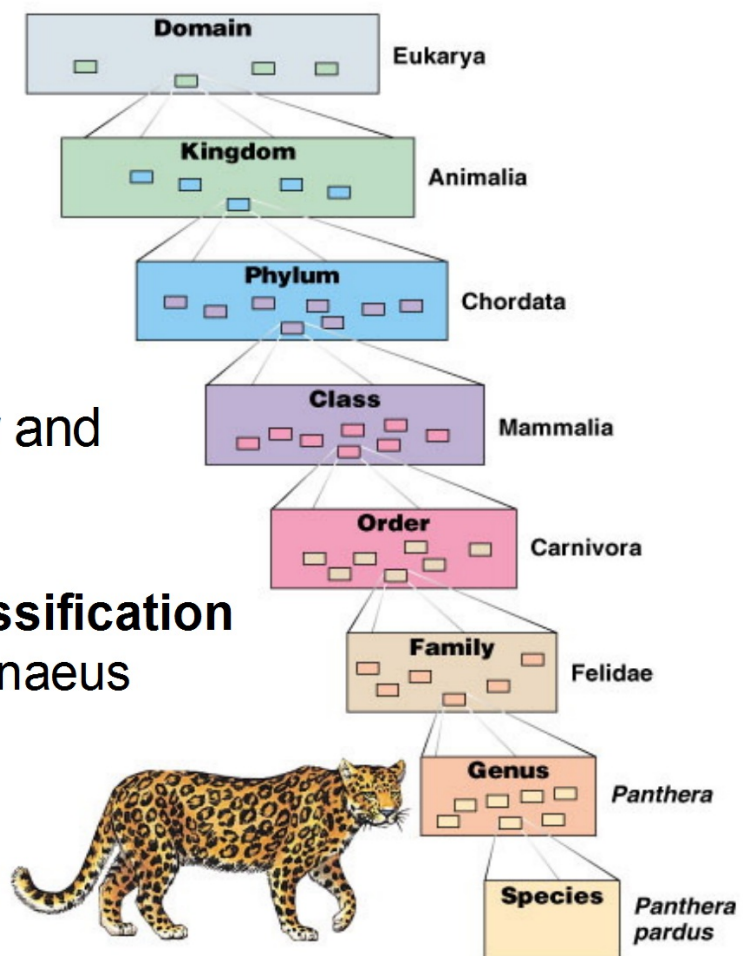


# Phylogeny & Systematics

## Hierarchical System of Classification -->

- **Taxon:** group of similar and related individuals

- The basis of modern **classification** was developed by Carl Linnaeus (1707-1778)

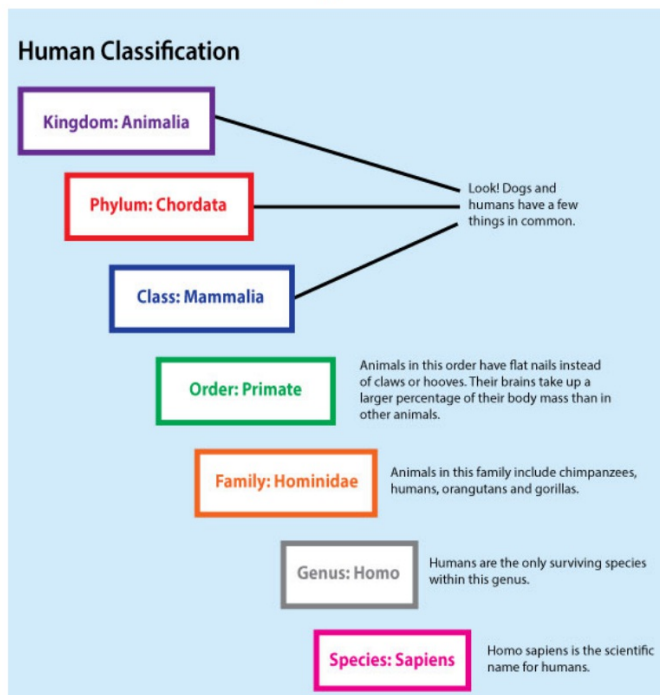


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# Bionomial nomenclature: 2 -word naming process "scientific name"

