Evolution Notes: Part I

What is Biological Evolution?

Simply put, biological evolution is ***descent with modification***, which includes:

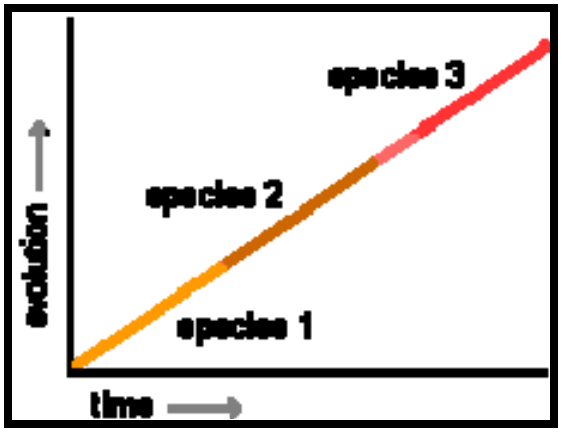
- ***small-scale evolution:*** changes in gene frequency in a population from one generation to another
- **large scale evolution:** the descent of different species from a common ancestor over many generations.

The central ideas of evolution are that life has:

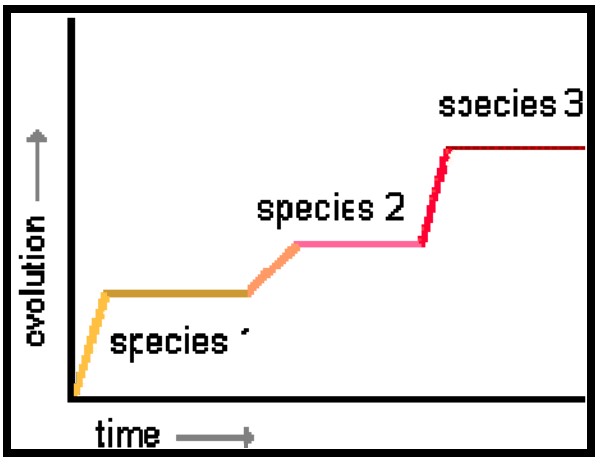
- *a history*
- *changed over time*
- *different species share common ancestors.*

Scientists are in disagreement on the rate at which evolution as occurred.

Gradualism: Evolution is a series of gradual long-term changes that occur over time, species evolve at an even or steady pace (see diagram below).

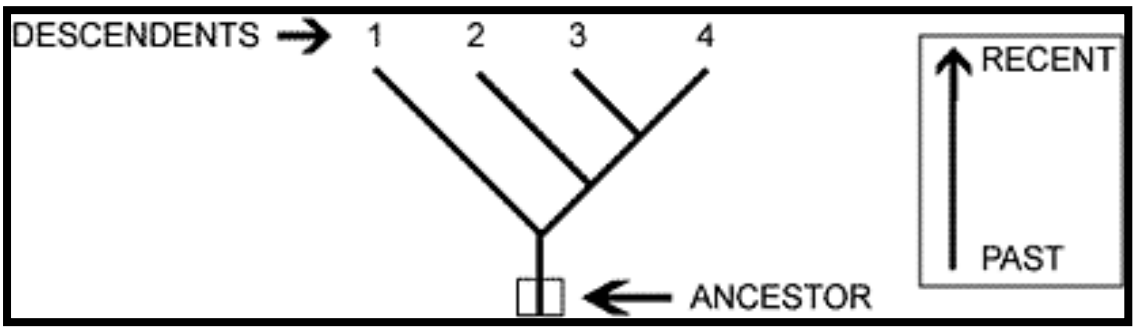


Punctuated Equilibrium: Species enjoy relatively long periods of little change punctuated with very rapid major change resulting in the development of new species (speciation).



Cladograms or Evolutionary Trees

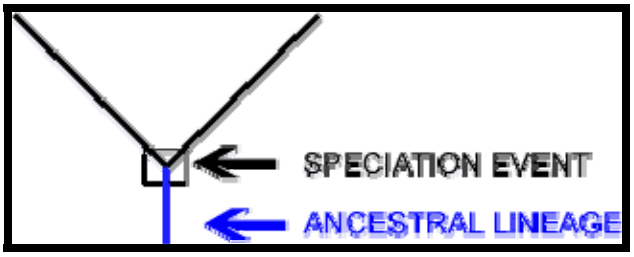
Cladograms or evolutionary trees illustrate the relationships between divergent species by classifying species based on common ancestry.



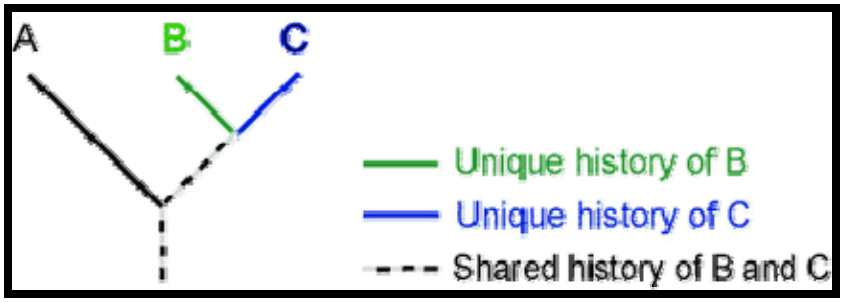
- The root of the "tree" is the common ancestor
- As you move from the root to the tips of the branches, you are moving forward in time
- The tips of the branches represent the descendents of the common ancestor and are the species that currently exist in the modern world.

