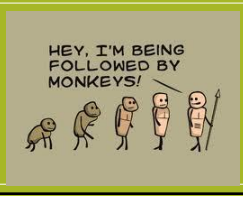
EVOLUTION AND DARWIN



Evolution

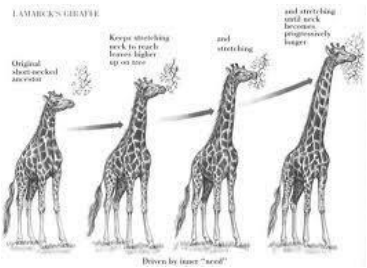
- The **processes** that have transformed life on earth from it's earliest forms to the vast diversity that characterizes it today.
- Ultimately evolution is caused by a change in the genes of a population

Somewhere, something went terribly wrong

Old Theories of Evolution

- Jean Baptiste Lamarck (early 1800's) proposed:
  - "The inheritance of acquired characteristics"
    - Offspring get characteristics inflicted on parents
- He proposed that by using or not using its body parts, an individual tends to develop certain characteristics, which it passes on to its offspring.

"The Inheritance of Acquired Characteristics"



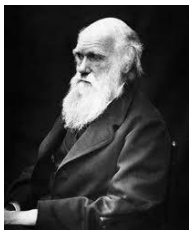
- **Example:**

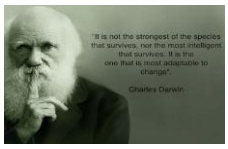
A giraffe acquired its long neck because its ancestor stretched higher and higher into the trees to reach leaves, and that the animal's increasingly lengthened neck was passed on to its offspring.

Mostly wrong, but.... https://www.youtube.com/watch?v=kp1bZEUgqVI

Charles Darwin

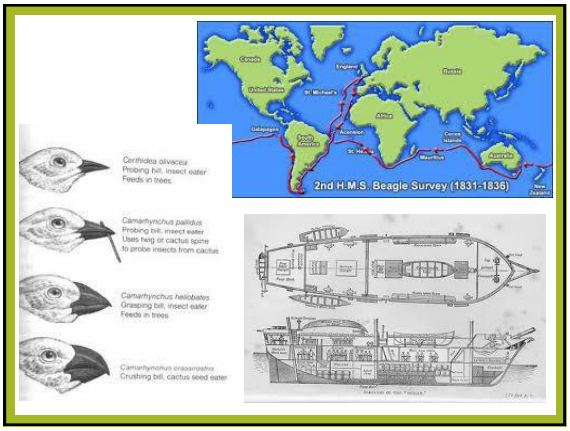
- Influenced by Charles Lyell who published "Principles of Geology"
- This publication led Darwin to realize that natural forces gradually change Earth's surface and that the forces of the past are still operating in modern times.



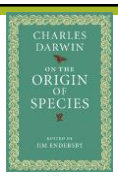


Charles Darwin

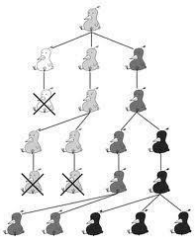
- Darwin set sail on the H.M.S. Beagle (1831-1836) to survey the south seas (mainly South America and the Galapagos Islands) to collect plants and animals.
- On the Galapagos Islands, Darwin observed species that lived no where else in the world.
- These observations led Darwin to write a book.



Charles Darwin

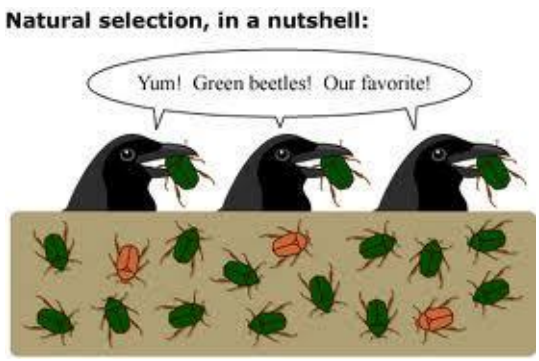


- Wrote in 1859: "On the Origin of Species by Means of Natural Selection"
- Two main points:
  - 1. Species were not created in their present form, but evolved from ancestral species.
  - 2. Proposed a mechanism for evolution: NATURAL SELECTION