**Rationale:** common global classification; written in Latin  
- **Ex: Human**

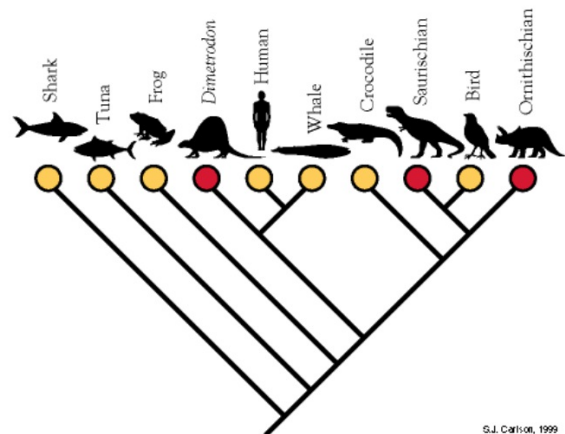
<b>Species</b>	<b>Homo sapiens</b> Members of the genus Homo with a high forehead and thin skull bones.
<b>Genus</b>	<b>Homo</b> Hominids with upright posture and large brains.
<b>Family</b>	<b>Hominids</b> Primates with relatively flat faces and three-dimensional vision.
<b>Order</b>	<b>Primates</b> Mammals with collar bones and grasping fingers.
<b>Class</b>	<b>Mammals</b> Chordates with fur or hair and milk glands.
<b>Phylum</b>	<b>Chordates</b> Animals with a backbone.
<b>Kingdom</b>	<b>Animals</b> Organisms able to move on their own.



- **Systematics:** the study of the diversity and relationship of organisms (how these organisms are named and classified is the discipline of **taxonomy**).

From similarity and differences of morphological, biochemical, cellular characteristics, biologist have constructed 'phylogenetic (evolutionary) trees' (i.e.: who is most closely related to who, analogous to a family tree)

**Question:** answer on paper

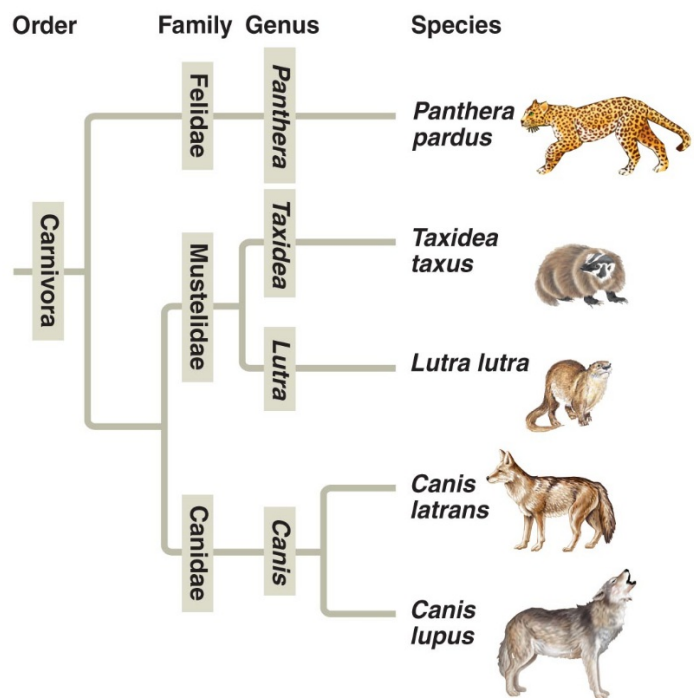


**Figure 4.** Cladogram illustrating phylogenetic relationships among ten familiar kinds of animals, interested in nine clades denoted by the nine nodes. Open circles denote living taxa; filled circles denote extinct taxa. The common names and Linnean binomials of the terminal taxa are: shark (*Carcharodon carcharias*); tuna (*Thunnus albacares*); frog (*Rana pipiens*); fin-backed pelycosaur (*Dimetrodon grandis*); human (*Homo sapiens*); whale (*Baleenoptera musculus*); crocodile (*Crocodylus acutus*); saurischian dinosaur (*Tyrannosaurus rex*); bird (*Melospiza melodia*); ornithischian dinosaur (*Triceratops homidus*). Redrawn from Carlson, 1995.

