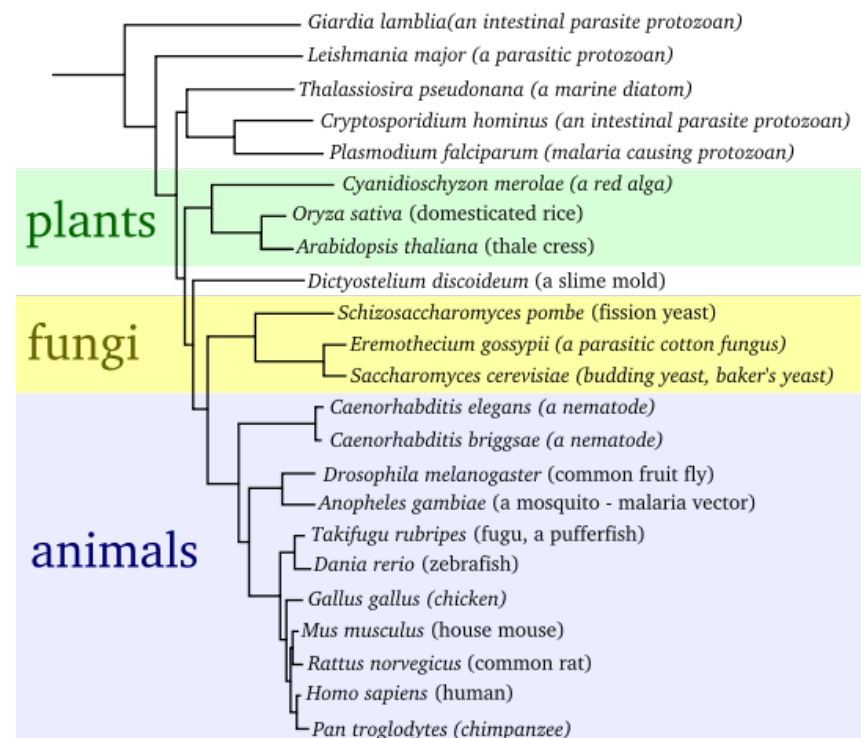


Tree-thinking for Teaching Evolution

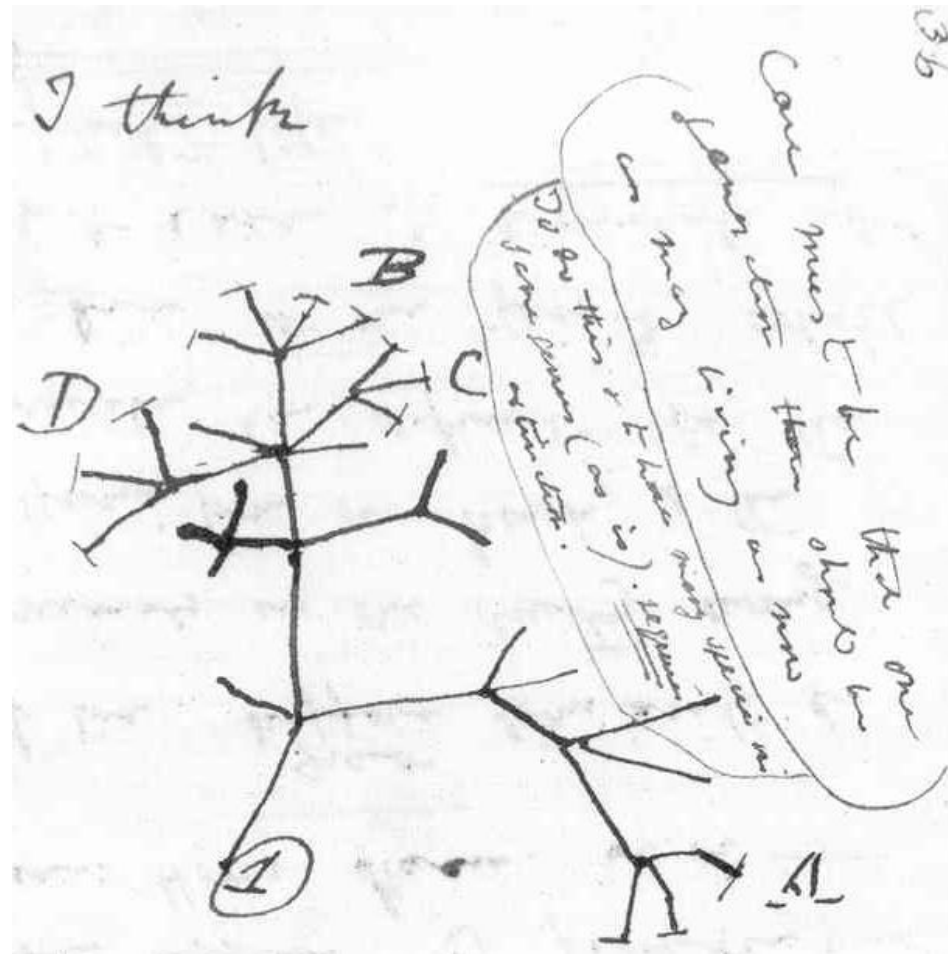
Evolution 2010: A Workshop
for Educators
June 21–23