Natural Selection

- Individuals with favorable traits are more likely to leave more offspring better suited for their environment.
- Also known as "Differential Reproduction"
- Example:
  - English peppered moth (*Biston betularia*)
    - light and dark phases – "industrial melanism"



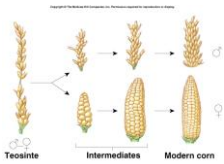
The Darwin-Wallace Theory of Evolution (1856)

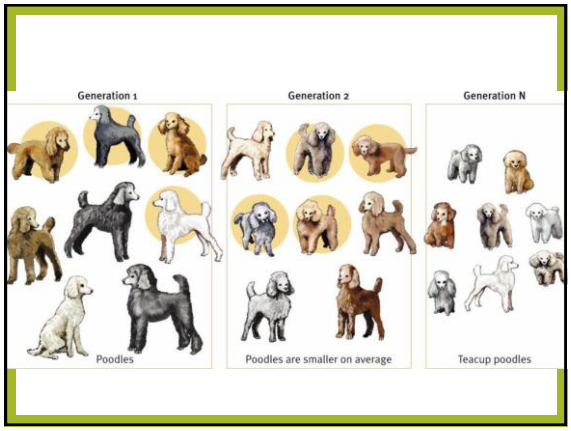
1. Populations have variations.
2. Some variations are favorable.
3. More offspring are produced than survive
4. Those that survive have favorable traits/variations (there is a "struggle for existence").
5. A population will change over time to reflect these beneficial variations.

Banana Horror: https://www.youtube.com/watch?v=exoURt hWj4

Artificial Selection

- The selective breeding of domesticated plants and animals by man.
- What's the ancestor of the domesticated dog?

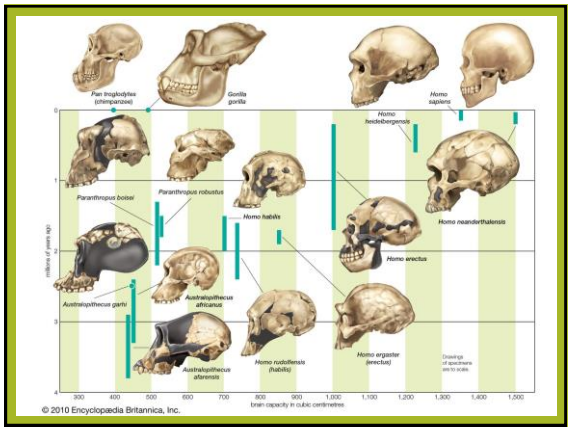




Evidence of Evolution

1. Fossil Record:

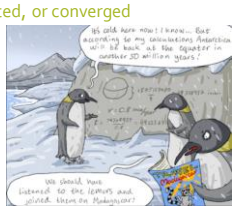
Fossils and the order in which they appear in layers of sedimentary rock (strongest evidence).



Evidence of Evolution

2. Biogeography:

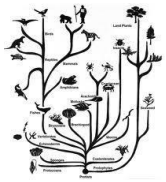
Geographical distribution of species. Similar organisms in similar environments—radiated out from ancestral species when continents connected, or converged

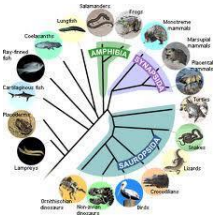


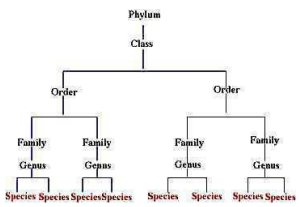
Evidence of Evolution

3. Taxonomy:

Classification of life forms.



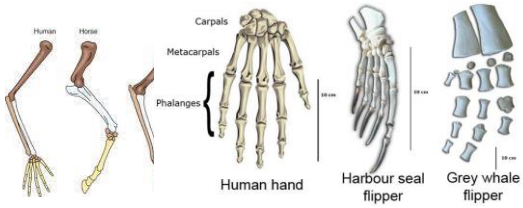




Evidence of Evolution

4. Homologous structures:

Structures that are similar because of common ancestry (comparative anatomy)



Evidence of Evolution

5. Comparative embryology:

Study of structures that appear during embryonic development.

