PHYLOGENY AND THE TREE OF LIFE

Objectives

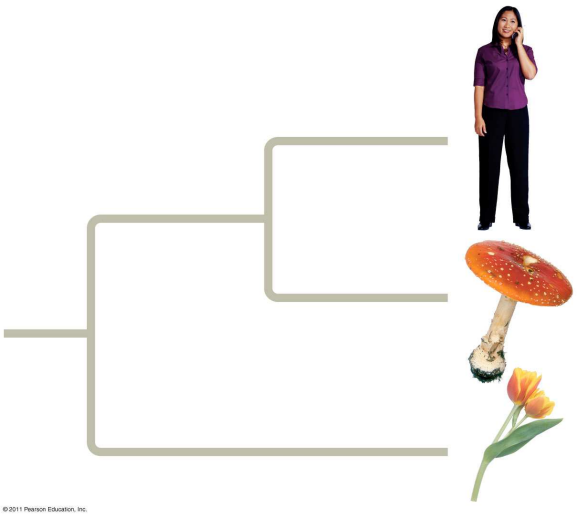
1. Define systematics, taxonomy and phylogeny.
2. Correctly name a species.
3. List the levels of biological organization.
4. Interpret phylogenetic trees.
5. Describe how phylogenetic trees are created.
6. Describe the discoveries regarding life derived from phylogenetics.

Outline

A. Classification
   1. Species Names
   2. Classification Levels
   3. Phylogenetic Trees
B. Inferring Phylogenies
   1. Constructing Phylogenies
   2. Clades
C. Discoveries From Phylogenetics

A. Classification

- Systematics
  - Grouped on similarity
    - Subdivided on greater similarities
- Taxonomy
- Phylogeny

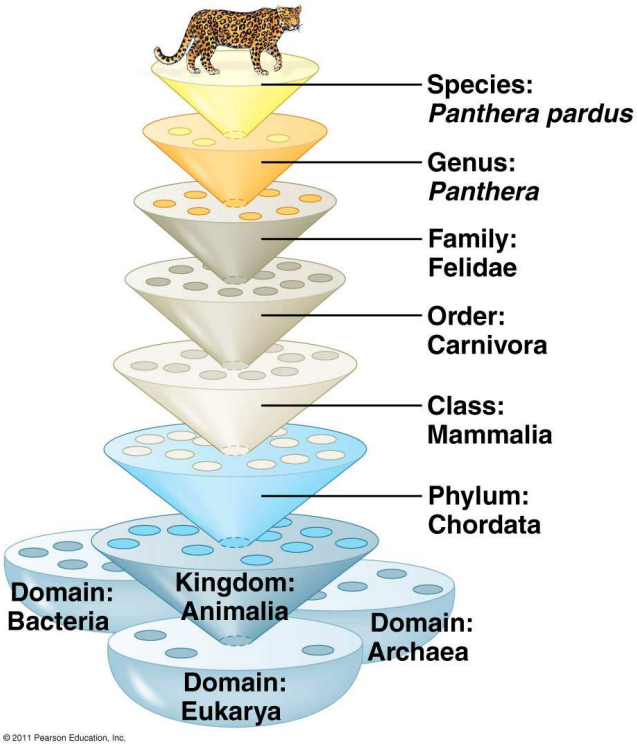


1. Species Names

- Developed by Carolus Linnaeus
- Genus
- specific epithet
- Species

2. Classification Levels

- Levels of Organization
  - Species
  - Genus (Genera)
  - Family
  - Order
  - Class
  - Phylum (animals)
    - Division (everything else)
  - Kingdom
  - Domain

