# Introduction to Cladogram Construction

*A Carolina Essentials™ Activity*

**Student Worksheet**

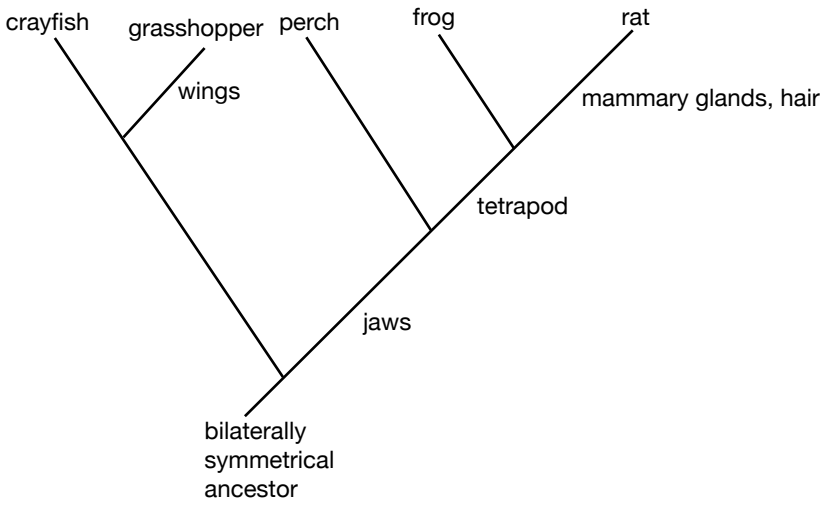
## Overview

*Cladograms* are diagrams that show phylogenies, the evolutionary relationships between organisms. A *phylogeny*, the hypothesized evolutionary history or relationship between species, is based on characteristics like physical traits, biochemical traits, genetics, and fossil records. Observable traits, genetic information, and the fossil record are examples of different kinds of empirical evidence supporting common ancestry and biological evolution.

Cladograms depict that evidence in a graphical representation that looks like a branching tree limb. They start with the common ancestor to all the species included on the limb. Each branch represents the emergence of a new, distinct trait called a **derived characteristic** that separates one species from another.

On the end of a branch tip is a single species being compared to the rest. If the branch tip ends before other tips, the shorter length represents species extinction. The branch points, called **clades**, represent shared characteristics where they join and a new trait where they split. Derived characteristics on a branching tree represent macroevolutionary relationships among different species and illustrate the appearance of structures or traits over time.

*Sample cladogram showing the correct arrangement of the animals based on shared derived characters*




**MATERIALS**

Pictures of animal species

Colored pencils, pens, or highlighters

## Essential Question

How is empirical evidence of common ancestry and evolutionary relationships identified and represented among several species?

## Activity Objectives

1. Identify derived characteristics for several species of animals to use as a line of evidence for common ancestry.
2. Construct a cladogram based on the evidence of derived characteristics to illustrate common ancestry.

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## Activity Procedures

**A. Respond to the phenomenon question.**

Are these animals related? Explain the evidence behind your reasoning.

**B. Identify common and derived characteristics.**

1. For each animal, list as many characteristics of that animal as you can. If you know something about the physiology of the animal (that it lays eggs, for example), list that too.
2. Across all of the animals, color code the traits. For example, if each animal has a backbone, color or highlight *backbone* in the same color. Choose a second color for other traits shared by the animals.
3. Circle the trait that separates each animal from the rest.

**C. Create a characteristics chart.**

4. List the traits you identified across the top row of the chart. List the animals in the far left column.
5. Use an X if the animal has the trait and an O if the animal does not have the trait.
6. Tally how many yes marks there are for each characteristic.

**Note:** The characteristics with a higher number of yes marks are ancestral characteristics because they are shared by many animals. Those traits with fewer yes marks are derived characteristics and evolved later.