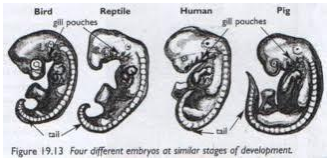
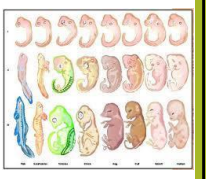


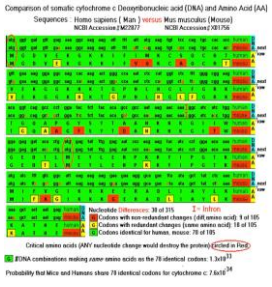
Figure 19.13 Four different embryos at similar stages of development.

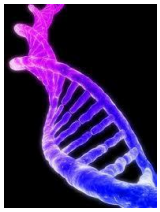


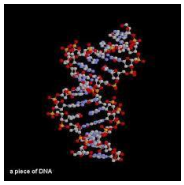
Evidence of Evolution

6. Molecular biology:

DNA and proteins (amino acids)

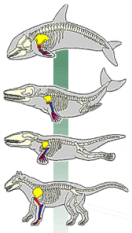






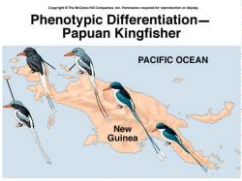
Macroevolution

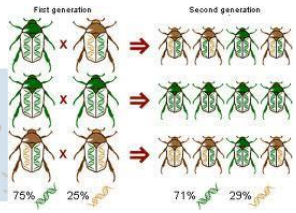
- The origin of taxonomic groups higher than the species level.



Microevolution

- A change in a population's gene pool over a secession of generations.
- Evolutionary changes in species over relatively brief periods of geological time.





Five Mechanisms of Microevolution

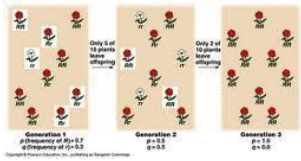
1. Genetic drift:

Change in the gene pool of a small population due to chance.

Two examples:

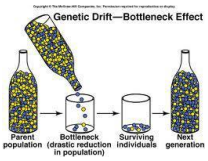
a. Bottleneck effect

b. Founder effect



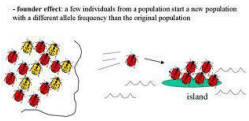
a. Bottleneck Effect

- Genetic drift (reduction of alleles in a population) resulting from a disaster that drastically reduces population size.
- Examples:
  1. Earthquakes
  2. Volcanoes



b. Founder Effect

- Genetic drift resulting from the colonization of a new location by a small number of individuals.
- Results in random change of the gene pool.
- Example:
  1. Islands (first Darwin finch)

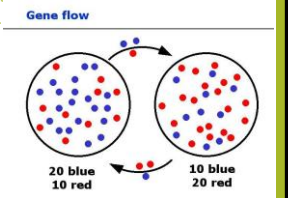


Five Mechanisms of Microevolution

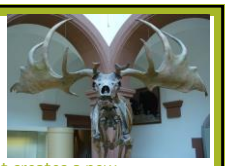
2. Gene Flow:

The gain or loss of alleles from a population by the movement of individuals or gametes.

- Immigration or emigration.



Five Mechanisms of Microevolution



3. Mutation:

Change in an organism's DNA that creates a new allele.

4. Non-random mating:

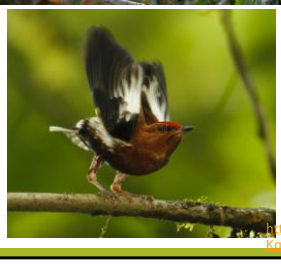
The selection of mates other than by chance.

5. Natural selection:

Differential reproduction.

