



Chapter 25 – Phylogeny & Systematics

Phylogeny

- The evolutionary history of a species
- Systematics:** the study of biological diversity in an evolutionary context; study morphological and biochemical relationships of present-day and extinct species
- Molecular Systematics:** uses comparisons of DNA, RNA, and other macromolecules to infer evolutionary relationships between genes and genomes



The Fossil Record

- The ordered array of fossils, within layers or strata, of sedimentary rock
- Help to determine phylogeny but only if age can be determined
- Paleontologists – study fossils



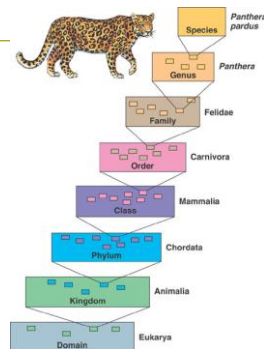
Morphological and Molecular Homologies

- Organisms that share very similar morphologies (both structural and molecular) or similar DNA sequences are likely to be more closely related than those with different structures or sequences.
- Must sort out analogy from homology. Convergent evolution can produce very similar organisms. It is critical to identify these relationships to reconstruct accurate phylogenies.



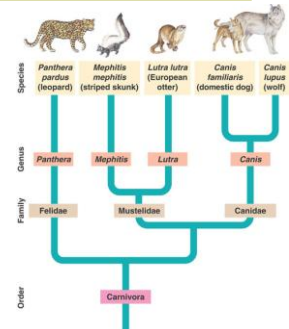
Taxonomy

- An ordered subdivision of organisms into categories based on a set of characteristics used to assess similarities and differences.
- Linnaeus
- Binomial nomenclature – Genus and specific epithet (species)
- Names are *latinized*



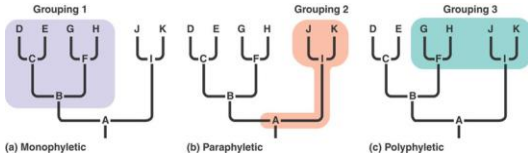
Classification and Phylogeny

- Phylogenetic trees – branching diagrams used to depict evolutionary relationships
- Constructed from a series of dichotomies (2-way branch points) where each branch point represents the divergence of two species from a common ancestor
- “Deeper” branch points represent more divergence



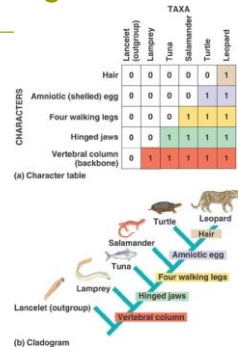
Systematics

- Cladistics - the analysis of how species may be grouped into clades
- Cladogram – forms the basis of a phylogenetic tree, but not a phylogenetic tree
- Clade – a group of species that includes ancestral species and all of its descendants
 - Monophyletic – consists of the ancestral species and all descendants
 - Paraphyletic – consists of an ancestral species and some of the descendants
 - Polyphyletic – grouping of several species that lack a common ancestor



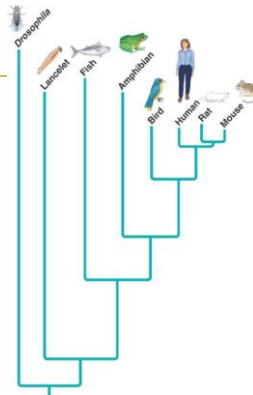
Constructing a Cladogram

- Shared primitive character** – shared beyond the taxon under definition (backbone in mammals)
- Shared derived character** – unique to a particular clade (hair in mammal clade)
- Must designate an outgroup, species closely related to the ingroup, the species under study
- Use various homologous structures to define groups, must predate the divergence of both the outgroup and ingroup
- Construct a cladogram using the following organisms: lamprey, leopard, tuna, lancelet, turtle, salamander. Include the characteristic that separates each clade from its outgroup.



Phylogenetic Trees

- Phylograms** – length of a branch reflects the number of changes that have taken place in a particular DNA sequence in that lineage
- Example – used *Drosophila* genes using *Drosophila* as the outgroup to show the evolution of the gene



Phylogenetic Trees

- Ultrametric trees** – same as a phylogram, but shows chronological time as compared to rate of evolution

