Life Sciences 11
How Species Are Determined

Learning Outcomes:

- **I can state the biological species definition.**
- **I can describe the 3 pieces of evidence used when classifying organisms.**
- **I can identify ancestral and derived characteristics on a cladogram.**

As our level of knowledge changed over the years, the way that different species were identified has changed.

The Species Concept

1. Typological Species Concept
   - used by Aristotle and Linnaeus
   - grouped organisms based on physical similarities
   - did not allow for organisms changing over time or variations that can be seen within a group (ex: pepper moth)
   - no longer in use

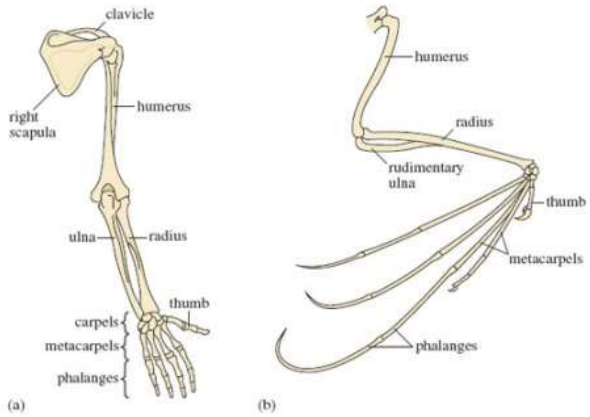
2. Biological Species Concept (1930/40's)
   - defined a species as a group of organisms that are able to interbreed and produce fertile offspring in a natural setting
   - most commonly used definition of species
   - limitations:
     - some different species are able to interbreed and produce fertile offspring (wolves and dogs; lions and tigers)
     - does not account for extinct species
     - does not account for species that reproduce asexually

3. Phylogenetic Species Concept (1940's)
   - used with the Biological Species Concept
   - takes into account ancestry (evolutionary history) so it can be used for extinct organisms
   - limitations
     - Not all evolutionary histories are known

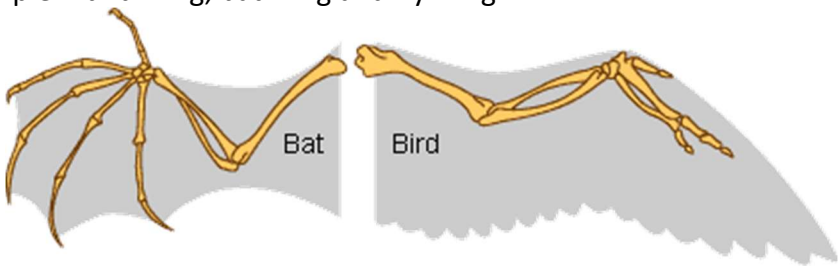
How do new species get classified?

1. Morphological Characters
   - looks at the physical similarities between species
   - Homologous Structures
     - structures from different species that have similar internal form but may have different functions

- anatomical similarities indicate a shared ancestry
- example – human hand and a bat wing



- Analogous Structures
  - structures from different species that have the same function but have different internal form
  - evolved separately to provide the same function – no shared ancestry
  - example – bird wing, bat wing and fly wing



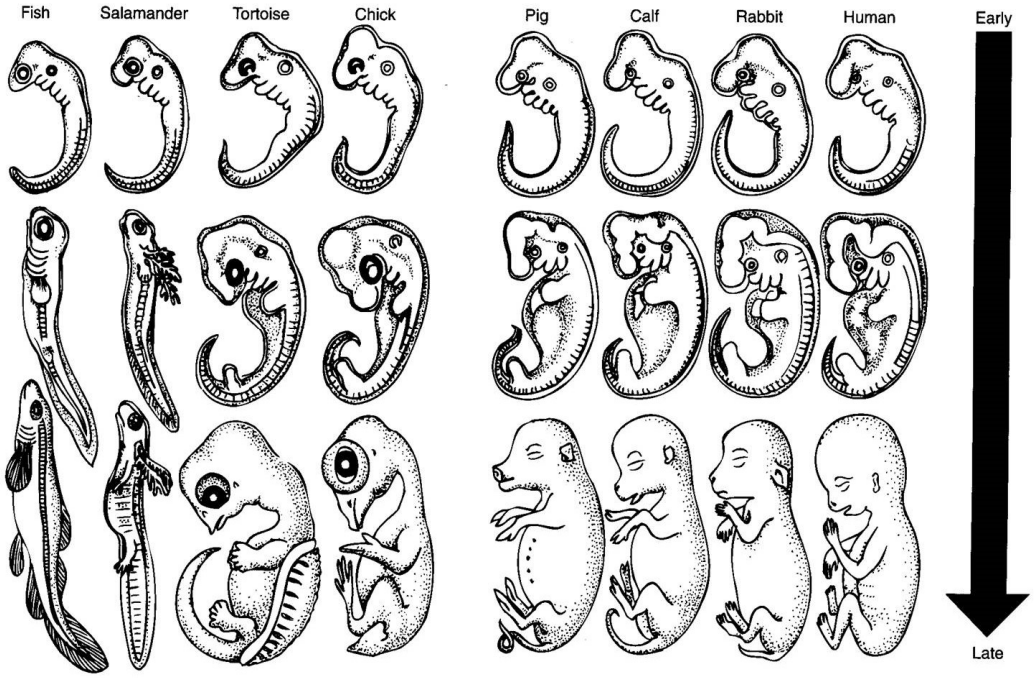
- Vestigial Structures
  - structures in one species that is smaller or less functional than in a closely related species
  - in terms of evolution, structures that no longer have a function in a species will become smaller over time and may eventually be lost
  - example – snake pelvis, human tail bone

2. Comparative Biochemistry
   - compares amino acids and DNA/RNA nucleotide sequences between species to determine evolutionary relationships
   - two species that have similar numbers and structure of chromosomes are more closely related than two species that have very different numbers and structure of chromosomes
   - comparing human DNA to:
     - Humans 99.5% (maximum difference)
     - Chimpanzee 97%

- Cow 80%
- Chicken 60%
- Banana 50%

- can link species that appear different morphologically (ex: broccoli and kale)

3. Comparative Embryology
   - the closer two different species are to having a common ancestor, the more similar the development of their embryos are
   - embryos develop homologous structures that develop into different adult structures
   - the ability of certain genes to turn off during development and other genes to turn on accounts for this
   - example – pharyngeal pouches in fish embryos (gills) compared to reptile, bird and mammalian embryos (parts of ears, jaws, and throat)



4. Geographic Distribution
   - plants and animals are more related to organisms on the same continent than they are to organisms on other continents
   - organisms on different continents may appear similar due to similar environmental selection pressures → convergent evolution
     - does not mean they are closely related
   - example:
     - marsupial animals on Australia are closely related to each other
     - Thylacine (marsupial wolf) and Gray wolf (mammal) are not closely related even though they have similar traits