Tree Thinking

- Phylogenetic trees represent hypotheses about historical relationships



The Origin



From: C. Darwin, 1837

Common Ancestry

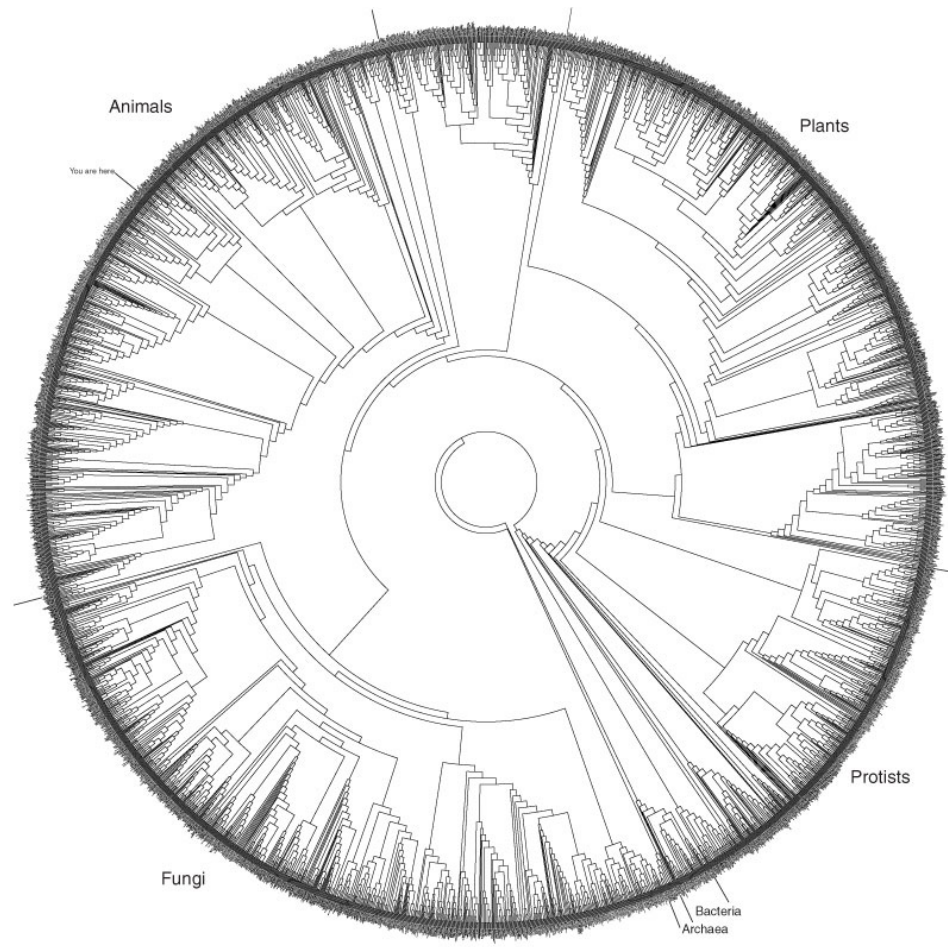
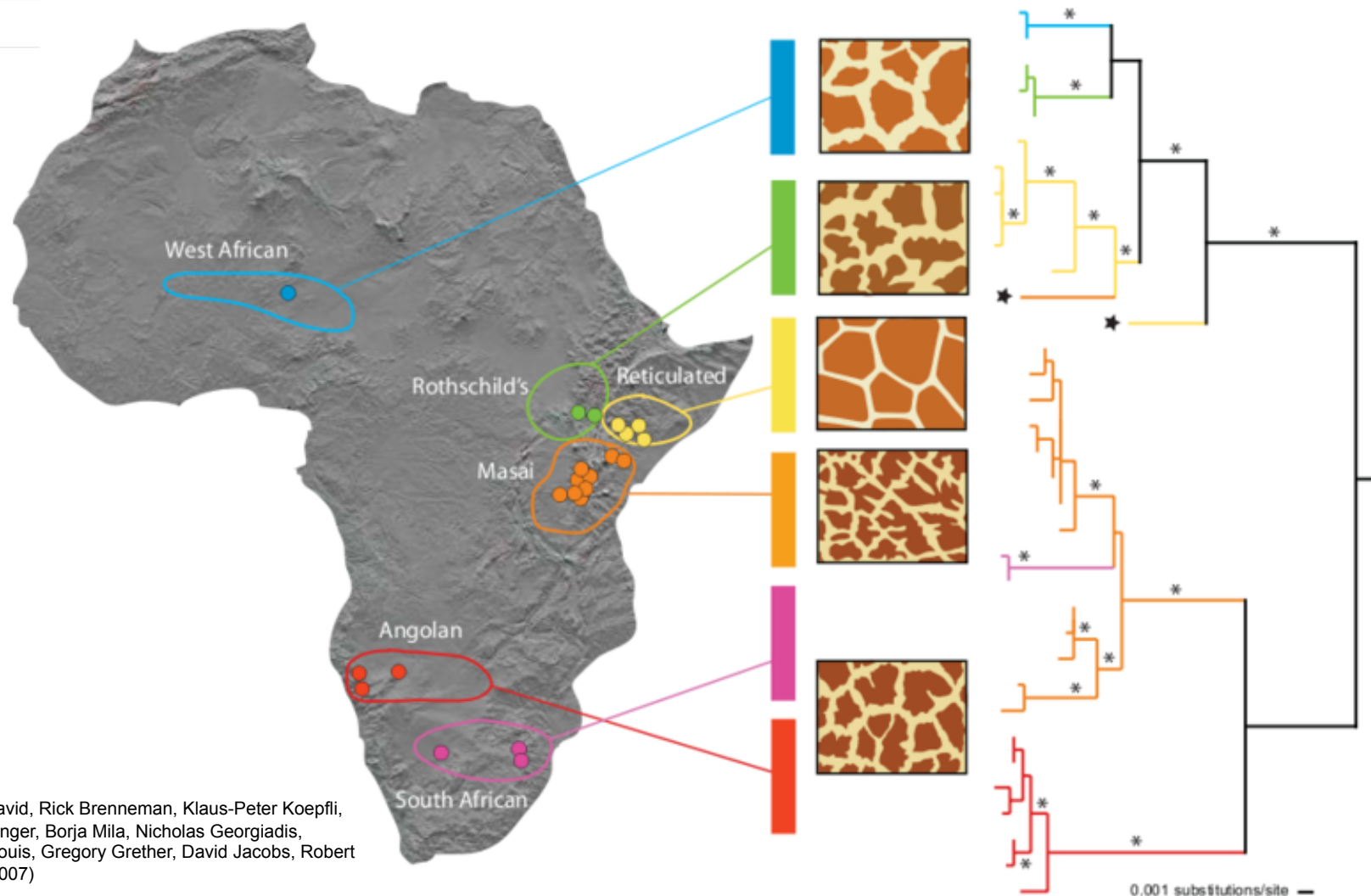


Image: David M. Hillis, Derrick Zwickl, and Robin Gutell, University of Texas

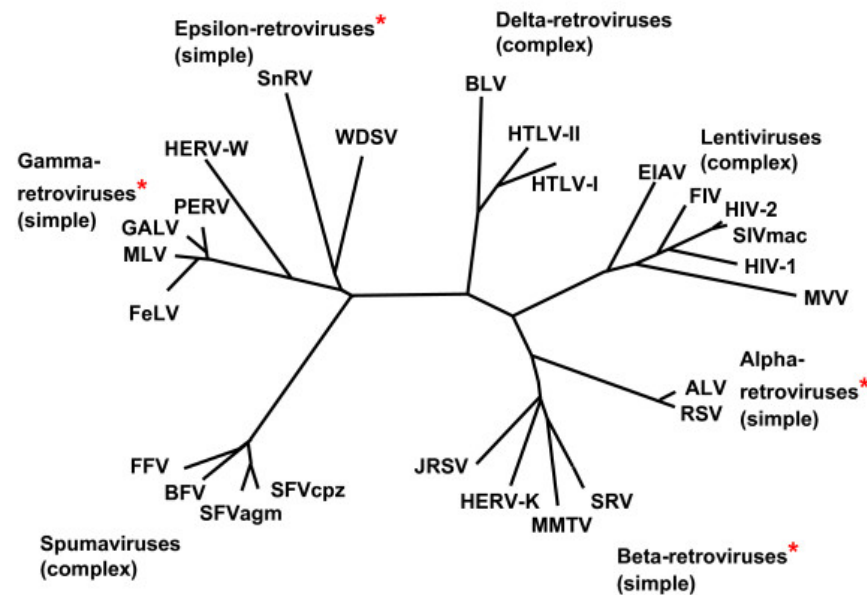
But other information may be included in a tree...



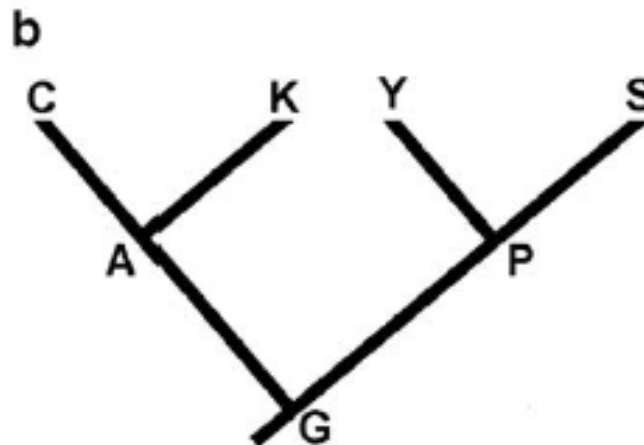
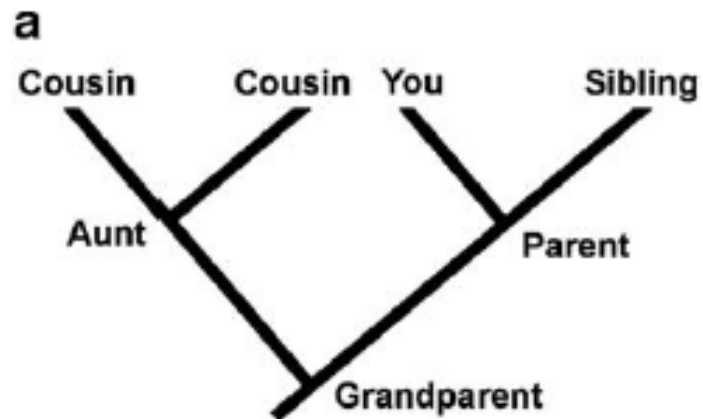
Brown, David, Rick Brenneman, Klaus-Peter Koepfli,
John Pollinger, Borja Mila, Nicholas Georgiadis,
Edward Louis, Gregory Grether, David Jacobs, Robert
Wayne (2007)

...and trees differ.

