NAME _____

DATE _____

Introduction to Cladistics

In these activities you will observe the body structure of three invertebrates and use your observations to construct a cladogram.

Go to a workstation and pick up a *Hydra*, planarian, or *Daphnia* as follows:

Hydra and *Daphnia*—Use a pipet to transfer an individual to a Deep-Well Slide. Add enough water to fill the well.

Planarian—Use a dropping pipet to transfer the planarian. First, fill the pipet with water and direct a stream of water at a planarian to dislodge it. Then, apply just enough suction to draw the planarian into the tip, no farther. Transfer the planarian into a Deep-Well Slide. Make the transfer quickly so that the planarian does not have time to attach to the inside of the pipet. Add enough water to fill the well.

Pick up a copy of the anatomy sheet(s) for each organism.

Place the completed slide on the stage of a stereomicroscope and observe the animal. Using your observations and the information on the sheets, complete the following data table. When you have finished, switch slides with someone else and continue until you have observed all three organisms.

The table is already filled in for a rat (a representative vertebrate). Mark any box with an X if the organism has the trait; otherwise, leave it blank. If you cannot make a judgment on the basis of your background knowledge, your observations, and the information from the anatomy sheets, leave that box blank.

Data Table 1

Body Function	Organs, Tissues, or Cells	Rat	*Hydra*	Planarian	*Daphnia*
Nervous	Brain or Ganglion	x			
	Nerves	x			
	Nerve Cells	x			
	Sense Organs	x			
Circulation	Heart	x			
	Blood Vessels	x			
Digestive Tract	1 Opening				
	2 Openings	x			
Excretion	Kidney	x			
	Flame Cells (Nephridia)	x			
Respiration	Lung or Gill	x			
	Diffusion through Epidermis				
Skeleton	Exoskeleton				
	Endoskeleton	x			
Locomotion	Jointed Appendages	x			
Symmetry	Radial				
	Bilaterial	x			

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Systematics is the study of the diversity of life. Its goal is to determine the evolutionary relationships of organisms. Cladistic analysis is one method that attempts to clarify these relationships. Consider the following data table.

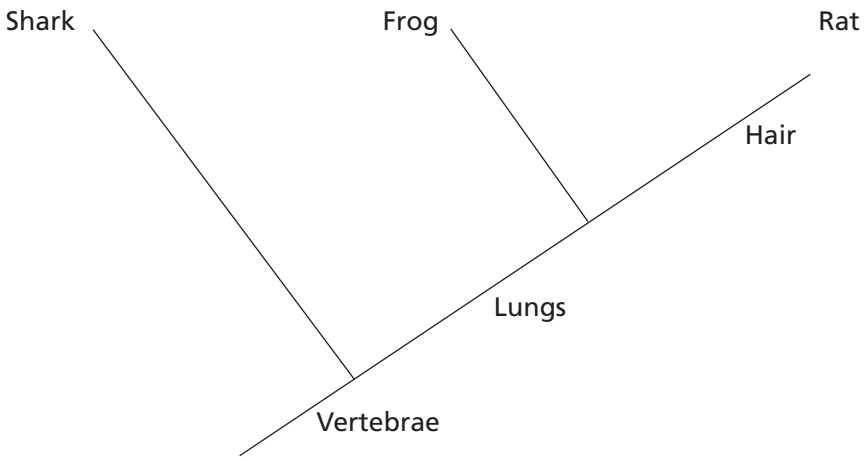
Trait	Shark	Frog	Rat
Vertebrae	x	x	x
Lung		x	x
Hair			x

Only one trait, the possession of vertebrae, is common to all three animals. Thus, for these three animals, the presence of vertebrae is likely a shared primitive trait; that is, the common ancestor of all three was an animal that had vertebrae. In comparing the frog with the shark, we see that the frog has lungs, which the shark lacks. Possession of lungs is then a derived trait, a trait not present in the ancestor of sharks and frogs. Further, it is a trait that the frog shares with the rat. Finally, the rat has hair, a derived trait not shared with the frog. With these facts in mind, we can now revise our data table.

We will use 0 to indicate the possession of a primitive trait and 1 to indicate possession of a derived trait.

Trait	Shark	Frog	Rat
Vertebrae	0	0	0
Lung	0	1	1
Hair	0	0	1

Notice that 0 does not mean the absence of a trait. It indicates the presence of a primitive trait. Thus, all three animals score 0 for vertebrae because they all have vertebrae, and that is a primitive trait. Likewise, the shark scores 0 for lung because not having lungs is a primitive trait, etc. We can now use our data to construct a cladogram to give a visual representation of the evolutionary relationships of these organisms.



This cladogram gives us the order in which the lineages that gave rise to sharks, frogs, and rats diverged. The intersections (nodes) of the lines indicate speciation events. The line that connects the node of the shark line to the node of the frog line indicates species that were ancestral to frogs and rats after the shark lineage had already diverged. The last common ancestor of frogs and rats would have been neither a frog nor a rat. It would have had some traits common to both, such as lungs and four feet, but would not have had hair or other traits unique to rats and other mammals. A cladogram is a hypothesis about the ancestry and relations of the taxons included. As it is tested against other information about the groups, the cladogram may be verified, modified, or even abandoned.

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Constructing a Cladogram

Examine Data Table 1 for a trait that is shared by all the animals. Enter this in Data Table 2 as a shared primitive trait. Remember to use a *0* for primitive traits and *1* for derived traits. Then look for a trait that is shared by three of the animals but not by the fourth. Continue until you have completed the table. If you run into a conflict, you may have to go back and use a different set of traits. When Data Table 2 is complete, use it to draw a cladogram showing your hypothesis of the evolutionary relationships of these animals.

Data Table 2

Trait	Rat	*Hydra*	Planarian	*Daphnia*

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