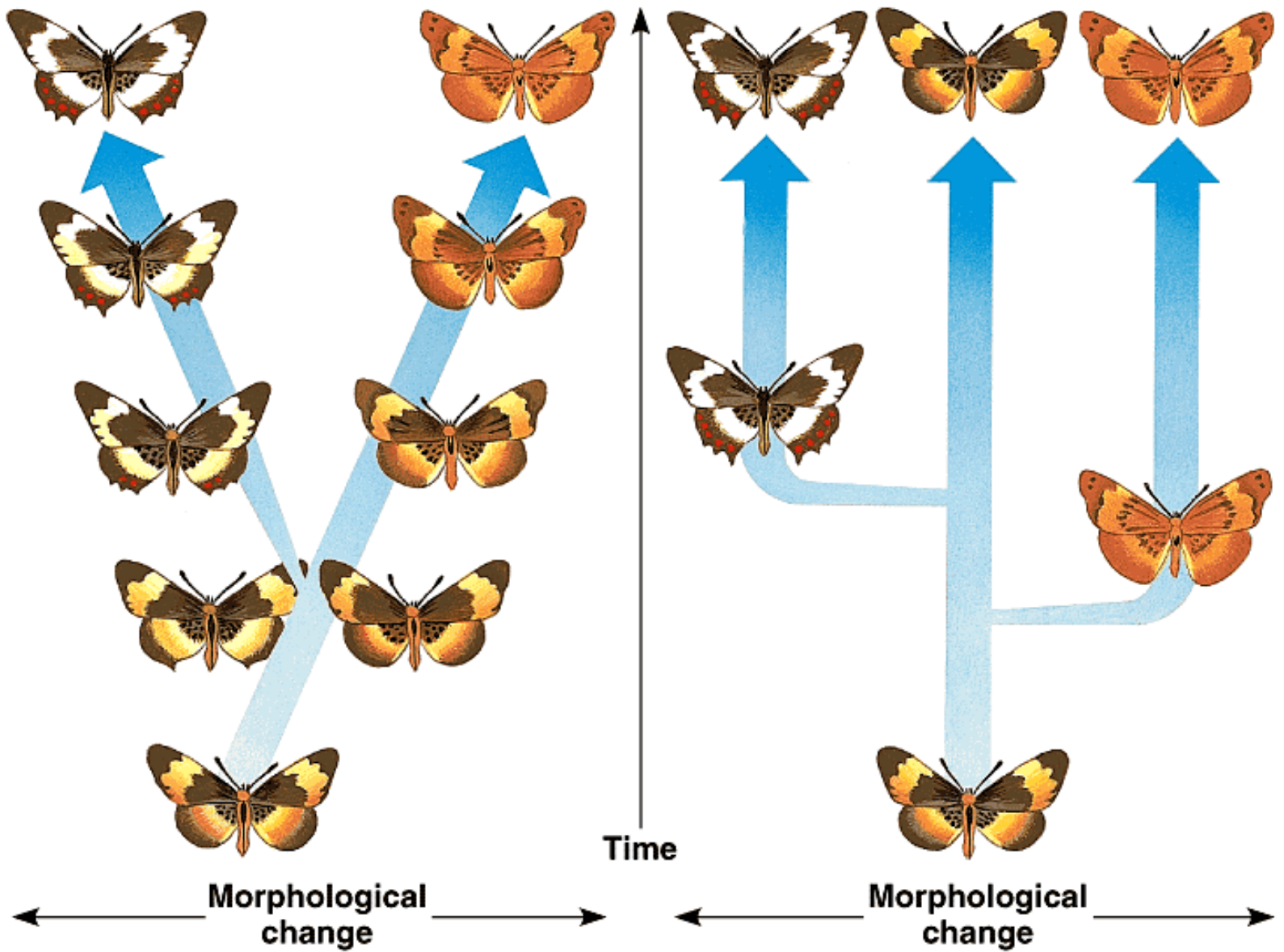
# Punctuated Equilibrium

- There is a period of stability, where little change, if any occurs.
- However, this is followed by periods of rapid change to a species of plant or animal
- Can be caused by environmental conditions such as an ice age. Some species will die off but others will need to change quickly and adapt to new environments – therefore, rapid evolution
- Animals with higher reproductive rates are better able to adapt. Therefore, new opportunities presented for survivors

Ex. Mammals, birds

# Punctuated Equilibrium





Gradualism

Punctuated equilibrium

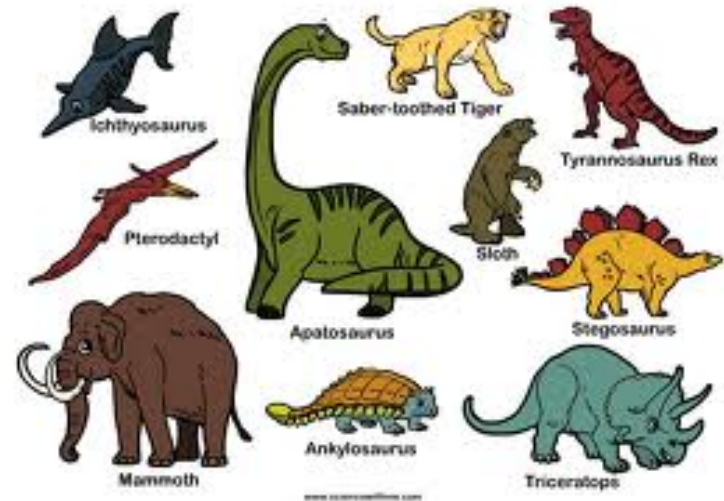
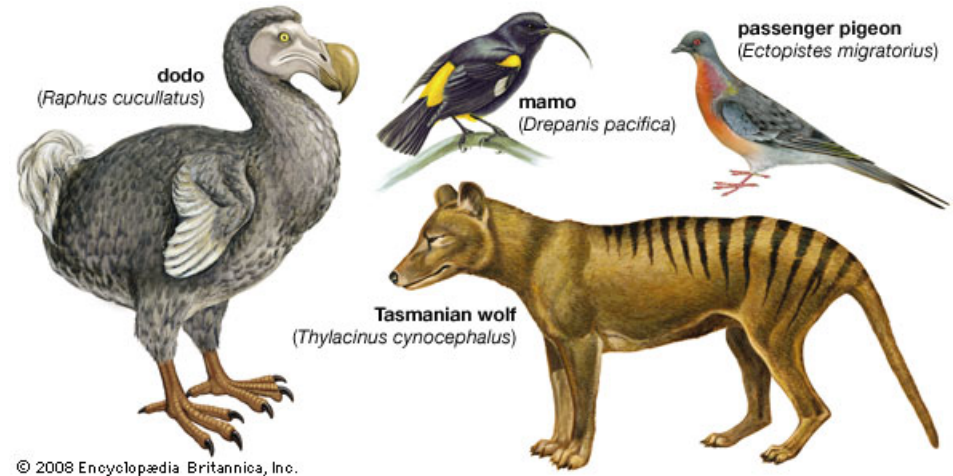
# Endangered Species

- Wild species with so few survivors that the species could soon become extinct
- Examples



# Extinction

- Complete disappearance of a species from the Earth
- Stops the evolution of that animal
- Leaves niches open for other animals to “fill”
- Increases speciation of other organisms
- Examples



# Factors causing extinction

- Pollution
- Climate change
- Hunting/poaching
- Invasive species
- Loss of habitat
- Speciation
- Can you think of others??

