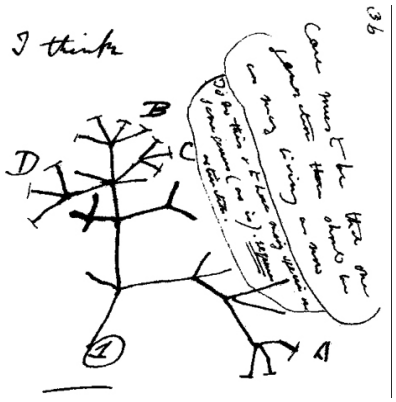
Name(s): _____ Date: _____

# A Pipe Cleaner Model of Animal Evolution

## Student Edition Worksheet

### Introduction:

The evolutionary tree shown here was drawn by Charles Darwin, a scientist who lived more than 150 years ago. It was Darwin, and another man named Alfred Russel Wallace that came up with the idea of natural selection, which is one of the ways that life evolves. Darwin wasn't the first person to suggest that life evolves, the idea had been around for a while, but he was one of the first to use evidence to explain his observations about life.




Darwin's tree, drawn in his 1837 notebook.

Source: Wikimedia Commons

This lesson isn't about Darwin or natural selection, though—not directly, anyway! It's about the trees—trees like the one that Darwin drew in his notebook to model evolutionary relationships. What are evolutionary trees, how do you make one, and what can they tell us about evolution?

In the first part of this activity, you'll build an evolutionary tree using pipe cleaners. Then, in the second part of the activity, you'll use evidence to infer relationships among different groups of animals.

# Part A: Pipe-Cleaner Tree

## Instructions:

**1.** Get six differently colored pipe cleaners from your teacher: blue, red, orange, yellow, purple, and black.

**2.** Line up the six pipe cleaners and twist them together about two centimeters (one inch) from the bottom. Twist all the way around twice.

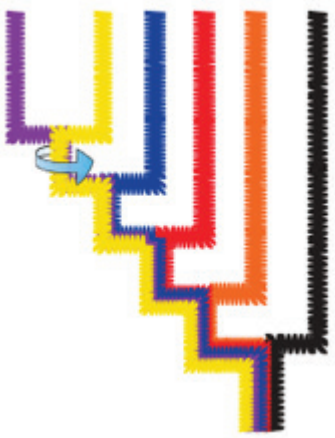
**3.** Bend black pipe cleaner to the right and the other five to the left so they are separated as shown in illustration below.


**4.** About an inch along, bend the black pipe cleaner 90° and the other group up 90°. It should now look something like this:

**5.** Now about an inch along the group of pipe cleaners, twist them and repeat steps 3 & 4 but with the orange pipe cleaner.

**6.** Repeat this process three more times: first for the red pipe cleaner, then the blue, then the yellow and purple together. Your final product should look like this:

**7.** Take some time and twist your model around one or more branching points and draw the result. For example, if you rotated around the purple-yellow branching point, your model would look like this:



**8** Use colored markers, pens, or pencils and draw at least two more "rotated" trees that you created below.

# Part B: Modeling Relationships Among Animal Taxa

To understand trees, you need to understand something called common ancestry. You likely know that chimpanzees are the closest living relatives to humans. But do you know what that means? It means that if you go back far enough (more than seven million years!) you'd find a population of animals that had some traits in common with just humans, some traits in common with just chimps, and probably a lot of traits in common with both humans and chimps.

This population of animals is the common ancestor of humans and chimpanzees. If you could follow this population through time, at some point something would happen that would separate the population into two different groups. Over time, one of these groups would become more and more chimplike, and the other group would become more and more humanlike.

It turns out that you can do this, go back in time to find a common ancestor, with any two taxa (organisms, or group of organisms, singular: taxon) on the planet. That's because all life on Earth is related by common ancestry.

In this part of the activity, you will use evidence to determine patterns of relatedness among different animal groups.

## Instructions:

The table below includes some important characteristics of six different groups of animals. Use the traits and your pipe cleaner to figure out which groups share the most in common by answering the questions after the table.