Non-Random Mating

https://www.youtube.com/watch?v=rHJcXoZ_Wro



https://www.youtube.com/watch?v=W7QZnwKqqnQ

One of the most elaborate "hey girl"s of the animal kingdom

https://www.youtube.com/watch?v=GPbWJPBPdA

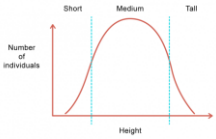
Contest

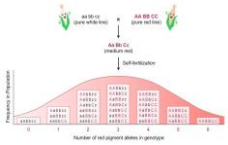
Territory

https://www.youtube.com/watch?v=VDhNu8XpFF

Types of variation

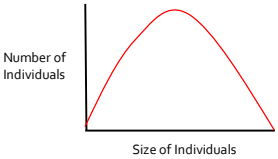
- **Continuous variation:** occurs on a spectrum (bell curve)
  - Might be polygenic in nature, different alleles with cumulative effects, etc.
- **Discontinuous variation:** discrete phenotypes (this or that)→ caused by individual genes coding for large impacts on phenotype





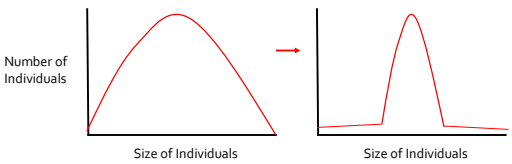
Modes of Action

- Natural selection has three modes of action:
  1. Stabilizing selection
  2. Directional selection
  3. Diversifying selection



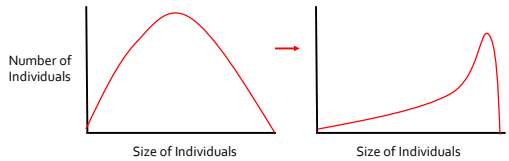
1. Stabilizing Selection

Acts upon extremes and favors the intermediate.



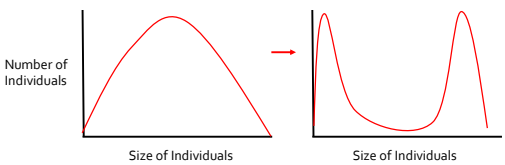
2. Directional Selection

Favors variants of one extreme

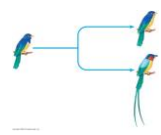


3. Disruptive Selection (Diversifying)

Favors variants of opposite extremes.



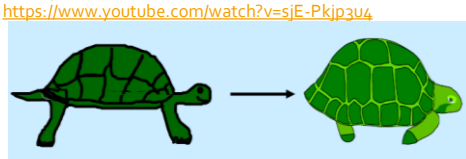
Speciation



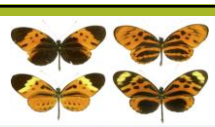
The evolution of new species.

Why? –Organisms speciate to avoid competition—easier to fill new niches than compete for occupied ones

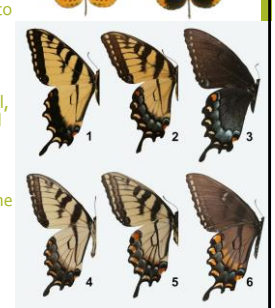
History of Life on Earth: https://www.youtube.com/watch?v=sjE-Pkjp3u4



What's in a species?



- Have historically used the ability to interbreed… problems!!
  - Hybrids? Sterile or not? Polyploidism? Collections in museums or extinct organisms?
- Organisms with similar behavioral, morphological, physiological, and biochemical features capable of reproducing to create fertile offspring
- "Reproductively isolated" from one another
- Differences may be very subtle!!



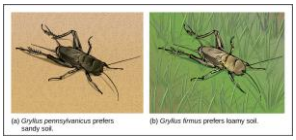
Reproductive Barriers

- Any mechanism that impedes two species from producing fertile and/or viable hybrid offspring.
- Two types of barriers:
  1. Pre-zygotic barriers
  2. Post-zygotic barriers

Different insects pollinating black sage and white sage

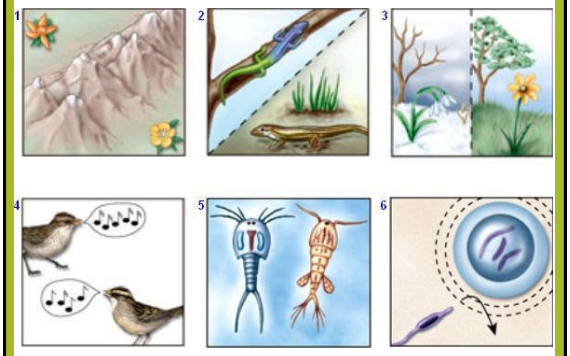
1. Pre-zygotic Barriers

- Temporal isolation: Breeding occurs at different times for different species.
- Habitat isolation: Species breed in different habitats.
- Behavioral isolation: Little or no sexual attraction between species.