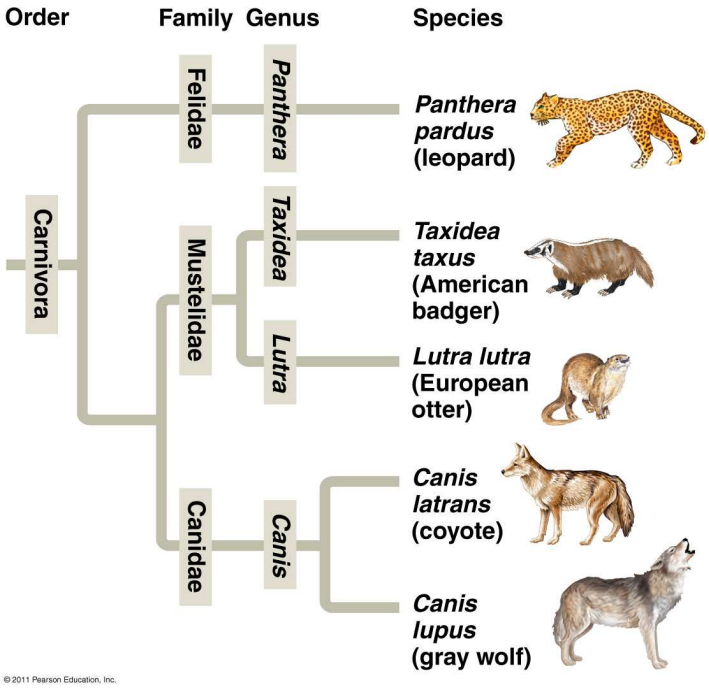


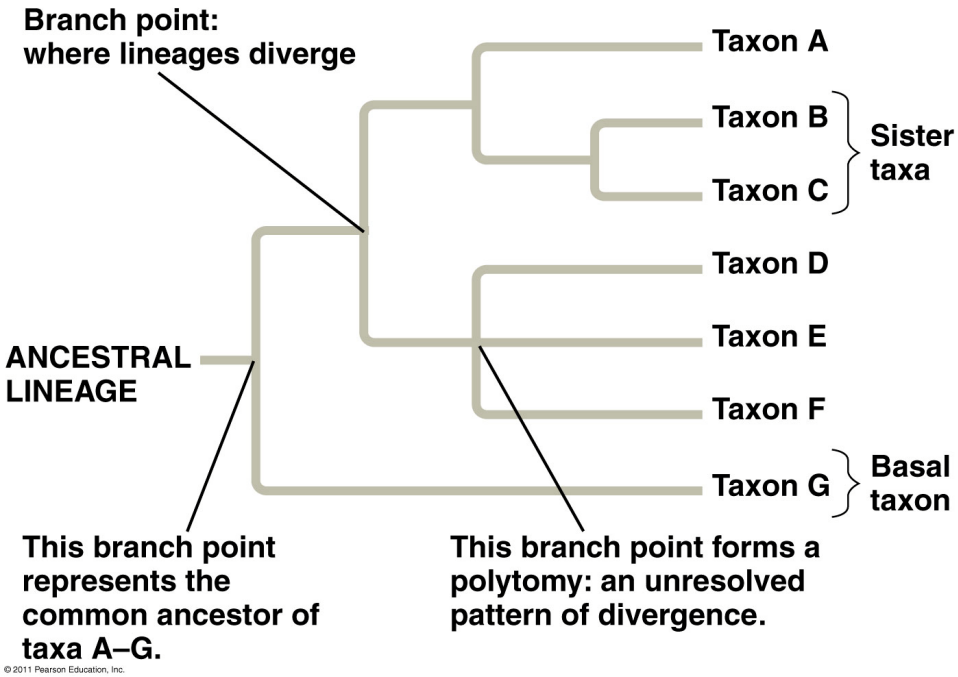
- Taxon (taxa)
  - Subdivided by prefixes
    - Super
    - Sub

