



How Can We Explain Evolutionary Relationships among Species?

INTRODUCTION

In the 1800s, naturalist Charles Darwin visited the Galápagos, a group of islands about 600 miles off the coast of Ecuador. There, Darwin observed many birds called **finches**. He noticed that some species of finches were more similar to others in terms of their physical traits and behaviors. Scientists today have continued to study these traits by collecting data on the finches over many generations.

You will use some of these traits to predict which finch species may be more closely related. Later, you'll learn more information that may help you revise your predictions. You will make observations, analyze and interpret data, and support claims with evidence. These skills are essential in science and many other fields.

MATERIALS

- one set of "Finch Species Cards" (13 cards)
- access to video clips used later in the activity

PART 1: Analyzing Data Based on Careful Observations

Your instructor will give you 13 cards with pictures of different finch species from the Galápagos Islands. Work in a small team, or as directed by your instructor, to answer the questions below.

1. Go through the cards and list the different traits you observe from the finch pictures. You can include both **physical traits** (how the finches appear in the pictures) and **behavioral traits** (what the finches are doing in the pictures).
2. Once your team has agreed on a list of traits, list each trait in the leftmost column of the table below. Add an "X" under each species that has that trait.

	Species (numbered on the cards)												
Trait	1	2	3	4	5	6	7	8	9	10	11	12	13

3. Next, you will group the cards based on which species you think are more closely related. In evolutionary terms, species being “closely related” means they share a recent common ancestor. Before moving the cards:
 - a. In your own words, explain what it means for two species to share a recent common ancestor.

 - b. Explain how you can use the table above to decide how closely related the finch species are.

4. Now group the cards based on which species are more closely related. Explain how you chose your groupings below, including the reasoning for your decisions.

5. Predict which traits would be most important for increasing an individual finch’s chance of **survival** (living longer) or **reproduction** (having more offspring). Categorize these traits in the table below. Next to each trait, explain why you put it in that category.

Traits that increase chances of survival		Traits that increase chances of reproduction	
Trait	Explanation	Trait	Explanation

6. Discuss your ideas for the previous question with other teams in your class, or as directed by your instructor.
 - a. Based on your discussion, which trait seems most important to finch survival?

 - b. Why would this trait be so important to finch survival?

Revisit your card groupings and make any changes you’d like based on your discussion above.

7. How might traits that increase *individual* survival help reveal evolutionary relationships among *species*? Support your answer using evidence from what you have figured out so far.

PART 2: Making Sense of a Phenomenon

Using what you figured out in Part 1, make some observations of the images below.



Figure 1. Some of the seeds available to finches as food on the Galápagos Islands.



Figure 2. Three different finch species from the Galápagos Islands.

8. Record your observations of the seeds and finches below.

9. Watch a video clip ([Clip 1](#)) to learn how these finches have been studied for the past several decades. Based on the clip and the images above:
 - a. Which of the traits you listed in Part 1 is most important to finch survival?

 - b. How would this trait help a finch survive?

10. Based on your observations of *the trait you picked in Question 9 only*, re-sort your finch species cards. Explain the criteria you used to determine your new groupings below. (If you did not change your groupings, explain why your original groupings were appropriate.)
11. **Selective pressures** are factors that affect an individual's chance of survival or reproduction in its environment. How might selective pressures drive certain versions of the trait you picked in Question 9 to become more common over generations?
12. Do you think selective pressures on the trait you picked in Question 9 could lead to a population of one species becoming so different that they diverge into a new species? Provide reasoning that supports your answer.

PART 3: Using Additional Data to Determine Evolutionary Relationships

13. What do you think makes an individual reproduce *only* with others of its own species?
14. Watch another video clip ([Clip 2](#)) of scientists playing finch songs. Predict what happened in the experiment described at the end of the clip.
15. Without changing your card groupings, flip your finch species cards over. The back of each card will have a graph like the ones shown in the video clip. This graph, called a **spectrogram**, represents a finch's song as a pattern of sound frequencies.
- Do the new data from the spectrograms support your current card groupings? Provide reasoning for your answer.