## Chart Example

| | Trait 1 | Trait 2 | Trait 3 |
|---|---|---|---|
| **Plant or Animal 1** | **O** | **O** | **O** |
| **Plant or Animal 2** | **X** | **O** | **O** |
| **Plant or Animal 3** | **X** | **X** | **O** |
| **Plant or Animal 4** | **X** | **X** | **X** |
| **Totals** | **3** | **2** | **1** |

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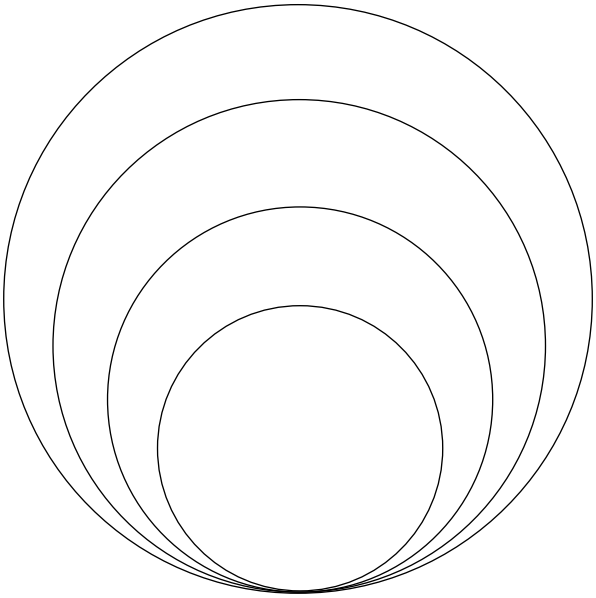
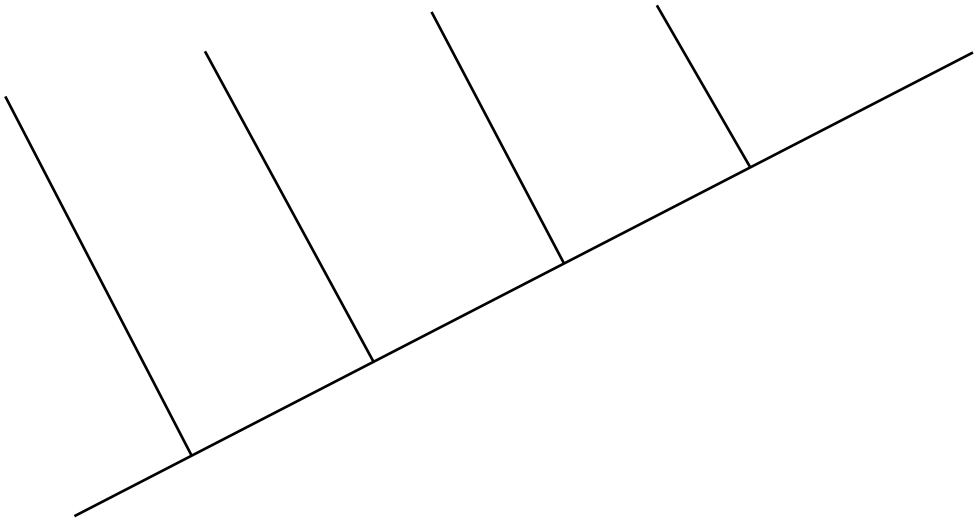
**D. Create a concentric circle diagram.**

7. Draw a multi-circular diagram**.** You will need as many circles as there are unique characteristics.
8. On the outside, start with the characteristic that is shared by all animals. (Make this a large circle.)
9. Inside each circle, write the species that has only that set of characteristics.



**E. Create a cladogram.**

10. Using the chart above, transfer the information on the derived characteristics to the main line, or limb, on the cladogram. (See the example above.)
11. Using your concentric circle diagram, write the species on the branches. (See the sample above.)



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## Analysis and Discussion

1. Using complete sentences, explain why you put each species where you did on the cladogram. What is the empirical evidence that led to the placement of each animal?

2. According to your cladogram and derived characteristics chart, which species are more closely related and share the most traits? What evidence supports your claim?

3. According to your cladogram, what is the most distant derived characteristic? What evidence supports your claim?

4. Use the same procedure and determine the common ancestry between dogs, wolves, and bears.

   Characteristics Chart

   Nested Diagram

   Cladogram

5. Explain if the evidence matches your initial thinking about the common ancestry among dogs, wolves, and bears.

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