	Gray Wolf	**Kentucky Bluegrass**	**Ergot**	**E. coli**
Domain	Eukarya	Eukarya	Eukarya	Bacteria
Kingdom	Animalia	Plantae	Fungi	Eubacteria
Phylum (Division)	Chordata	Anthophyta	Ascomycota	Proteobacteria
Class	Mammalia	Monocotyledones	Pyrenomycetes	Gammaproteobacteria
Order	Carnivora	Cyperales	Clavicipitales	Enterobacteriales
Family	Canidae	Graminiae (Poaceae)	Clavicipitaceae	Enterobacteriaceae
Genus	*Canis*	*Poa*	*Claviceps*	*Escherichia*
Species	*Canis lupus*	*Poa pratensis*	*Claviceps purpurea*	*Escherichia coli*

3. Phylogenetic Trees

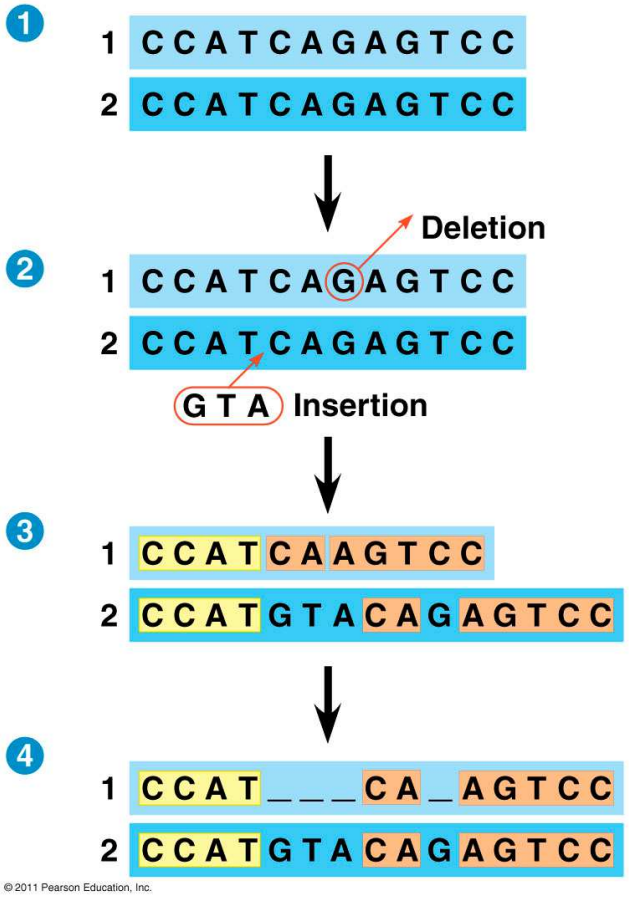
- Based on relatedness
  - Continuously being refined
- Branch points
  - Polytomy
- Line lengths
- Roots
  - Outgroup (Basal Taxon)



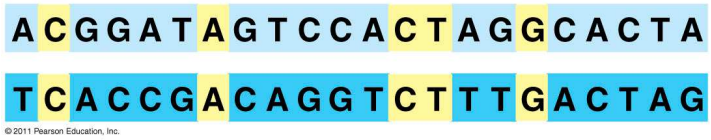


B. Inferring Phylogenies

- Homologous Characteristics
  - Synapomorphies
  - Homoplasies
    - Similar structures derived independently (analogous)
- Occur anatomically and molecularly
- Must judge homology
  - Are structures simple or complex?
  - Does gene make same structure?



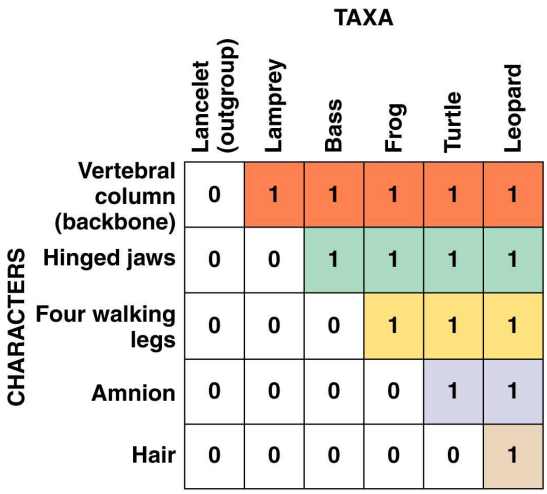
  - Does a large sequence of nucleotides align?