**Phylogeny:** evolutionary relationships among organisms;

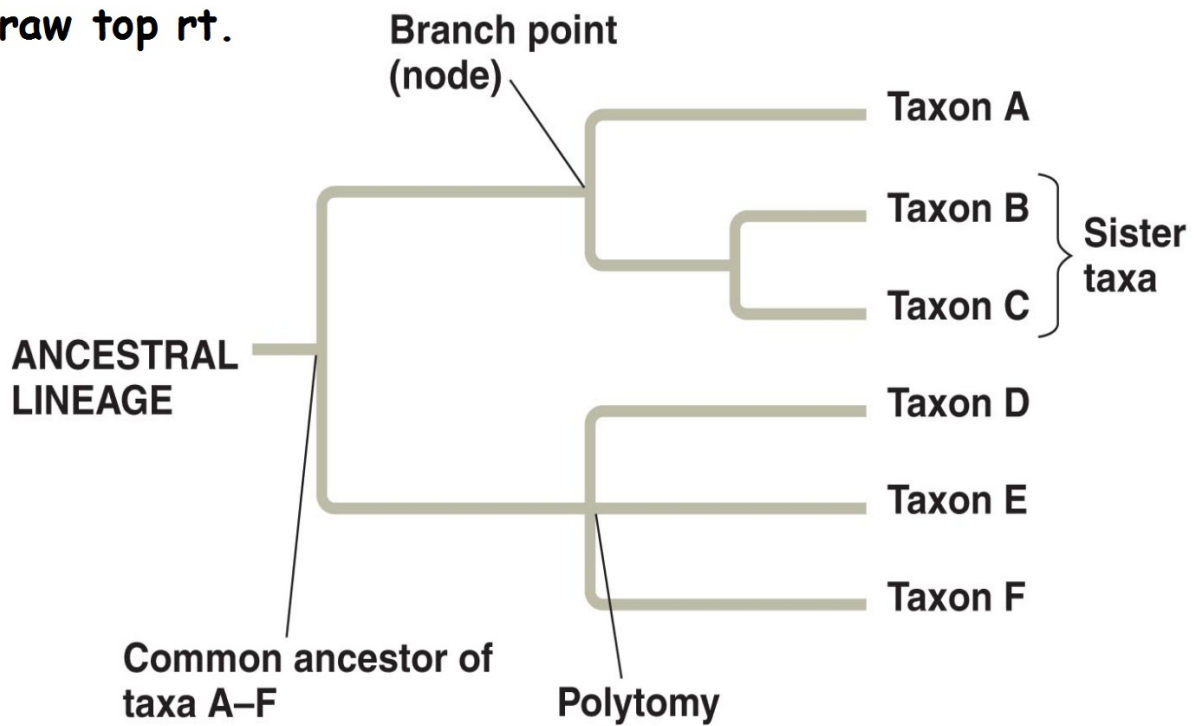
- The patterns of lineage **branching** produced by the true evolutionary history of the organisms being considered.

**Phylogentic trees link classification with phylogeny:**



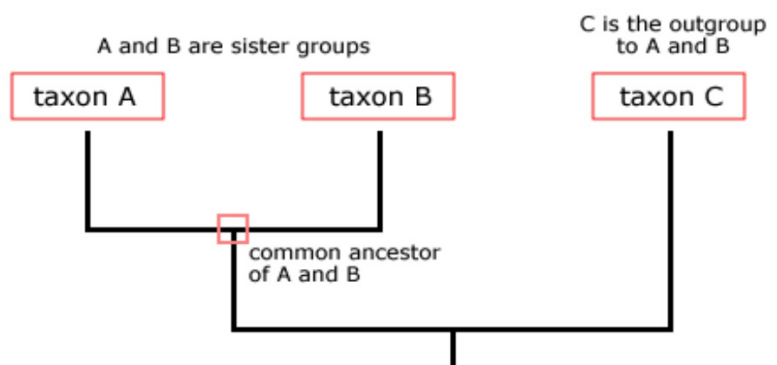
Phylogenetic **Trees** generally show divergence of lineages through **time** (i.e. the evolutionary relationship of taxa)