## Table 1: Some Characteristics of Animal Groups

| | Has specialized cells with nuclei | Has tissue | Has organs | Has a head | Has jointed arms and legs |
|---|---|---|---|---|---|
| Beetles | Yes | Yes | Yes | Yes | Yes |
| Crabs | Yes | Yes | Yes | Yes | Yes |
| Jellyfish | Yes | Yes | No | No | No |
| Snails | Yes | Yes | Yes | Yes | No |
| Sponges | Yes | No | No | No | No |
| Starfish | Yes | Yes | Yes | No | No |

Evolutionary trees model relationships among taxa. Every taxon has a unique lineage, or evolutionary history. You can think of a lineage as the path back through time from the present to the beginning of all life. If you trace back any two lineages through time, eventually they will join up.

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

On a tree, lineages join at nodes. A node represents the time when one lineage split off from the other lineages on the tree.

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

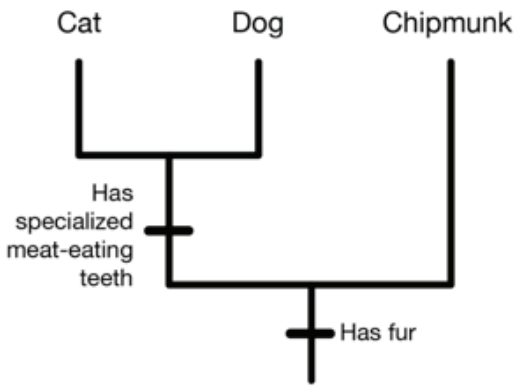
The nodes on your pipe cleaner model represent the common ancestors of all the taxa "above" the node. The more recently two taxa share a common ancestor, the more recently their lineages split, and therefore the more closely related the taxa are.

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

How do you know how recently two taxa shared a common ancestor? By looking for patterns in the traits they share. When a trait evolves in a population, it is passed down to all of the lineages that descend from that population. In this way, different groups of taxa come to share traits that other taxa (that descended from a different common ancestor) lack. When a trait is shared by a very small group of taxa, it usually means that those taxa are very closely related.

Look at the tree below. When you read a tree from root to tip, if you come across a trait, that means that all of the taxa "above" that trait share it. For example, in the tree below, dogs, cats, and chipmunks share the group trait "has fur." Fur evolved in the common ancestor population of all mammals, so all mammals share it.

Dogs and cats share the group trait "specialized meat-eating teeth." This trait evolved in a common ancestor of dogs and cats, which lived more recently than the common ancestor of all mammals. Other mammals do not have this trait. So cats and dogs belong to two groups: the mammal group (because they have fur) and the dog-cat group (because they have specialized meat-eating teeth). From this evidence, we can infer that cats and dogs are more closely related to each other than to mammal taxa that doesn't have specialized meat-eating teeth, like chipmunks.

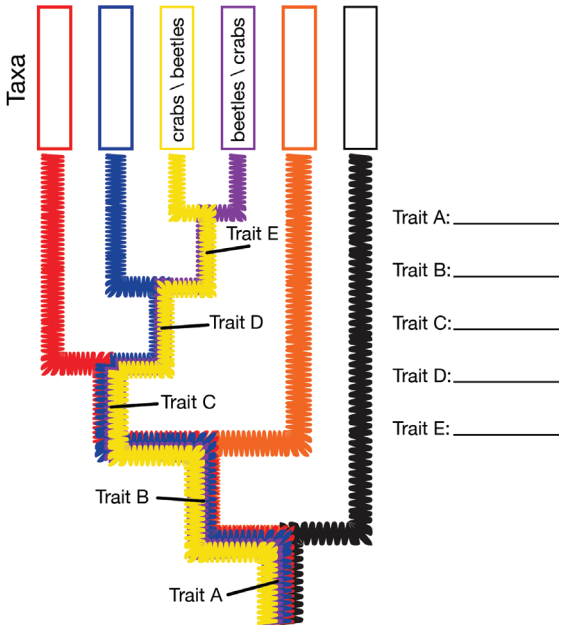


**4.** Complete the table below by writing in all of the taxa that have each group trait. The first group trait has been completed for you on this page.

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

**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?

A representation of your pipe cleaner tree is shown below.



**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.

**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.