1. Constructing Phylogenies

- Shared Characteristics
  - Ancestral
  - Derived
    - Segregates ingroup from outgroup

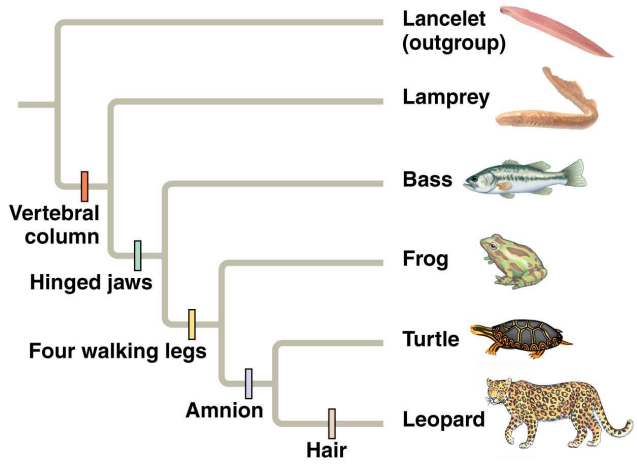
- Assume state changes rare
    - Fewest changes most likely
        - Parsimony
        - Maximum Likelihood



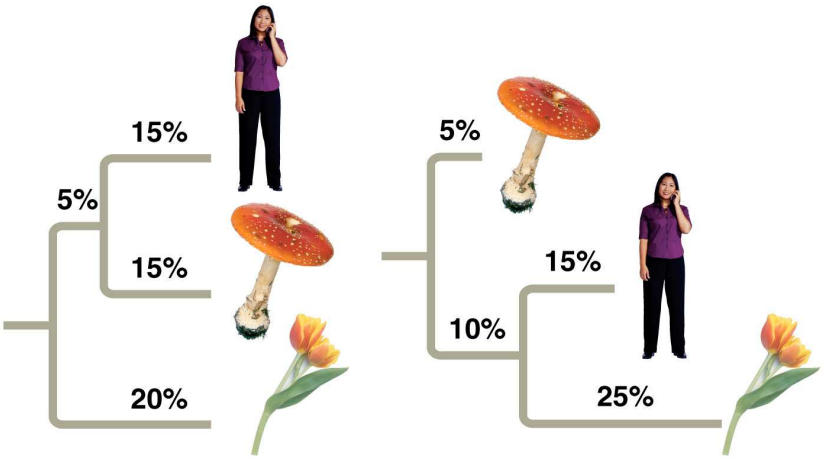
CHARACTERS	Lancelet (outgroup)	Lamprey	Bass	Frog	Turtle	Leopard
Vertebral column (backbone)	0	1	1	1	1	1
Hinged jaws	0	0	1	1	1	1
Four walking legs	0	0	0	1	1	1
Amnion	0	0	0	0	1	1
Hair	0	0	0	0	0	1

