

**CHAPTER**  
**17**

 BUILDING A CLADOGRAM  
**Pre-AP Activity**

You have learned about cladistics in Chapter 17, and more specifically, how cladograms are used to illustrate hypotheses of evolutionary relationships. What is challenging for systematists—scientists who use cladistics to find relationships among species and other taxa—is how to discern which characters are derived from those that are analogous.

**DERIVED CHARACTERS**

Many years ago, before the discoveries of the fossil record or DNA, a taxonomist might have deemed “wings” a derived character, and created a cladogram or phylogeny that grouped birds, bees, and bats into a “winged” clade, thereby separating these distantly related groups from their true relatives. Another example: If you were to catch a sixgill shark, a bull shark, and a Southern stingray and examine them, you might infer that the two sharks are more closely related to each other than either is to the ray; but in fact, the sixgill shark is more closely related to the stingray.

**CHARACTER MATRIX**

A good first step in building a cladogram is to organize your data to clarify which derived characters are shared by which species or taxa in question. For example, data gathered into a character matrix, such as the one below, can be reorganized so that the hypothetical evolutionary relationships are more obvious.

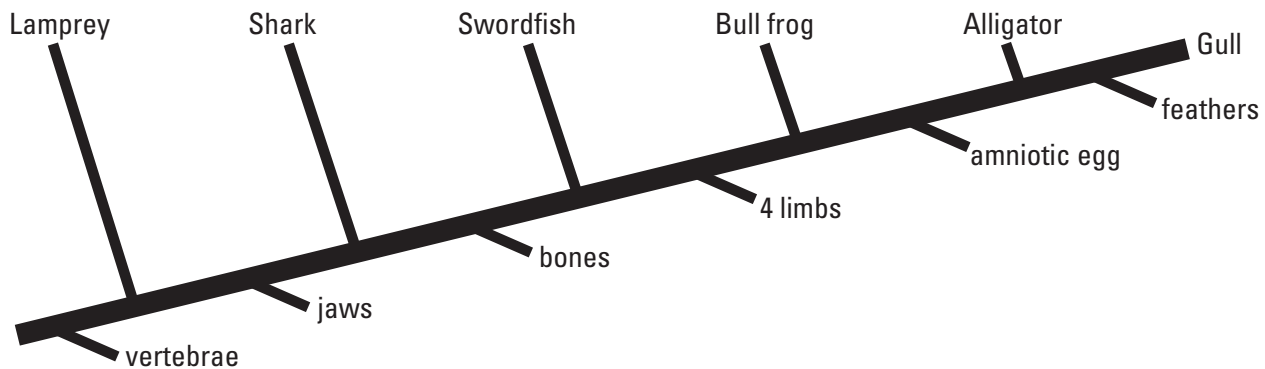
Derived Character	Shark	Swordfish	Alligator	Gull	Lamprey	Frog
Vertebrae	X	X	X	X	X	X
Jaws	X	X	X	X		X
Bones		X	X	X		X
Four Limbs			X	X		X
Amniotic Egg			X	X		
Feathers				X		

Reorganizing the table according to the number of derived characters yields the matrix on the following page.

Derived Character	Lamprey	Shark	Swordfish	Frog	Alligator	Gull
Vertebrae	X	X	X	X	X	X
Jaws		X	X	X	X	X
Bones			X	X	X	X
Four Limbs				X	X	X
Amniotic Egg					X	X
Feathers						X

### CLADOGRAMS

From the second table, it is not difficult to draw a cladogram like the one shown here. Notice that the animal that had only one of the derived characters in the matrix is the first outgroup, the one with just two shared derived characters is next, and so on.



### BUILD YOUR OWN MATRIX AND CLADOGRAM

Now, imagine that you are given a list of the following animals and their characters:

**Mouse:** *hair, claws or nails, lungs, backbone, distinct tail*

**Salamander:** *backbone, lungs, distinct tail*

**Fish:** *backbone, distinct tail*

**Ape:** *opposable thumbs, backbone, hair, lungs, claws or nails*

**Lizard:** *distinct tail, claws or nails, lungs, backbone*

**Human:** *hair, backbone, lungs, claws or nails, opposable thumbs, fully bipedal*

Use a separate piece of paper or a computer application to sort out these animals' characters, determine which should be considered derived, construct a table to organize them, and draw a cladogram. If you find yourself having difficulty, consider the possibility that one of the listed characters may be analogous rather than homologous and derived.