**\*Draw top rt.**



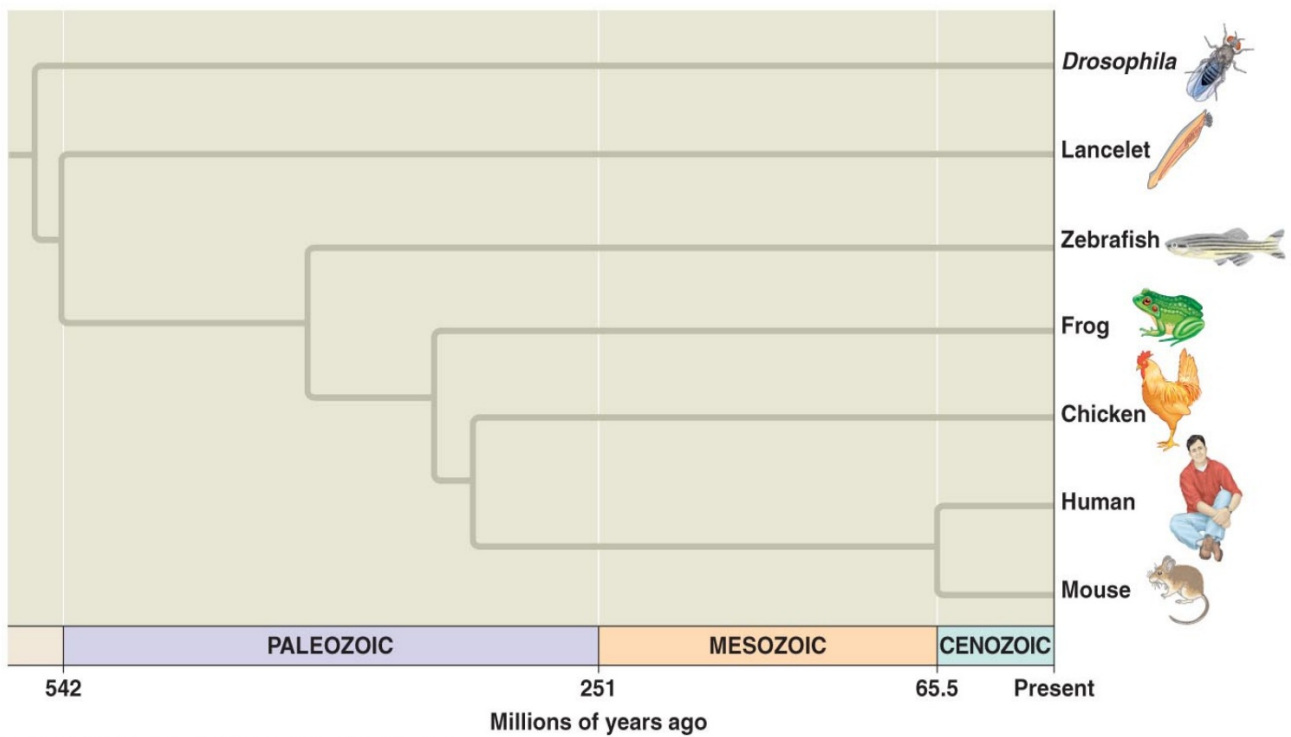
## Phylogenetics

- The tips of the tree represent groups of descendent **taxa** (often species)



- The nodes on the tree represent the **common ancestors**
- Two descendants that split from the same node are called sister groups.

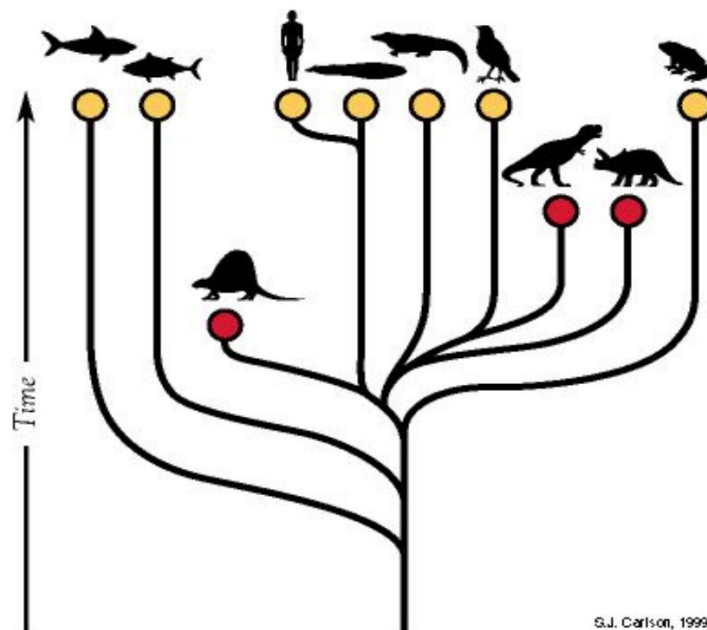
Some trees can indicate estimated time since divergence or the amount of evolutionary change:



## Practice Questions:

In the tree shown below:

- 1) What taxon is most closely related to birds?
- 2) Which taxon is least closely related to humans?



