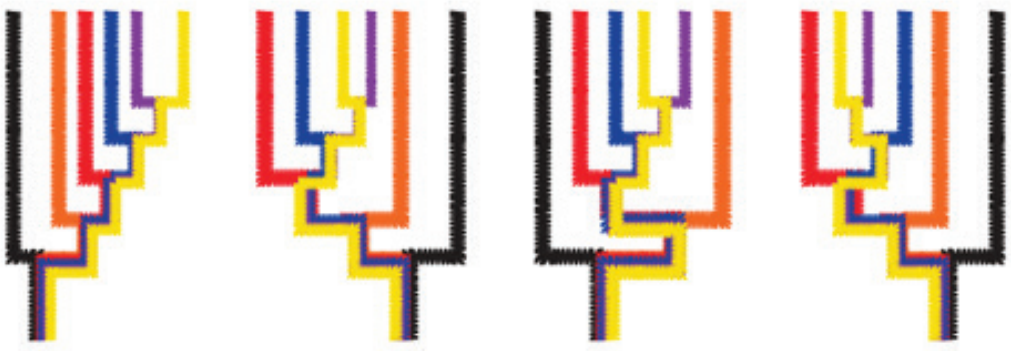
A Pipe-Cleaner Model of Animal Evolution

Teacher Edition Worksheet

Part A: Pipe-Cleaner Tree

Make sure that students understand what is meant by "rotating branching points" as this is a critical part of the lesson. A sampling of equivalent trees are shown below.



Part B: Modeling Relationships Among Animal Taxa

1. How many different taxa are in your pipe cleaner model, and how did you represent each of their lineages?

There were six taxa. Each taxon's lineage was represented with a different colored pipe cleaner.

2. How did you model nodes in your pipe cleaner tree?

By twisting together the pipe cleaners and then splitting one color off at a time from the others.

3. In your pipe cleaner model, which two colored taxa are the most closely related, and how do you know?

Purple and yellow. I know because they were the last two taxa to split off, so they have the most recent common ancestor.

4. Complete the table below by writing in all of the taxa that have each group trait. The first group trait has been completed for you.

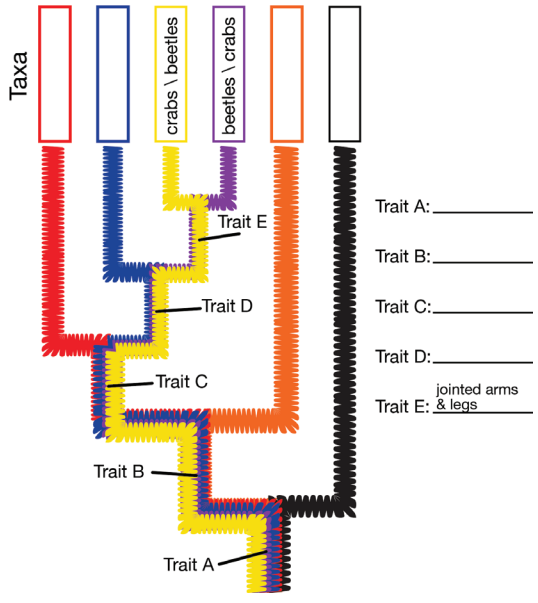
***Note to teachers: Tree-building is not quite as simple a presented here. A shared-derived character, what we are calling a "group character" here, is a characteristic that has evolved in the most recent ancestral lineage of a group and was passed down to all descendant lineages. Evolutionary biologists use many different methods to build trees. An important method is called parsimony and involves grouping taxa such that the number of evolutionary changes is minimized. Instead of specialized meat-eating teeth evolving independently twice, for example, dogs and cats (and other taxa in the order Carnivora) are all grouped together such that specialized meat-eating teeth evolved just once and was passed on to all descendant lineages. In this way, subgroups of organisms can be defined by sets of shared-derived characters that only they have. You can learn much more about tree-building on the Understanding Evolution site.*

Trait	Specialized cells with nuclei	Tissues	Organs	A Head	Jointed arms and legs
Taxa that have the trait	Beetles Crabs Jellyfish Snails Sponges Starfish	Beetles Crabs Jellyfish Snails Starfish	Beetles Crabs Snails Starfish	Beetles Crabs Snails	Beetles Crabs

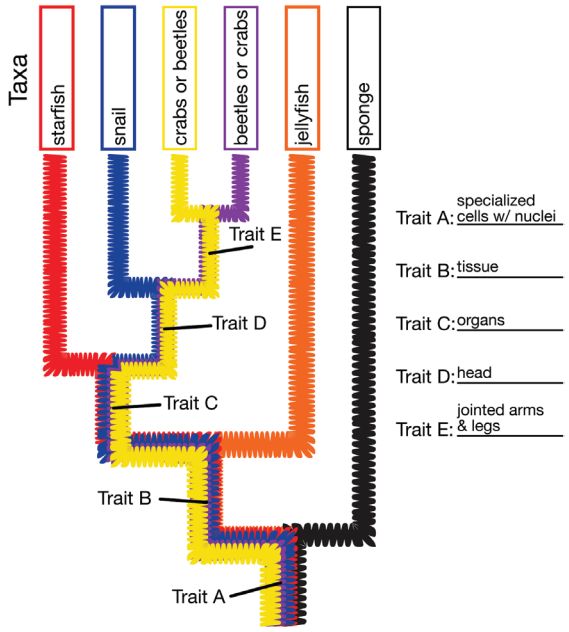
5. Based on your table, which two taxa are the most closely related? Hint: Which pair of taxa share the most traits that other organisms don't have?

The beetle and crab

6. Look at your answer to Questions 4 and 5. Then, on the tree, fill in the two most closely related taxa and group trait that unites them.



7. Using your understanding of trees, and your table to guide you, label the rest of the taxa and group traits on the tree.



8. Two claims about your tree are below.

> **Claim 1**: Jellyfish are more closely related to sponges than to crabs because they are closer together on the tree.
>
> **Claim 2**: Jellyfish are more closely related to crabs than to sponges because they share a more recent common ancestor.
>
> **a.** Which claim do you support?
>
> **b.** Explain your reasoning. *Hint:* Look back at Part A, Question 8 where you drew rotated trees. It might help you realize why one of the claims is wrong.

Sample answer: Closeness across the tips doesn't tell you anything about how closely related taxa are. I can rotate around any node and get jellyfish far away from sponges. However, I know from the tree that jellyfish and crabs share a more recent common ancestor (and therefore share more of their lineages and split apart more recently) than do jellyfish and sponges. That makes jellyfish and crabs more closely related to each other than either is to sponges.

9. A friend sees your tree and says that it must mean that snails are more evolved than sponges. Are they right? Use the concept of lineage to justify your answer.

Sample answer: My friend is wrong. The tree tells me that snails split off from other taxa more recently than sponges did, but their lineages are the same length because they share a common ancestor. No one living taxon can be more evolved than another.