- b. Would you change any of your groupings with the new data in mind? Why or why not?
16. Using what you figured out in Parts 1 and 2:
- Describe any patterns you observe in both the songs (behavior) and the physical traits of these finch species.
 - Do these patterns help explain why finches of different species may not reproduce with one another? Provide evidence to support your answer.
17. Which of the traits you observed may keep different species of finches that live in the same place from mating with each other?
18. Do finch songs aid more in the survival of the individual finches or more in their chances of reproduction? Provide reasoning for your answer.

PART 4: Using Genetic Data to Determine Evolutionary Relationships

Similarities in the physical and behavioral traits of the Galápagos finches suggested that these species are more closely related to each other than to other types of birds. This led scientists to ask *how* exactly different finch species are related.

Watch a new film clip ([Clip 3](#)), which explains how genetic evidence (DNA) helped determine the evolutionary relationships among the different finch species.

19. Each line below is a DNA sequence from a different finch species.

CATACACTACACAGCAGACACCAACCTCGCCTTCTCCTCTGTAGCCACATATGCCGAGA
 CATACACTACACAGCAGACACCAACCTAGCCTTCTCCTCCGTCGCCCACATATGCCGAGA
 CATACACTACACAGCAGACACCAACCTAGCCTTCTCCTCCGTCGCCCACATATGCCGAGA

By making careful observations of the DNA sequences, explain how they could be used to better understand the evolutionary relationships among the different finch species.

By analyzing DNA sequences like the ones shown above, we can create an evolutionary tree diagram that shows the most likely evolutionary relationships among the species. Below is a tree diagram for the finch species you've observed throughout this activity.

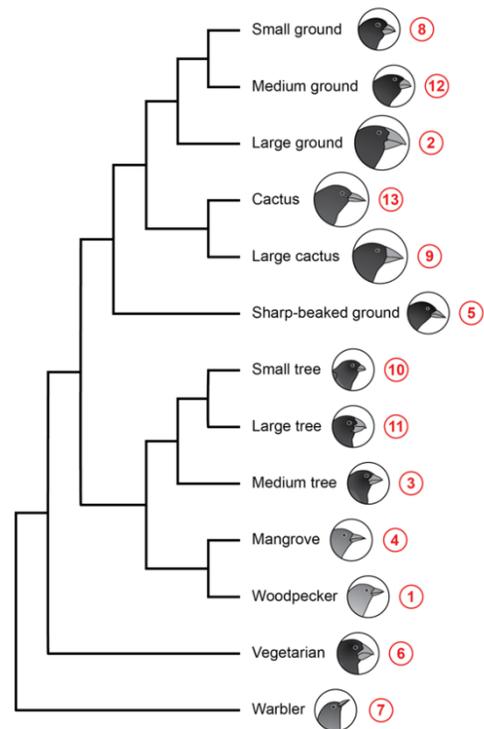


Figure 3. An evolutionary tree diagram based on DNA sequences. The diagram shows the most likely evolutionary relationships among the 13 finch species on the cards.

20. Based on the new data shown by Figure 3, would you change your finch species groupings? Explain how the new data may allow you to revise your model.

21. How do you think DNA sequencing changed how we view the many different species on Earth?

22. Over the course of this activity, you observed different types of data, including images, spectrograms, and evolutionary trees based on DNA sequences. Why are multiple lines of evidence important when studying evolutionary relationships among different species?

EXTENSION: Transfer Task with Anole Lizards

You'll now apply what you've figured out about evolution in the Galápagos finches to another type of animal: lizards called **anoles**.

1. Watch the first video clip ([Extension Clip 1](#)), which describes different anole species found on the islands of the Caribbean.
 - a. Which traits that aid in the survival of anoles are under high selective pressure in their environments?

 - b. How are these traits similar to the finches' beaks?

2. Watch the second video clip ([Extension Clip 2](#)).
 - a. Which trait in the anoles is similar to the finches' songs?

 - b. How is this trait similar to the finches' songs?

3. Watch the third and final video clip ([Extension Clip 3](#)).
 - a. How do traits you mentioned in the previous questions allow for anoles on each island to become different species?

 - b. Why is genetic data so important for determining evolutionary relationships among species?