- Based on what is being analyzed
 - ♦ Species
 - ♦ Genes
- Based on the analytical method
 - ♦ Parsimony
 - ♦ Nearest Neighbor
 - ♦ Bayesian



Map of Relationships



Vocabulary

- Dendrogram: tree diagram
- Cladogram: a phylogeny that shows only branching order
- Phylogram: a phylogeny that shows a measure of divergence

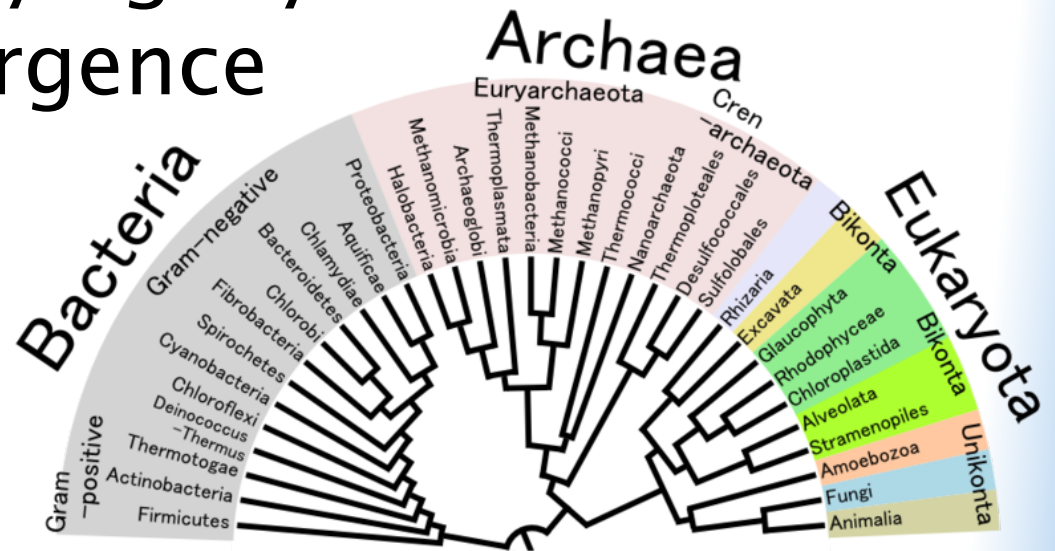
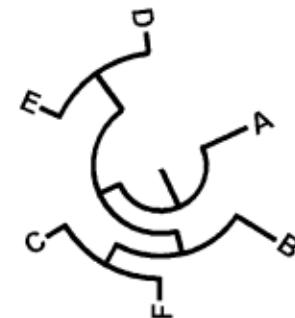
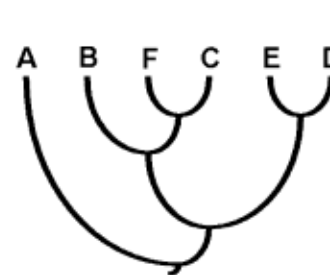
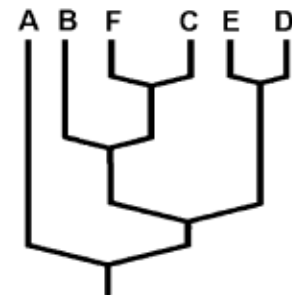
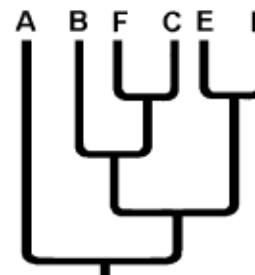
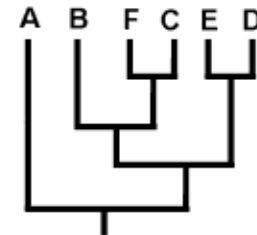
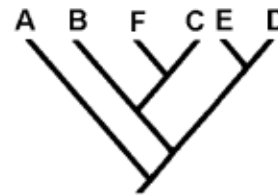


Image: Crion

Reading Trees

- Tips
 - ♦ Typically contemporary species
- Nodes
 - ♦ Genetic isolation
 - ♦ Rotation around the nodes