S.J. Carlson, 1999

**Figure 5.** Phylogenetic tree congruent with cladogram in Figure 4. Redrawn from Carlson, 1995.



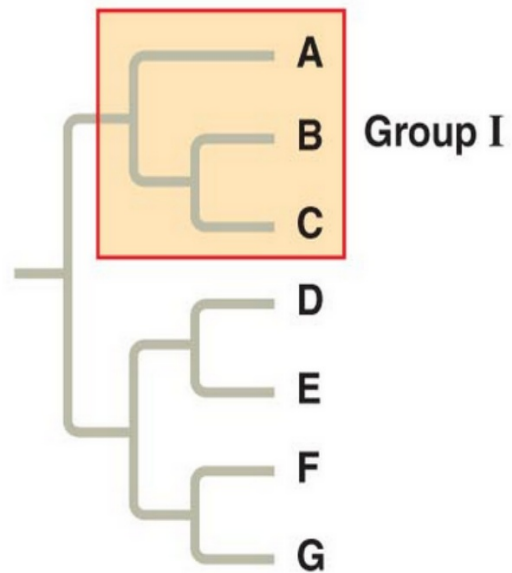
The most obvious way to determine the evolutionary relationship of organisms (i.e. their phylogenetic tree) is compare **morphological** similarities

- **Cladistics** (phylogenetic systematics), demands adherence to using only homologous, shared derived characteristics.

**Ex:**

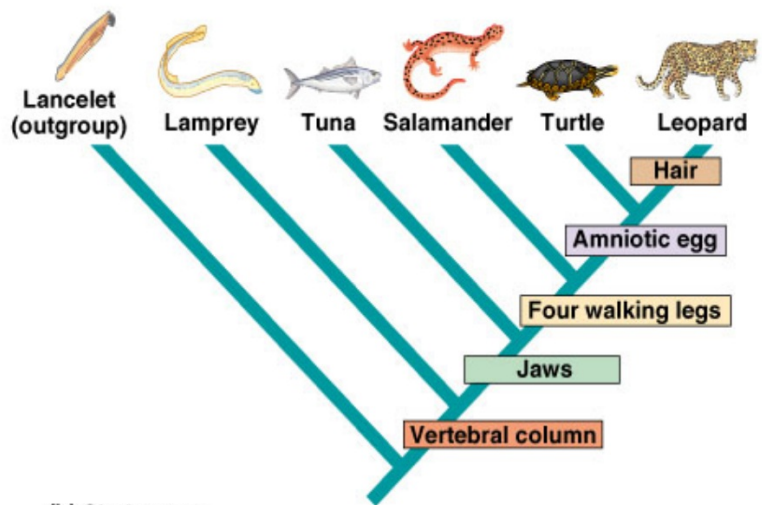
A **clade** is a group of species that includes an **ancestral** species and all of its descendants

(i.e. members within the clade are all more closely related to each other than any members outside the clade).



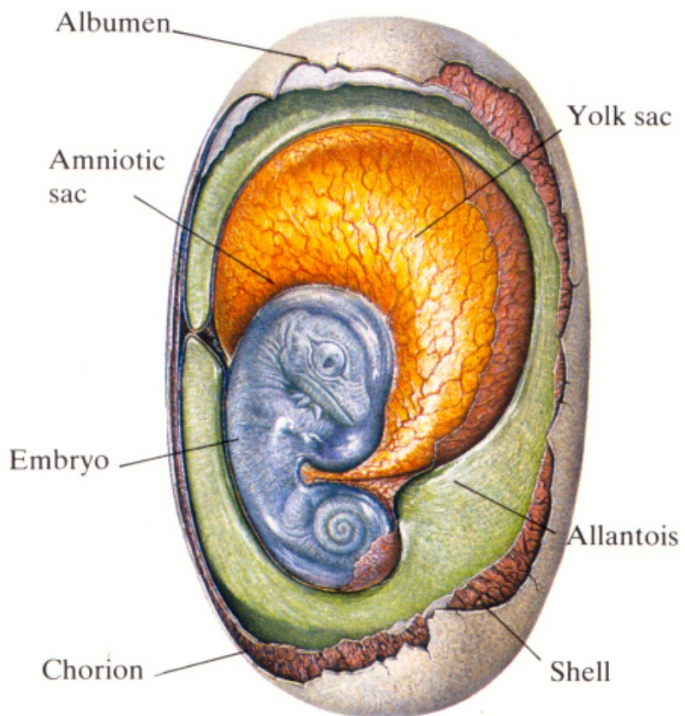
CHARACTERS	TAXA					
	Lancelet (outgroup)	Lamprey	Tuna	Salamander	Turtle	Leopard
Hair	0	0	0	0	0	1
Amniotic (shelled) egg	0	0	0	0	1	1
Four walking legs	0	0	0	1	1	1
Jaws	0	0	1	1	1	1
Vertebral column (backbone)	0	1	1	1	1	1