TAXA

(a) Character table



(b) Phylogenetic tree



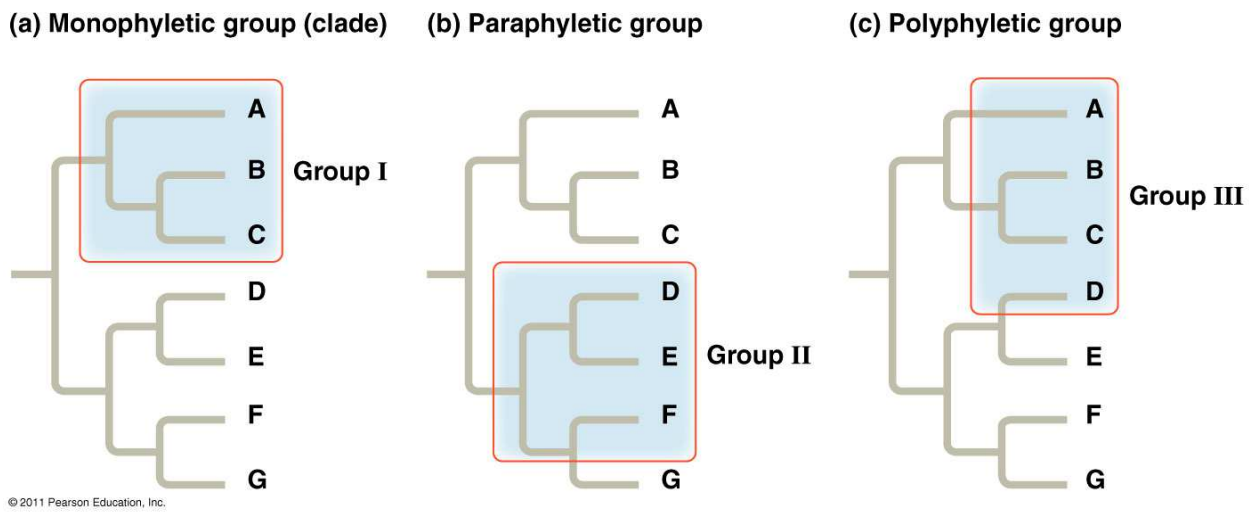
Tree 1: More likely

Tree 2: Less likely

(b) Comparison of possible trees

2. Clades

- Offspring of single ancestor



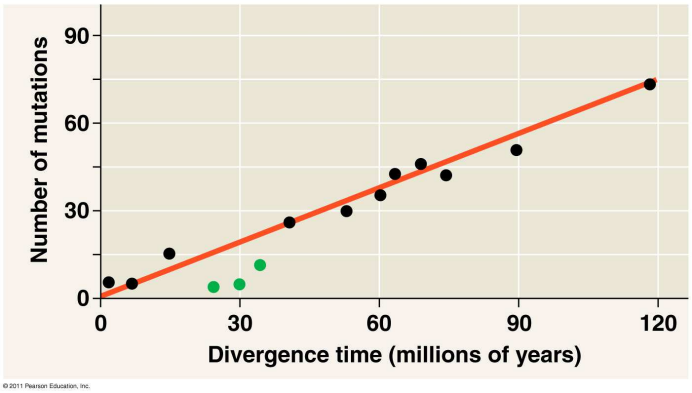
- Monophyletic

- Paraphyletic

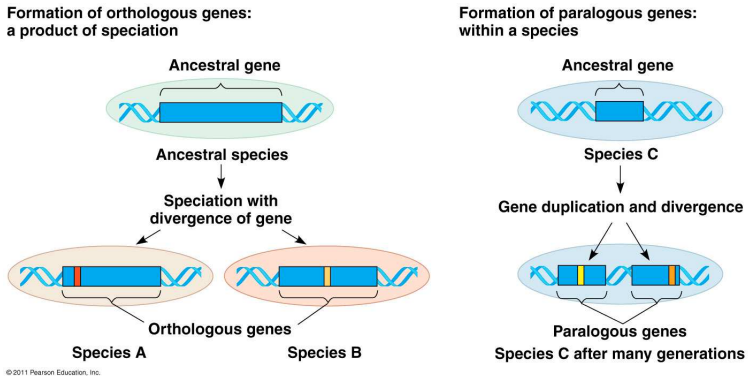
- Polyphyletic

C. Discoveries From Phylogenetics

- Different genes evolve at different rates
  - Molecular clock
    - Depends on neutral mutations
    - Best when tied to fossils



- Genes have duplicated in organisms
  - Orthologous genes
  - Paralogous genes



- Horizontal Gene Transfer

- Three Domains of Life