Reading Trees

- Branches
 - ♦ Acquisition of traits
 - ♦ Divergence

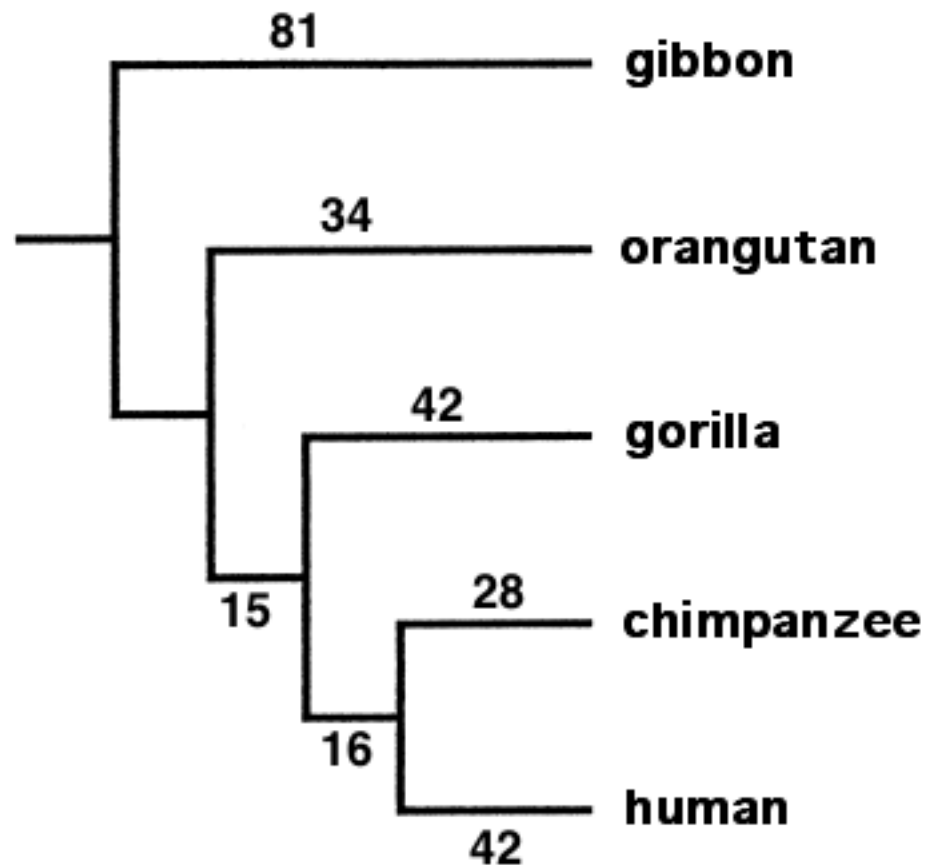
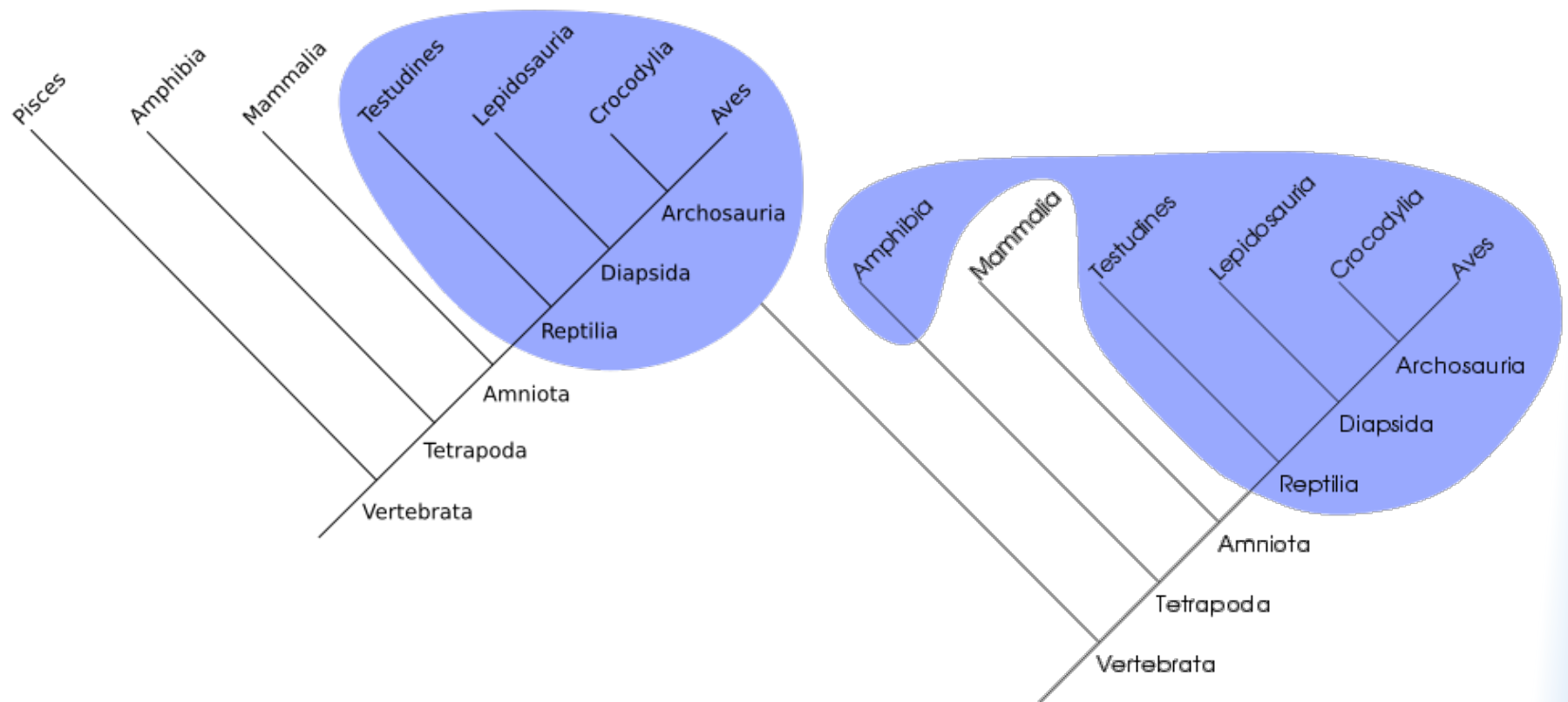
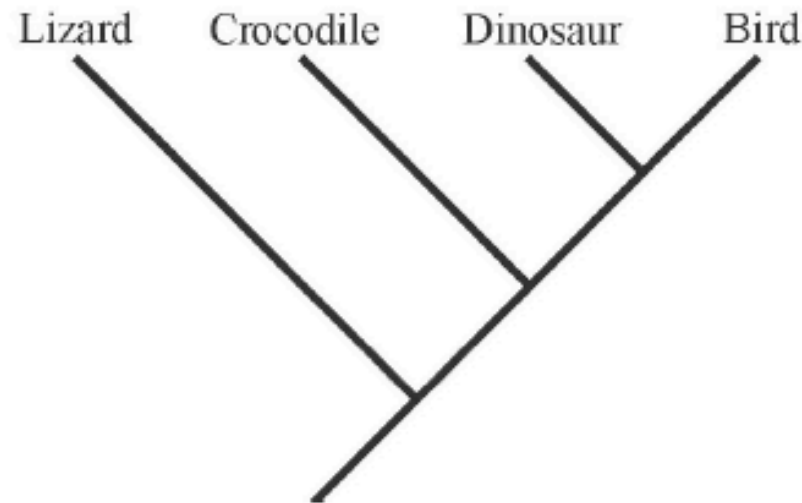


Image: JWSchmidt

Reading Trees

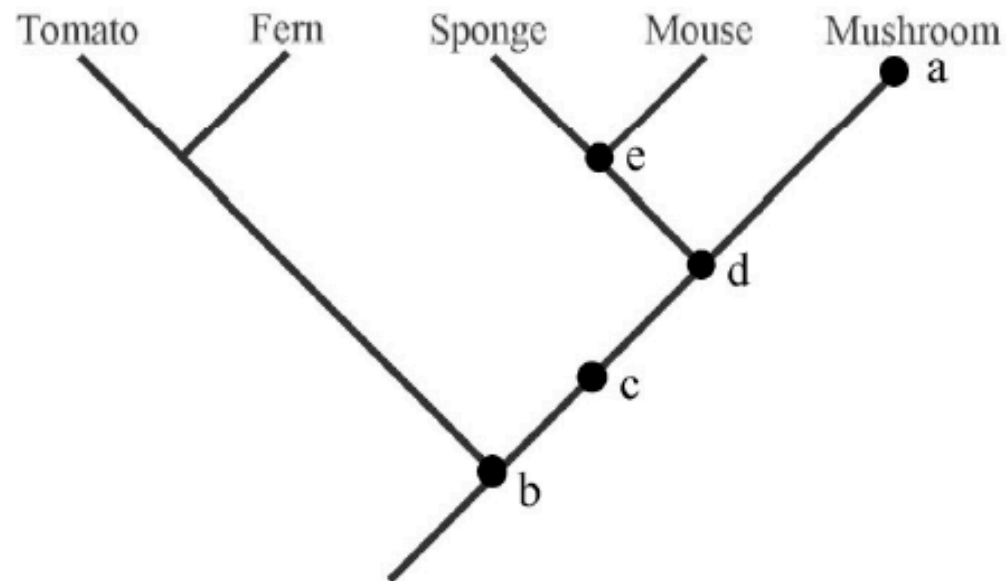
- Clades
 - ♦ Common ancestor and all descendants



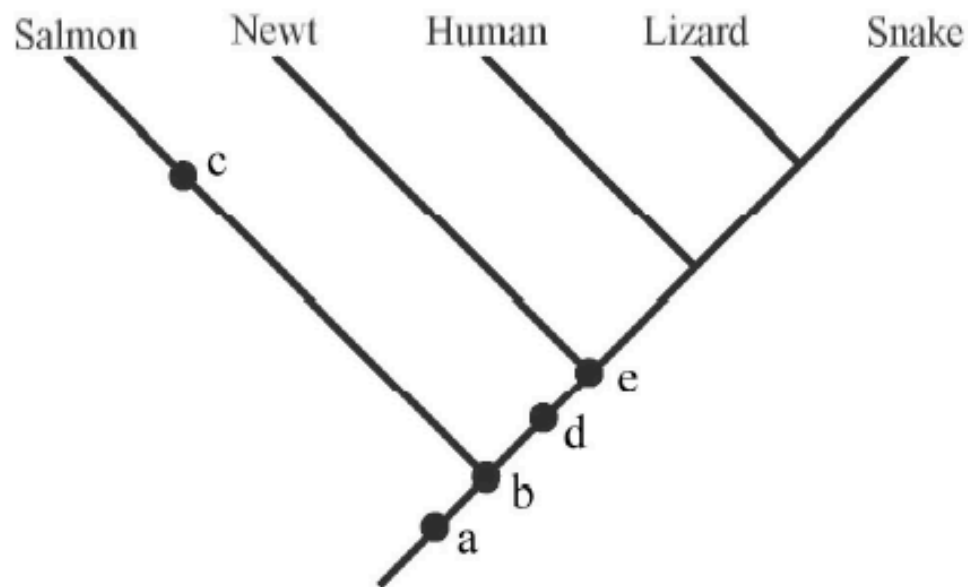


2) By reference to the tree above, which of the following is an accurate statement of relationships?