(a) Character table

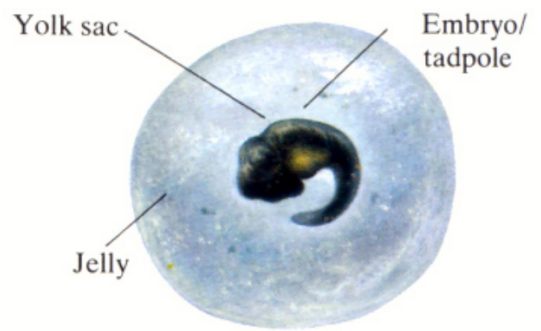


(b) Cladogram

### Amniotic egg



### Amphibian egg



**Table 1. Beastie Characters** (REMEMBER – the outgroup will have a “0” for each character!)

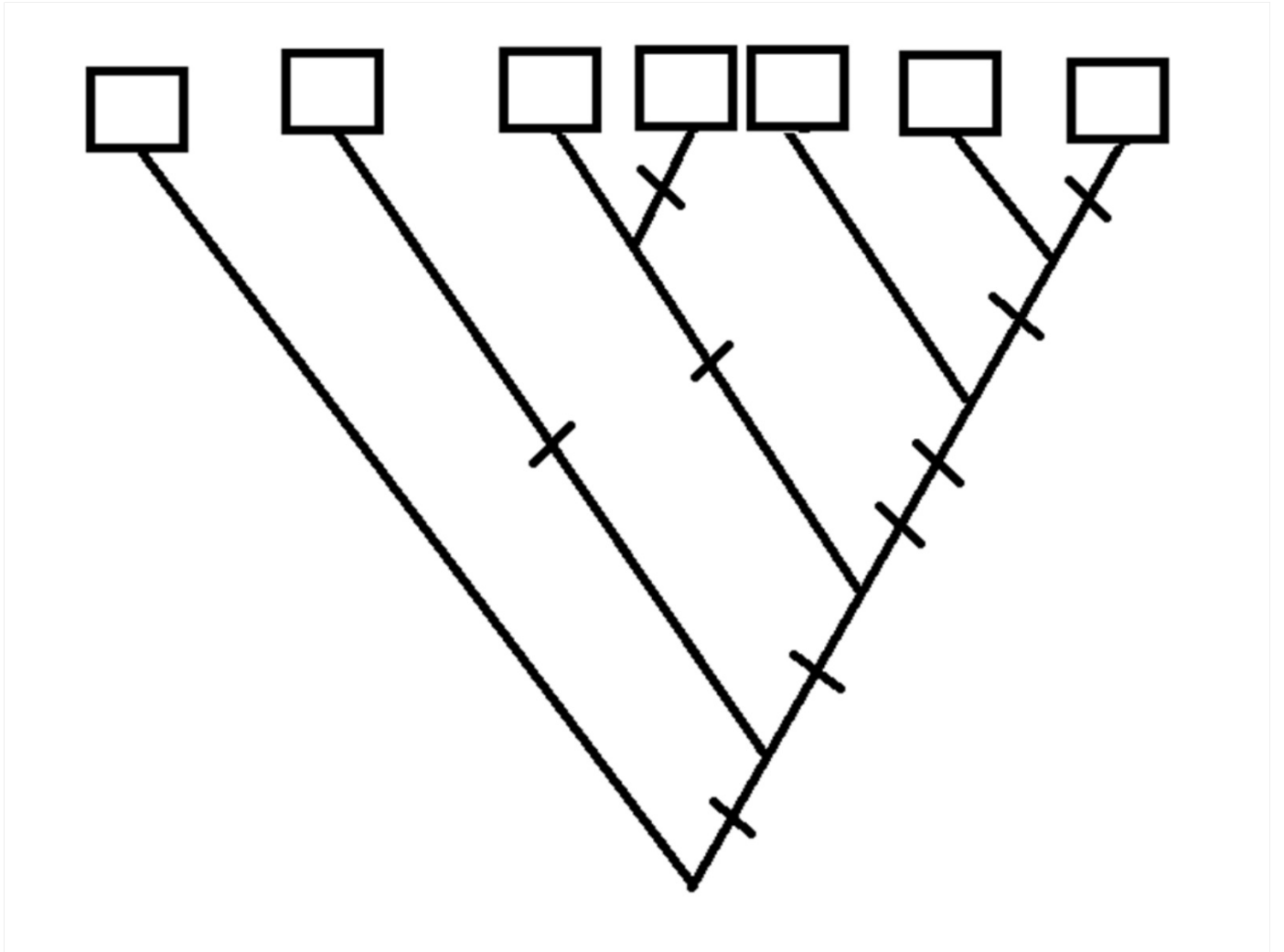
<b>Characteristic Name</b>	<b>Coding scheme</b>	
<i>e.g., Ears</i>	<i>0: absent</i>	<i>1: present</i>