Speciation: evolutionary process by which new species arise

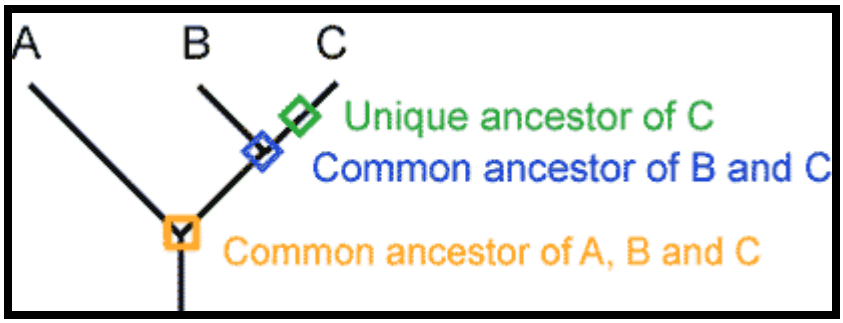
- When speciation occurs, it is represented as branching on an evolutionary tree
- When a speciation event occurs, the single ancestral lineage gives rise to two or more daughter lineages (2 or more species).



- Evolutionary trees trace patterns of shared ancestry between lineages (species).
- Each species has a part of its history that is unique to it alone and parts that are shared with other species.

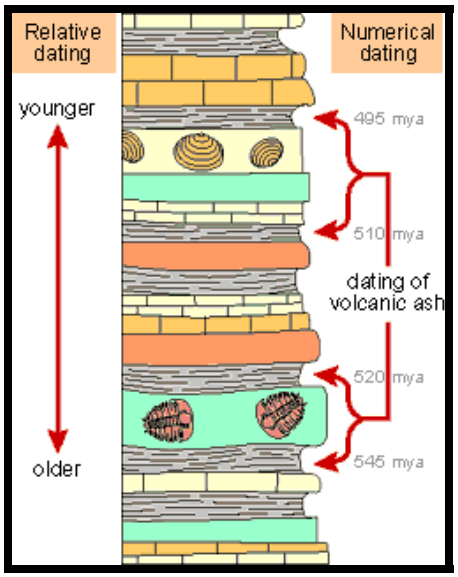


- Similarly, each lineage has ancestors that are unique to that species and ancestors that are shared with other lineages



Evidence of Evolution:

1. **Fossils:** the remains or evidence of any organism that once lived on Earth.
   - The fossil record indicates that organisms existed over 3 billion years ago.
   - Fossil can be:
     --***preserved in amber*** (whole insects preserved in tree sap)
     --***preserved in ice*** (woolly mammoths)
     --***preserved in tar*** (Le Brea tar pits, woolly mammoths and saber tooth tigers)
     --***petrifaction*** (minerals replace the structures of the organism and turn to stone – petrified wood)
     --***molds***(organism shapes preserved in rock as a hollow form)
     --***casts*** (reverse of a mold – mold can be filled later to form the cast of the fossil)
     --***imprints*** (impressions of organisms such as a dinosaur foot hardened in mud)
     --***preservation in sedimentary rock***
     Comparison of layers of sedimentary rock evidence links between modern and ancient forms of fossils as well as deviation (speciation) from common ancestors. The upper undisturbed layers generally contain fossils that are more complex (younger fossils) while the lower layers contain simpler, older fossils.



In the older, bottom layers are the trilobites, ancient ancestors to the clam fossils found in the upper layers of this sedimentary rock illustration.

2. Comparative Cytology

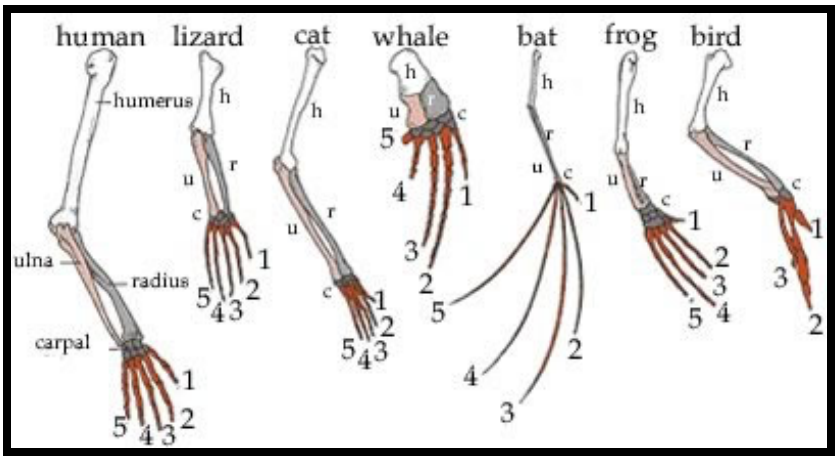
- The cell is the unifying structure for all living organisms
- Organelles (the small structures of the cell) such as the cell membrane, mitochondria, and ribosomes structurally and functionally similar in most divergent organisms.

3. Comparative Biochemistry

- The more similar two organisms are in their DNA, enzymes, proteins, and other substances of the body, the greater the chance they share a common ancestor.

4. Comparative Anatomy

- ***Homologous structures***: anatomical parts that are similar in structure and origin, but have different functions.



- Homologous structures are evidence of common ancestry.

5. Comparative Embryology

- Early embryos resemble one another. As development continues, the distinct traits of each

species becomes visible.

- Comparison of early embryonic development among groups of organisms evidences similarities, suggesting common ancestry.