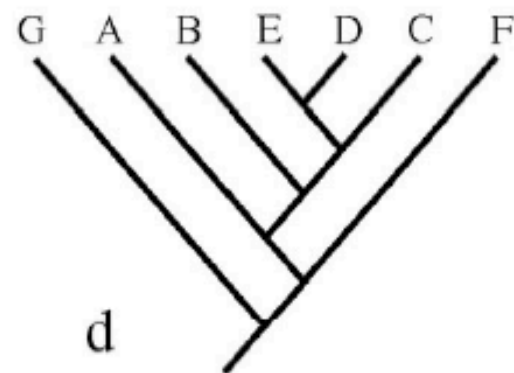
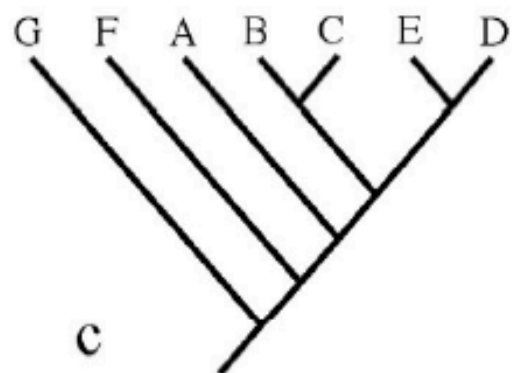
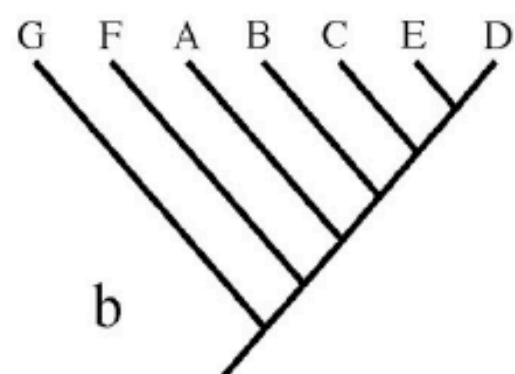
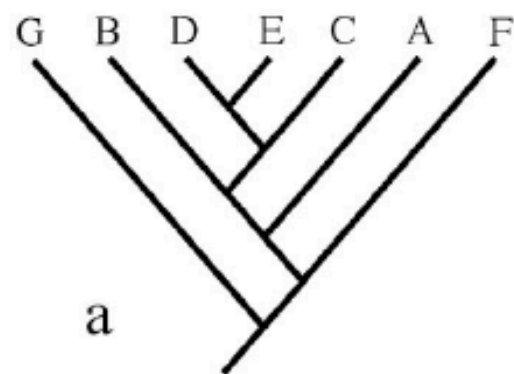
- a) A crocodile is more closely related to a lizard than to a bird
- b) A crocodile is more closely related to a bird than to a lizard
- c) A crocodile is equally related to a lizard and a bird
- d) A crocodile is related to a lizard, but is not related to a bird



4) Which of the five marks in the tree above corresponds to the most recent common ancestor of a mushroom and a sponge?

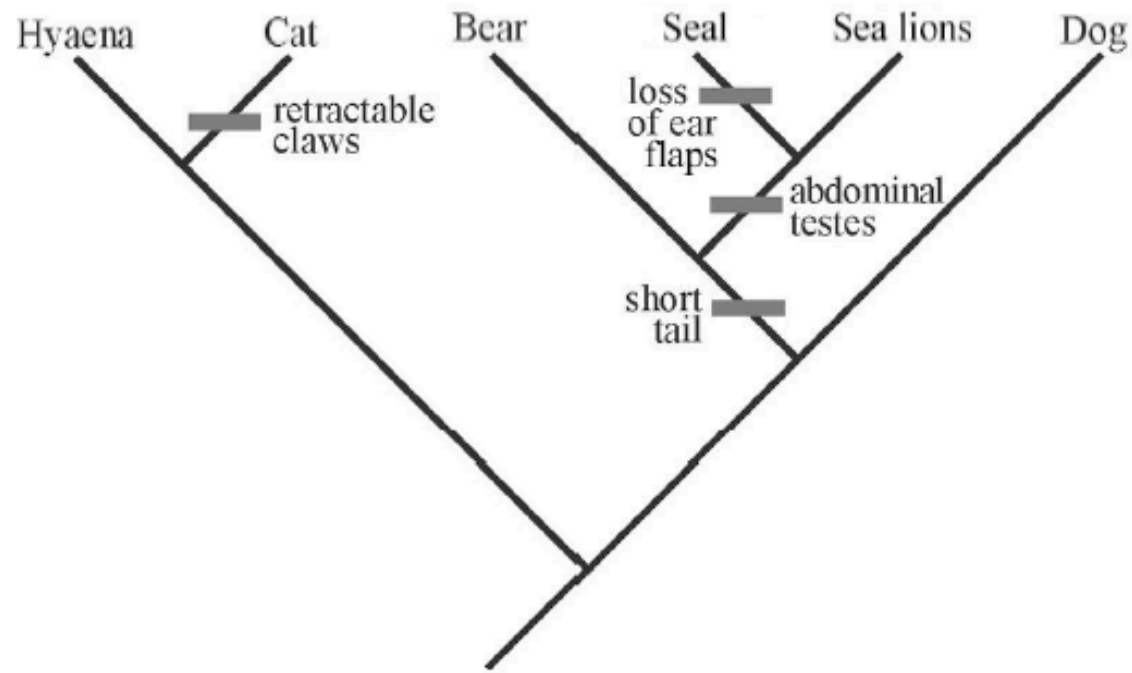


5) If you were to add a trout to the phylogeny shown above, where would its lineage attach to the rest of the tree?



