

## Fossils and Evolution Follow-up Activity: Tree Diagrams

**SCSh1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.**

b. Recognize that different explanations often can be given for the same evidence.

**SCSh4. Students use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.**

a. Develop and use systematic procedures for recording and organizing information.

The “Tree of Life” in the Fossils and Evolution program is a type of tree diagram. You will encounter several different types of tree diagrams in the course of your education.

In this activity you will make another type of tree diagram used in biology, called a *cladogram*.

A cladogram shows relationships between different things. Things that seem to be closely related are close together on a cladogram, while less closely related things are farther apart.

### Dime-Nickel-Penny-Quarter Questions Game

Each pair of students will need one of each of the above coins.

Pair up with a partner. Your partner thinks of one of the above four coins. You find out which coin by asking questions with the following rules:

1. Every question must be answered with yes or no.
2. No questions about value of coins are allowed.
3. You can only ask the name of the coin as your last question.

**Now switch roles and let your partner ask the questions.**

### Dime-Nickel-Penny-Quarter Cladogram

To get an idea of how a cladogram works, use the same four coins. Fill out the following table. First, find a coin that seems different from all the rest. Then fill out the first row of the table.

Next, take that different coin away, and again pick a coin that seems different. Fill out the second row of the table. Repeat till all coins have been taken away and all rows are filled out.

To fill out the first row of the table, use the following procedure:

Coin that is different	How this coin is different	How the remaining coins are alike
(1)	(a)	(b)
(2)	(c)	(d)
(3)	(e)	
(4)	(f)	

**Then use the letters and numbers to transfer the words from the blanks to the “Coin Cladogram” diagram on page 3.** Note: there is no one “right” answer to this exercise.

Based on your Coin Cladogram, which two coins appear to be least closely “related?”

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### Food cladogram

Here are six items on the menu at a restaurant (listed alphabetically):

Chicken      Beef (=Cow)      Broccoli      Fish      Pork (=Pig)      Shrimp

Using the same method as you used for the coins, and thinking about what you know about the six food items, fill out each row of the table below.

Food item that is different	How this one item is different	How the remaining items are alike

Scientists might classify the food items differently than you did above. You can come very close to the scientific classification by thinking of the above list of foods in terms of the structural support, or skeleton (including parts such as legs, wings, etc.) of each life form. Complete the table below using this information. The first row has been worked as an example.

Food item that is different	How this one item is different	How the remaining items are alike
(1) Broccoli	(a) has a stem	(b) has a skeleton (shell or bone)
(2)	(c)	(d)
(3)	(e)	(f)
(4)	(g)	(h)
(5)	(i)	
(6)	(j)	

**Then use the letters and numbers to transfer the words from the blanks to the “Food Cladogram” diagram on page 4.**

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Discussion of Food Cladogram (Teachers – these questions can be either assigned, or used to structure class discussion.)

1. Which organisms/ food types are most closely related according to your cladogram?
2. As you saw, the scientists classification depended on complete knowledge of the supporting structure (such as the whole skeleton) of the organism. Suppose scientists could only use what is on the plate in, say, a Chinese restaurant, where food is usually served in bite-sized boneless pieces. Would this change the picture of which foods are considered closely related, and why?
3. Look at your notes from the five fossils you examined during the Fossils and Evolution program. Which fossils, if any, gave a fairly complete idea of the organism's shape and size when it was alive?
4. Which fossils gave the least complete idea?
5. How does the fact that many fossils are incomplete affect scientists' ability to classify fossils into groups?
6. Compare the Food Cladogram with the Tree of Life diagram. Above each box (1 through 5) on the Food Cladogram, write the name of the major group to which you think it belongs. (The major groups are the labels for the lines in the Tree of Life diagram; shrimp belong to the group "Other Arthropods".)
7. Bonus question:  
Study the Tree of Life diagram to learn the geological period and approximate number of millions of years ago that each major group is thought to have branched off. Using this information, below letters b, d, f, h, and j on the Food Cladogram, write your best guess as to when the trait you listed first appeared.