**Table 2. Comparison Data Table**

Taxon	Characteristics									Total (present)
	Eye Size	Teeth	Antenna	Fin	Feet	Tail	Spots	Beard	Tongue	
Outgroup										
A										
B										
C										
D										
E										
F										

**Table 3. Ranked Data Table**

Taxon	Characteristics									Total (present)
	Eye Size	Teeth	Antenna	Fin	Feet	Tail	Spots	Beard	Tongue	
	0	0	0	0	0	0	0	0	0	
	1	0	0	0	0	0	0	0	1	
	1	1	0	0	0	0	1	0	0	
	1	1	0	0	0	0	1	1	0	
	1	1	1	1	0	0	0	0	0	
	1	1	1	1	0	1	0	0	0	
	1	1	1	1	1	1	0	0	0	





outgroup

E

D

B

F

A

C



**Dichotomous Key:** used to identify an organism in which each stage presents descriptions of two distinguishing characters with a direction to another stage in the key, until the species is identified

Read statements 1a and 1b in the classification key in Figure 2. One of these statements describes salamander 1; the other statement does not. Follow the directions in the statement that describes salamander 1 and continue following the correct statement directions until salamander 1 has been identified.

1	a Hind limbs absent	<i>Siren intermedia</i> , siren
	b Hind limbs present	Go to 2
2	a External gills present in adults	<i>Necturus maculosus</i> , mud puppy
	b External gills absent in adults	Go to 3
3	a Large size (over 9 cm long in Figure 1)	Go to 4
	b Small size (under 9 cm long in Figure 1)	Go to 5
4	a Body background black, large white spots irregular in size and shape completely covering body and tail	<i>Ambystoma tigrinum</i> , tiger salamander
	b Body background black, small round white spots in a row along each side from eye to tip of tail	<i>Ambystoma maculatum</i> , spotted salamander
5	a Body background black with white spots	Go to 6
	b Body background light color with dark spots and/or lines on body	Go to 7
6	a Small white spots on a black background in a row along each side from head to tip of tail	<i>Ambystoma jeffersonianum</i> , Jefferson salamander
	b Small white spots scattered throughout a black background from head to tip of tail	<i>Plethodon glutinosus</i> , slimy salamander
7	a Large irregular black spots on a light background extending from head to tip of tail	<i>Ambystoma opacum</i> , marbled salamander
	b No large irregular black spots on a light background	Go to 8
8	a Round spots scattered along back and sides of body, tail flattened like a tadpole	<i>Triturus viridescens</i> , newt
	b Without round spots and tail not flattened like a tadpole	Go to 9
9	a Two dark lines bordering a broad light middorsal stripe with a narrow median dark line extending from the head onto the tail	<i>Eurycea bislineata</i> , two-lined salamander
	b Without two dark lines running the length of the body	Go to 10
10	a A light stripe running the length of the body and bordered by dark pigment extending downward on the sides	<i>Plethodon cinereus</i> , red-backed salamander
	b A light stripe extending the length of the body, a marked constriction at the base of the tail	<i>Hemidactylium scutatum</i> , four-toed salamander