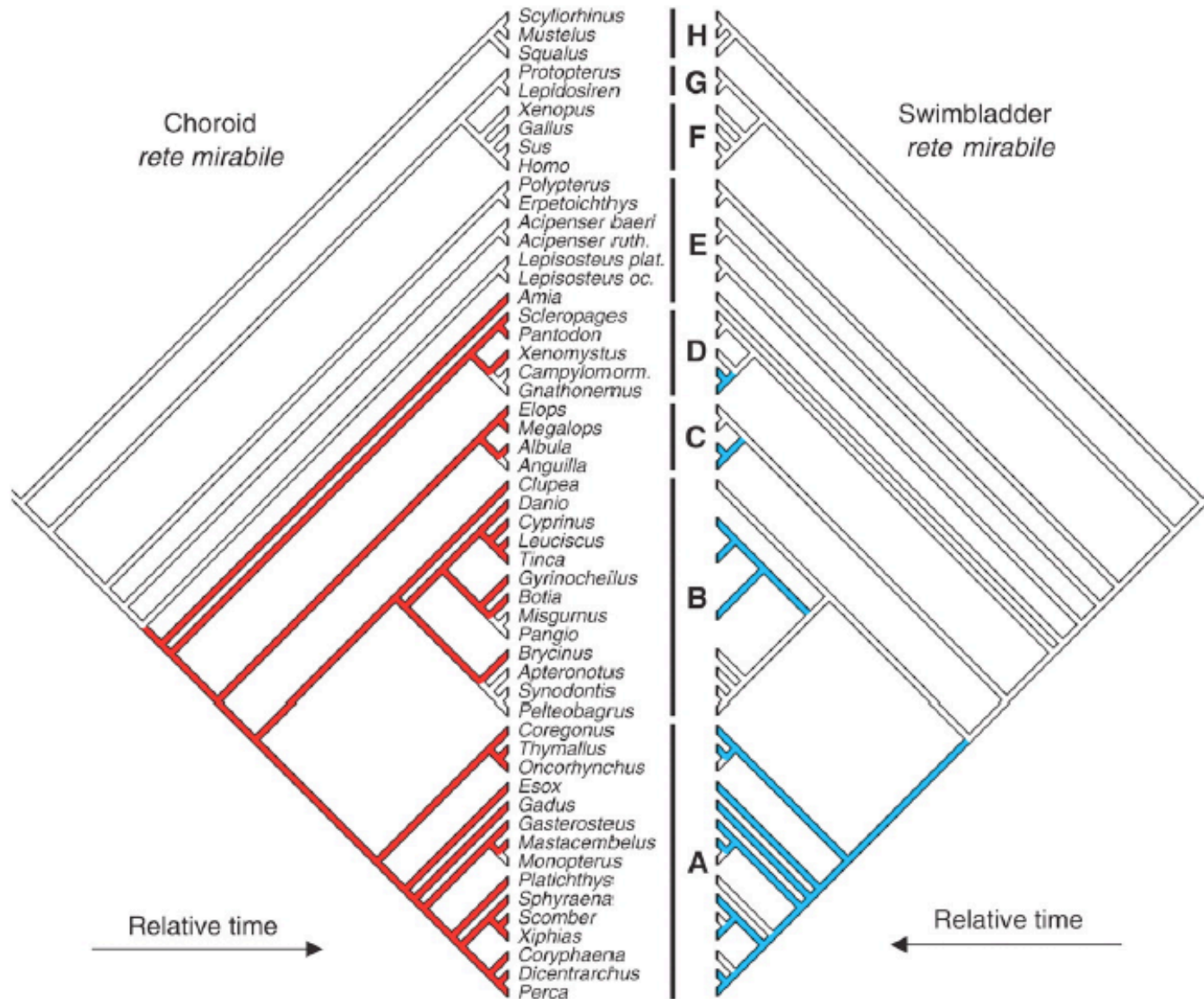
7) Which of the four trees above depicts a different pattern of relationships than the others?

From: Baum, et al Science, 2005



9) In the above tree, assume that the ancestor had a long tail, ear flaps, external testes, and fixed claws. Based on the tree and assuming that all evolutionary changes in these traits are shown, what traits does a sea lion have?

- a) long tail, ear flaps, external testes, and fixed claws
- b) short tail, no ear flaps, external testes, and fixed claws
- c) short tail, no ear flaps, abdominal testes, and fixed claws
- d) short tail, ear flaps, abdominal testes, and fixed claws
- e) long tail, ear flaps, abdominal testes, and retractable claws

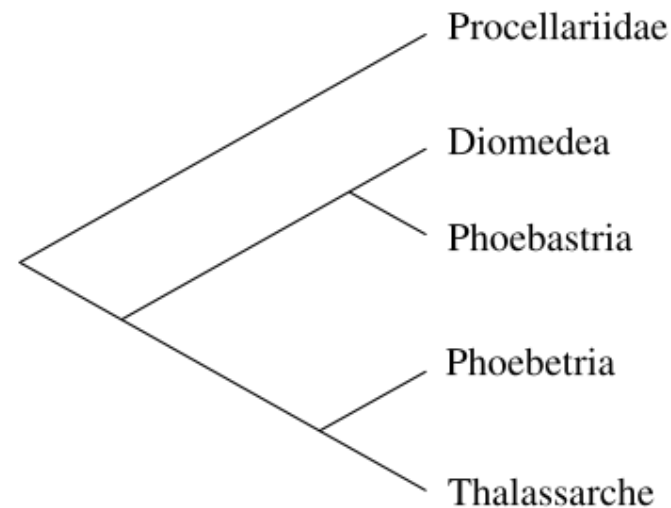


M. Berenbrink, P. Koldkjaer, O. Kepp, A. R. Cossins, Evolution of oxygen secretion in fishes and the emergence of a complex physiological system. *Science* **307**, 1752 (2005).