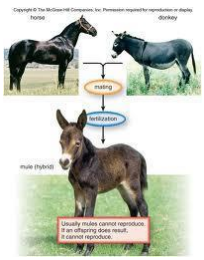
1. Pre-zygotic Barriers

- Mechanical isolation: Structural differences prevent gamete exchange.
- Gametic isolation: Gametes die before uniting with gametes of other species, or gametes fail to unite.



2. Post-zygotic Barriers

- Hybrid inviability: Hybrid zygotes fail to develop or fail to reach sexual maturity.
- Hybrid sterility: Hybrid fails to produce functional gametes.
- Hybrid breakdown: Offspring of hybrids are weak or infertile.

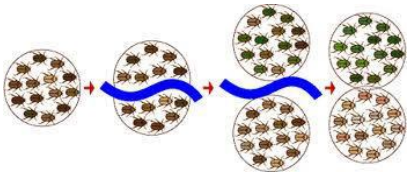


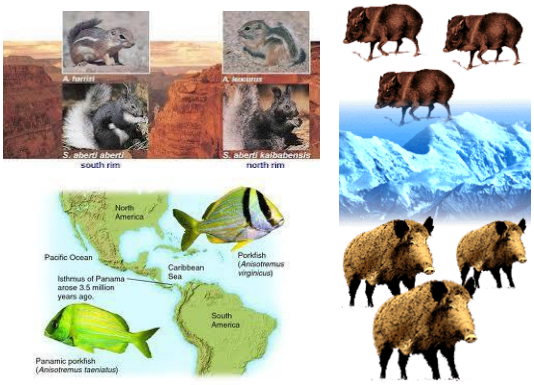
The mighty Liger: https://www.youtube.com/watch?v=1zOWYj5_BXI

Allopatric Speciation

- Induced when the ancestral population becomes separated by a geographical barrier.
- Example:

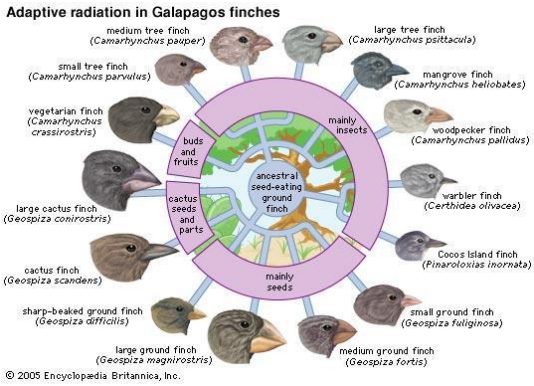
Grand Canyon and ground squirrels





Adaptive Radiation

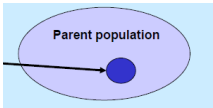
- Emergence of numerous species from a common ancestor introduced to new and diverse environments.
- Organisms radiate to fill "niches"—an organism's "role" in the environment
  - Less competition!
  - Example:
    - Darwin's Finches

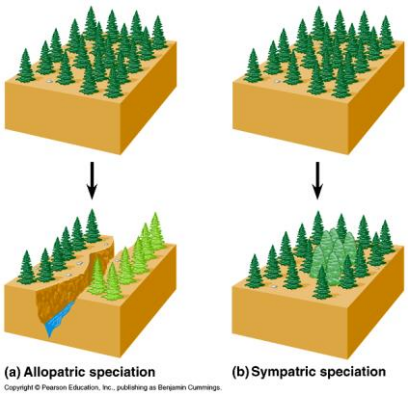


Hawaiian Honeycreepers

Sympatric Speciation

- Result of a radical change in the genome that produces a reproductively isolated sub-population within the parent population (rare).
  - Example: Plant evolution - polyploid
- A species doubles it's chromosome # to become tetraploid.
  - Autopolyploid: all chromosomes come from the same species
  - Allopolyploid: created by hybridization events

