Taxonomy/phylogeny

1) Taxonomy
   a) **Taxonomy** is a system of naming and grouping species.
      i) Taxonomy is part of the larger science of **systematics** which looks at variation among animal populations to reveal evolutionary relationships.
   b) Aristotle was the first to truly start classifying organisms based on their structural similarities.
   c) However it wasn't until the eighteenth century that **Carolus Linnaeus** produced our current system of classification.
      i) He used **Morphology**, the study of organismal form, to arrange organisms into groups.
      ii) He used a hierarchical system to classify species. Though his was more simplistic than what is currently used the basic properties are still there.
         (1) Taxonomic categories from most broad to most specific:
            (a) Domain
            (b) Kingdom
            (c) Phylum
            (d) Class
            (e) Order
            (f) Family
            (g) Genus
            (h) Species
               (i) * note* many of these groups have sub groups to further distinguish groups (e.g. subclass, subphylum, etc…)
      iii) Linnaeus's system for classification came down to the **binomial nomenclature**. Each species has a two word name (a genus and species). These are typically always written in Latinized name so that they can be universally used by all scientists around the world. (e.g. *Callinectes sapidus* (blue crab, translates to "tasty beautiful swimmer"), *Homo sapiens* (humans, translates to "wise man"), *Tyrannosaurs rex* (t-rex, translates to "tyrant lizard"), etc…)
2) Species
   a) What actually defines a species is not as clear as it would seem, scientist have been debating this concept for over 140 years now. What we do agree on is:
      i) **Common descent** is essential. Member of a species must trace their ancestry to a common ancestral population.
      ii) a species must be the smallest grouping or organisms sharing ancestry and descent. Usually this has been done with morphology, however recent advances in genetics have allowed for better resolution.
      iii) They must occupy a specific ecological niche and form a distinct reproductive community.
         (1) Every species has a distinct geographic range and time scale. Species that are spread worldwide are **cosmopolitan** (large mouth bass) while species who have a restricted range are called **endemic** (Etowah Darter).

3) Phylogeny

a) The goal of taxonomy and systematics is to form an evolutionary tree called a **phylogeny.**
    i) Phylogenies are constructed by studying characteristics that species share. Characteristics can be morphology, DNA, or other molecular features.
    ii) Species that share similar characteristics that result from a common ancestor is called **homology.**
        (1) Feathers in birds
    iii) However, not all traits come from a common ancestor, they evolved independently. This is called **Analogy**.
        (1) Wings in bats and birds
        (2) Compound eyes in mammals and cephalopods
b) Construction of a phylogenetic tree
    i) The most widely used method of systematics is **cladistics**.
        (1) Cladistics used common traits to group ancestral species and descendants into **clades**.
        (2) This is based on the common descent idea that animals share some traits with ancestors but also differ in some distinctive way.
            (a) So for mammals a backbone is a **shared ancestral character** that originated in an ancestor to all vertebrates.
            (b) Hair however, a trait of mammals but not of any other vertebrate, is a **shared derived character**. These characteristics distinguish clades and represent branching points in the tree of life.
    ii) Phylogenetic trees represent hypotheses for how species are related. As more fossils are found and technology in genetics improves trees are changing to account for new evidence.
        (1) When creating these hypothesis scientists rely on a concept of **parsimony.** Parsimony tells us that the simplest explanation is the most likely.
            (a) Parsimony tells us that the beaver is more related to a kangaroo than a platypus because embryo development is internal in the kangaroo and beaver and not the platypus.
                (i) It is possible that internal gestation evolved independently in kangaroos and beavers but this is far more complicated and thus less likely.
            (b) Each phylogenetic tree allows us to test this hypothesis.
                (i) A few years ago birds were on their separate clade and reptiles were in their own clade, but when scientist tested this hypothesis they could not find a common ancestor for the split of the birds clade. What they did find were common ancestors with dinosaurs (dinosaurs are reptiles) and an even older common ancestor for dinosaurs and birds that connects them to modern reptiles.
                (ii) Now genetics is testing trees and looking for homologous genes.
                    1. When comparing the genome of humans we share homologous genes 99.6% with chimpanzees, 99% with mice, and 50% of human genes are shared with those of yeast. This gives support to the decent with modification ideas of Darwin.

4) Major divisions of life

a) There are three domains that contains all life on earth
   i) Archaea – group of single celled organisms, many are extremophiles (they live in conditions like around thermal vents, very salty areas, acid, and in glaciers.
   ii) Bacteria- single celled organisms with a specialized cell wall lacking membrane bound organelles.
   iii) Eukarya- can be multi cellular, have membrane bound organelles, cytoskeletons.
b) Eukarya kingdoms
   i) Protista
   ii) Plantae
   iii) Fungi
   iv) Animalia
      (1) Tree of Animalia