From: Baum, et al Science, 2005

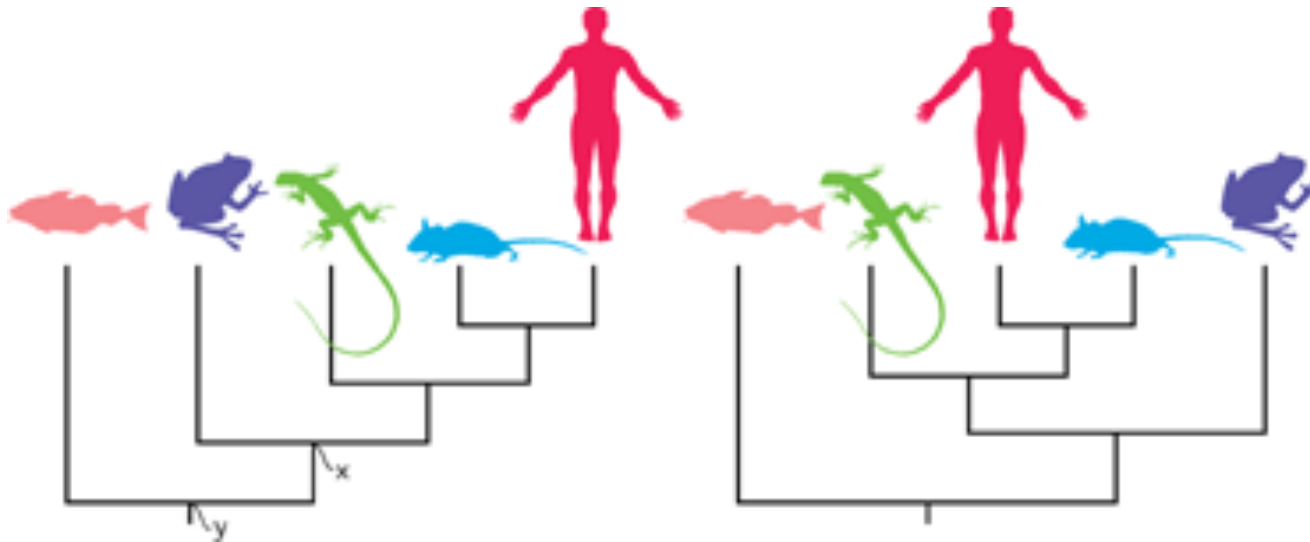
Common Problems with Reading Trees

- Incorrect mapping of time
- Straight line = no evolution occurring

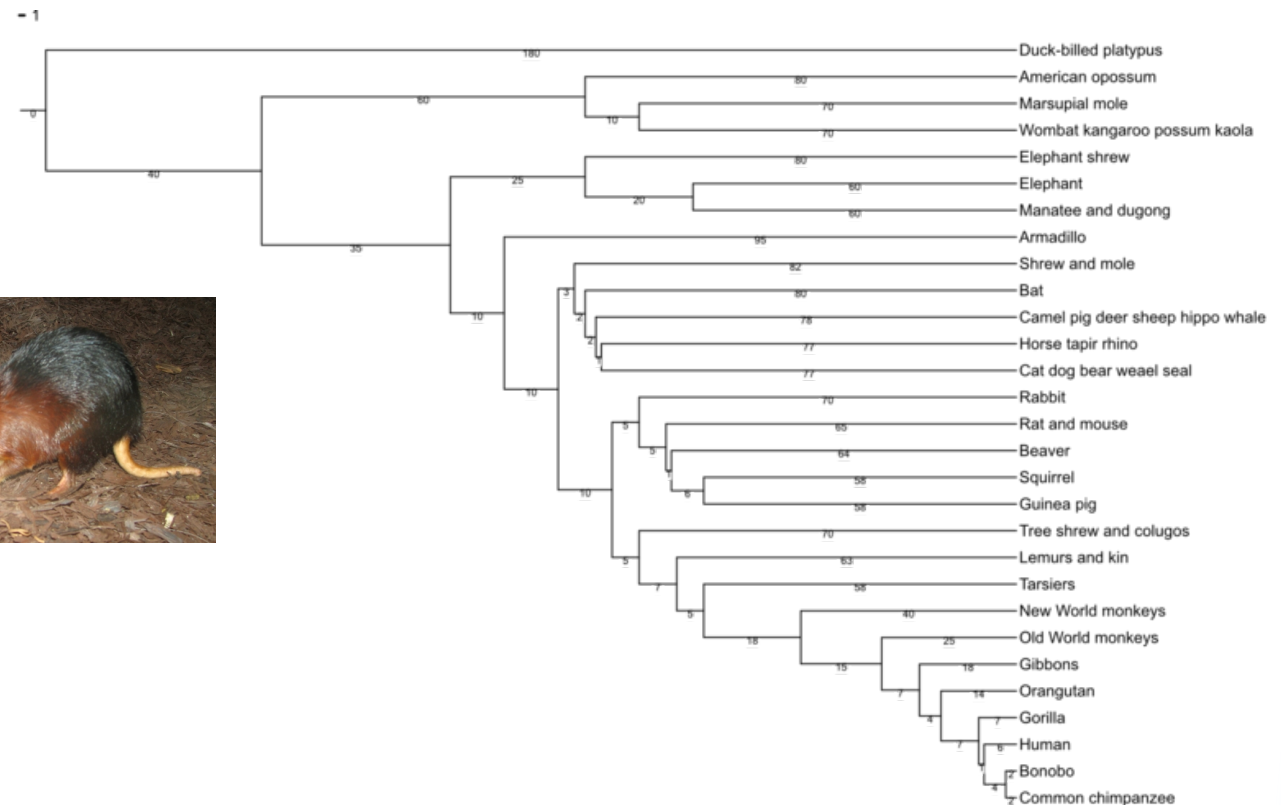


Common Problems with Reading Trees

- Reading along the tips
- Node counting

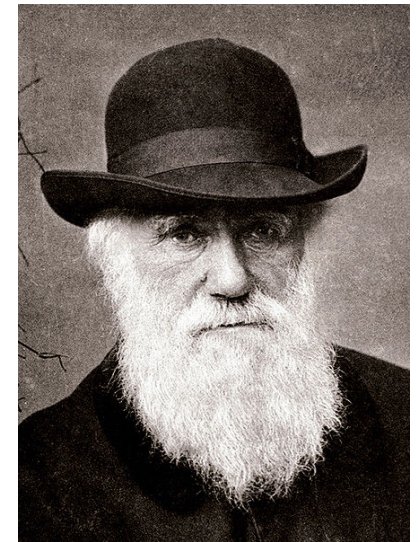
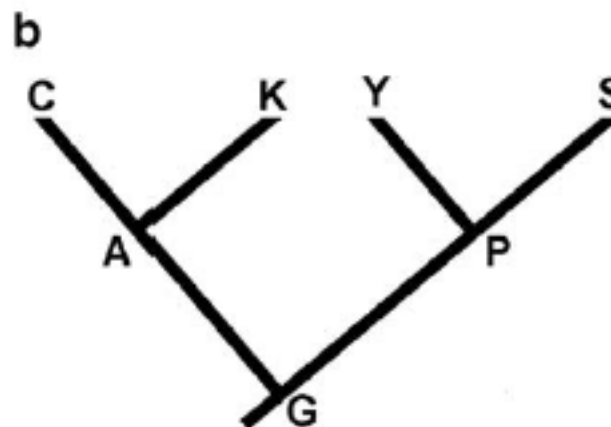
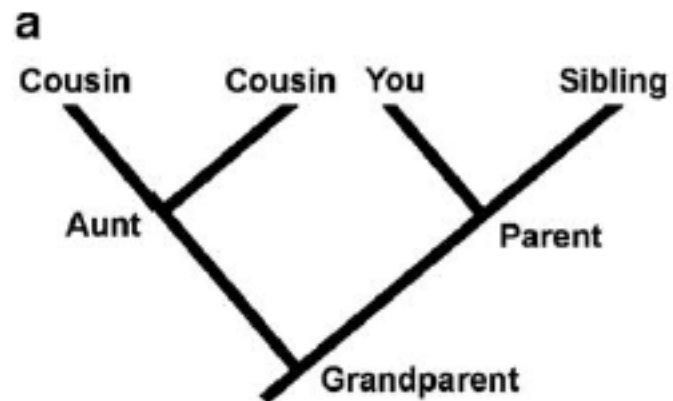


Similar vs. related

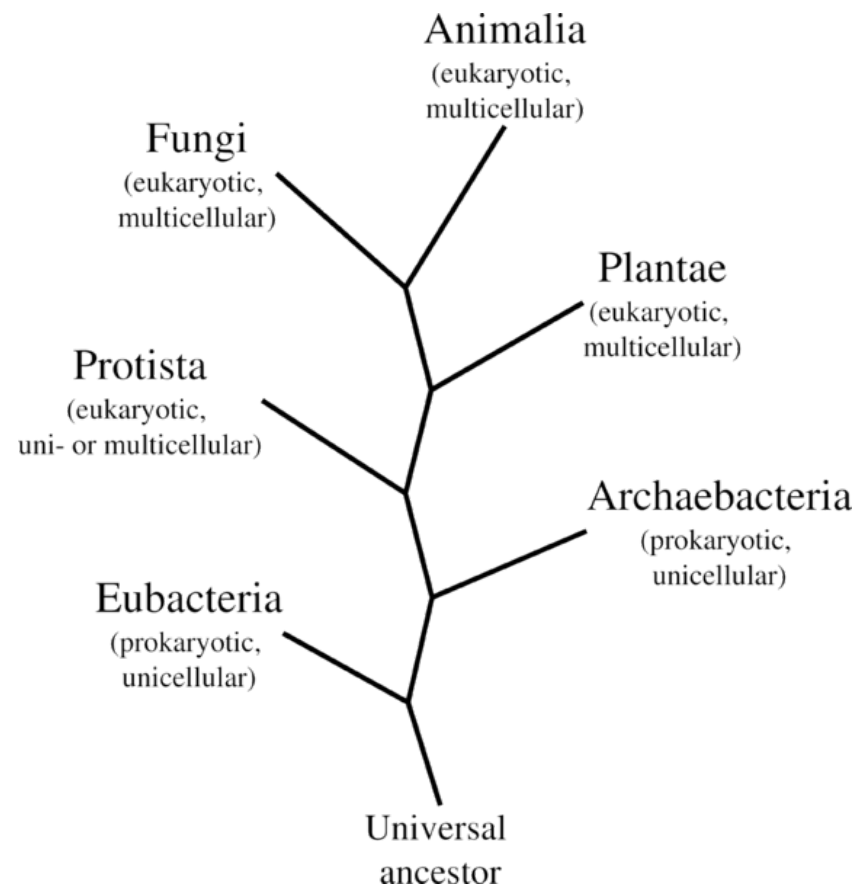
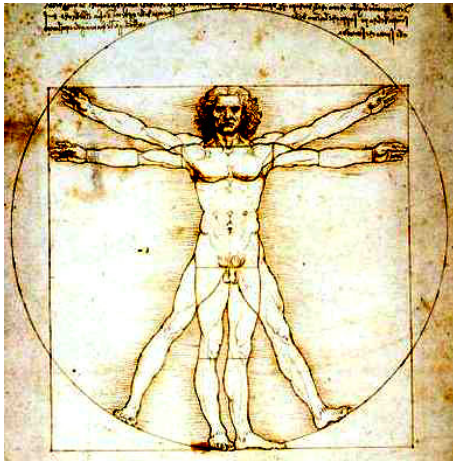