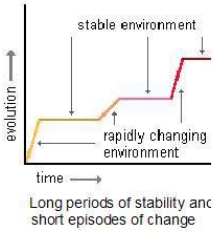


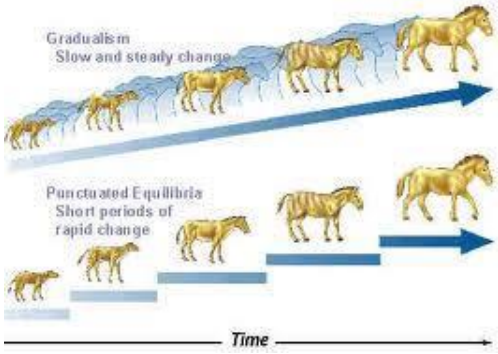


Interpretations of Speciation

Two theories:

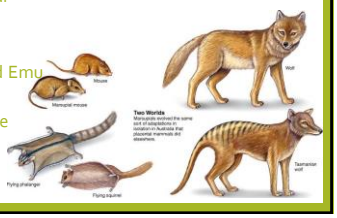
1. Gradualist Model (Neo-Darwinian): Slow changes in species overtime.
2. Punctuated Equilibrium: Evolution occurs in spurts of relatively rapid change.





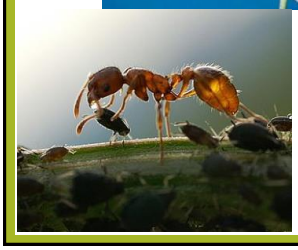
Convergent Evolution

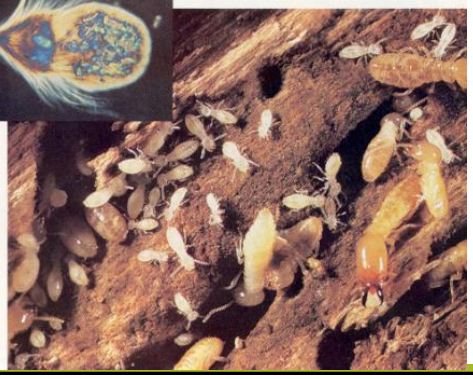
- Species from different evolutionary branches may come to resemble one another if they live in very similar environments: "Ecological equivalents"
- Example:
  1. Ostrich (Africa) and Emu (Australia).
  2. Sidewinder (Mojave Desert) and Horned Viper (Middle East Desert)

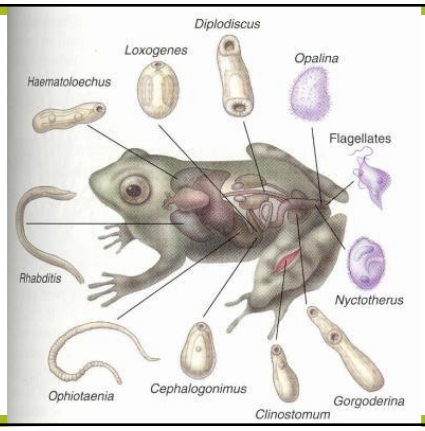


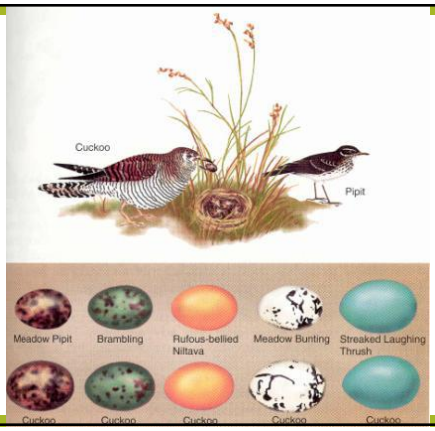
Coevolution

- Evolutionary change, in which one species act as a selective force on a second species, inducing adaptations that in turn act as selective force on the first species.
- Example:
  1. Acacia ants and acacia trees
  2. Humming birds and plants with flowers with long tubes









Overall, what does evolution DO?

- Different organisms with different roles in the environment
- Roles make organisms more suited to a specific *niche*
- Specific niches means more interactive, dynamic environment!

Questions?