Images: Chris Muenzer, Sjonge, Fred Hsu

Ancestor vs. Sibling

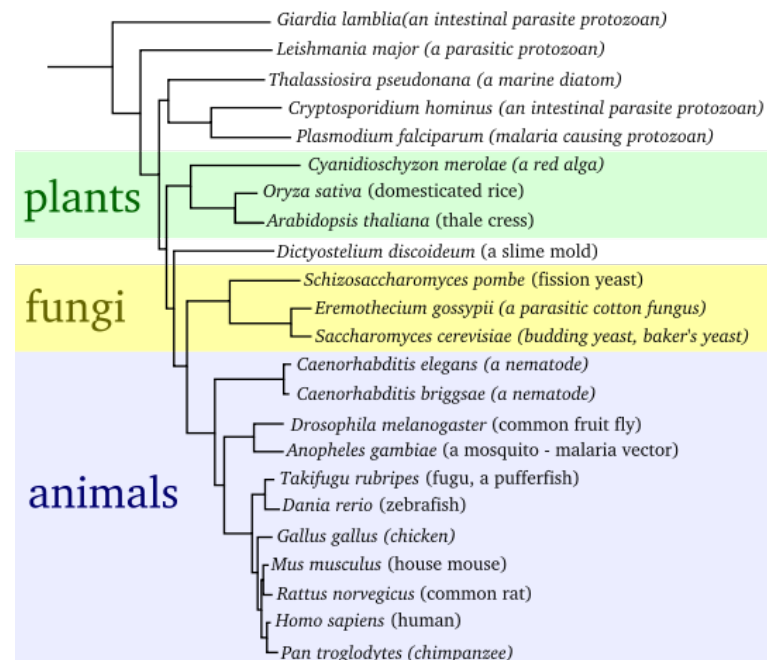


“Higher” or “Lower”



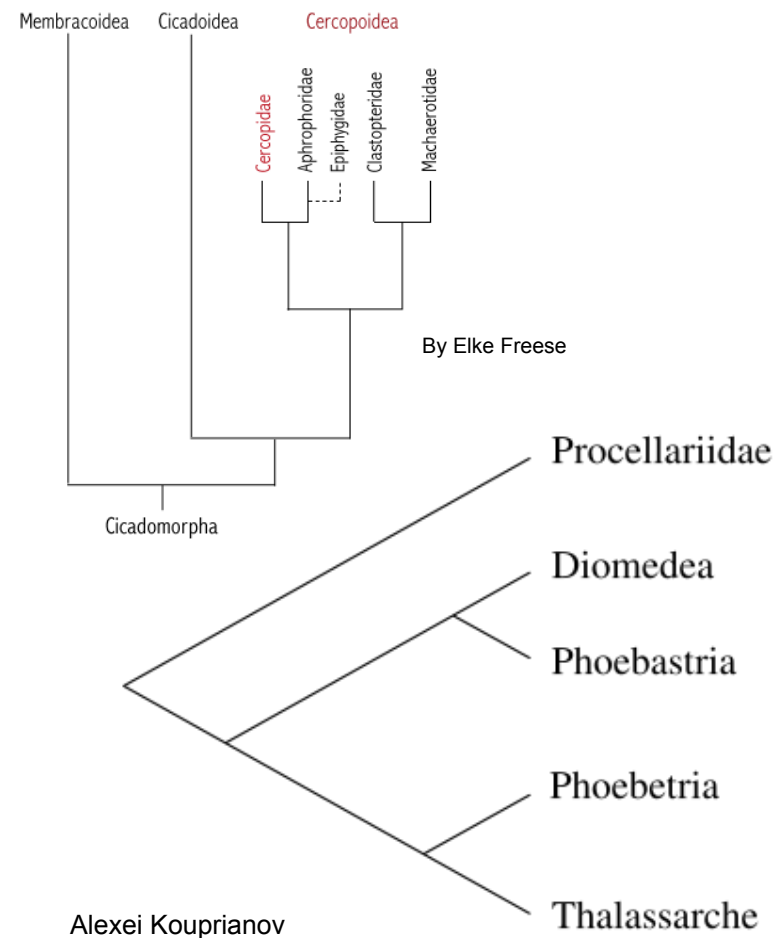
Lineage Age

- Extant species have been evolving for the same amount of time



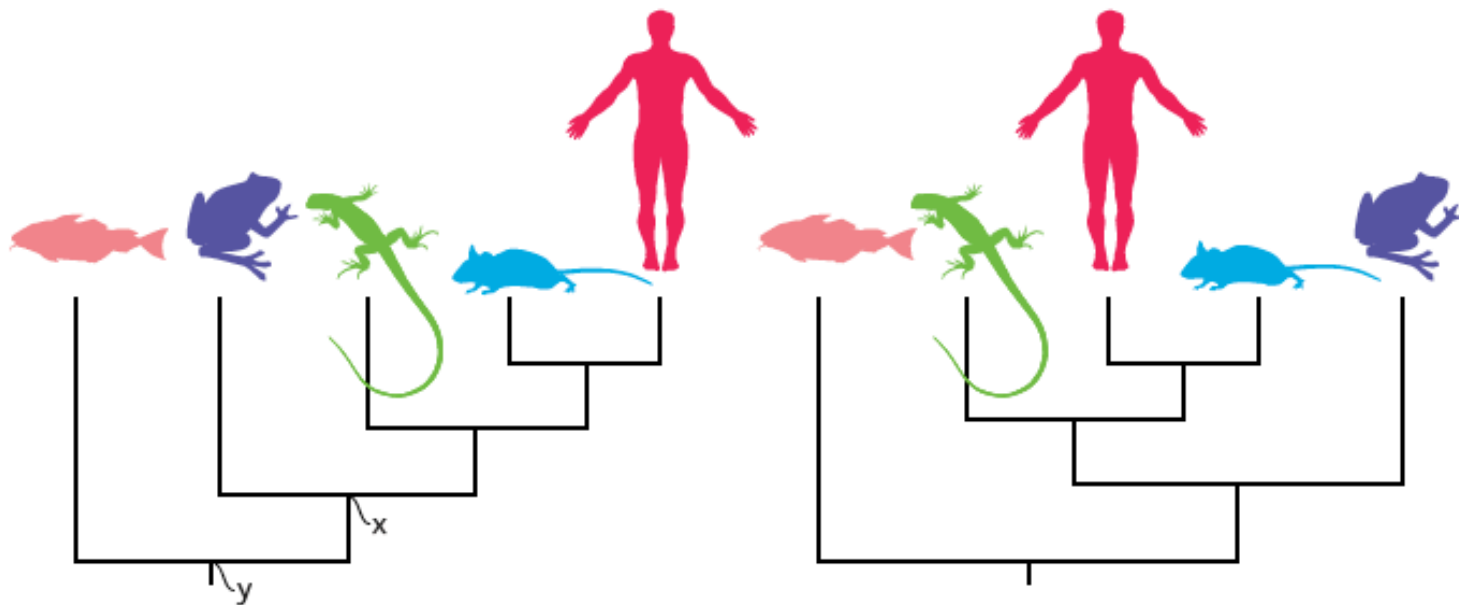
Helpful Approaches

- U-trees
- Trees pointing sideways



Helpful Approaches

- Top-down grouping (by clade)
- Avoid misleading terminology, try “derived” and “ancestral”



From: Baum, et al Science 2005

Tree thinking

- A visual hypothesis about historical relationships
- A representation of common ancestry
- A way of representing evolutionary thinking

