Name _____ Class _____ Date_____

Birds on an Island

A Simulation of Natural Selection

Question Can natural selection change the frequency of traits in a population in only a few generations?

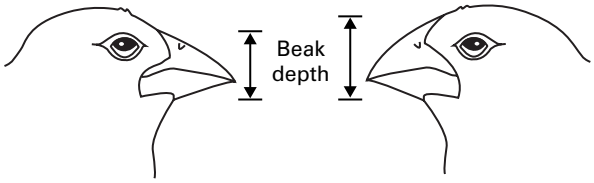
Lab Overview In this investigation you and your classmates will use a simulation exercise to explore how the frequencies of three beak phenotypes change over several generations in a population of birds on an island.

Introduction To start your investigation you will learn about a population of birds called medium ground finches on Daphne Major, one of the Galápagos Islands. Then you and your classmates will simulate the fitness of birds of a fictional species called *Saccharae utensilus*. This bird species has three possible variations in beak phenotype. Each "bird's" ability to acquire food will determine whether it dies, or whether it survives and reproduces. The number of offspring produced depends on the amount of food each bird acquires, which can vary greatly under changing environmental conditions. After simulating changes in the bird population for six generations, you will analyze data to discover how the frequency of each beak phenotype in the population changed over the generations.

Background Medium ground finches typically feed on small, soft fruit and seeds. The birds prefer soft seeds because they are easier to crack. However, during periods of drought, food becomes scarce. The birds are forced to eat more hard seeds that are difficult to break open. Scientists Peter and Rosemary Grant and their team studied the island's population of medium ground finches and discovered that there are significant variations in the beak depths of individual birds. Birds with deeper beaks are better able to crack open hard seeds than birds with shallower beaks. These variations in beak depth made it possible for some of the medium ground finches to get enough food to survive and reproduce during long droughts.

Prelab Activity To find out more about the variations in beak depth found in the medium ground finch population of Daphne Major, follow the steps below. Afterward, answer the Prelab Questions.

1. With a metric ruler, measure the beak depths of the two medium ground finches pictured below. Record your measurements in the spaces provided.

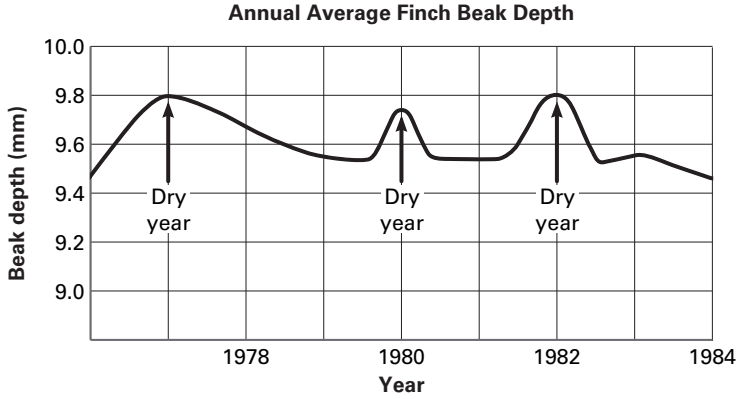


Medium ground finches

Finch A Beak Depth: _____ mm

Finch B Beak Depth: _____ mm

2. Study the graph below showing the average beak depth found in the medium ground finch population over a period of 8 years.



Prelab Questions

1. In which years did the medium ground finch population have the largest average beak depth? Were these wet years or dry years?

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2. Which of the two finches you measured in the Prelab Activity do you think would be more likely to survive and reproduce in a drought year? Explain.

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Materials

- plastic spoon, knife, or fork
- self-sealing plastic sandwich bag
- food pieces (candies, unshelled nuts, beans, etc.)
- plastic container for nest (optional)

Rules of the Island

a. You may not use your hands except to hold the plastic utensil (your "beak") and open the plastic bag (the "nest").

b. You may not push other "birds," deliberately knock the food out of the other "birds' beaks," or steal food from the other "birds' nests."

c. You must put your nest in the same general area as the other birds' nests.

d. When your teacher says that time is up, stop where you are. If you have food held securely in your beak, you may bring it to your nest.

e. Do not eat any of the food.

Procedure

(**NOTE:** *Not every student will participate in the simulation for each round. If you are not participating in the simulation for a round, your responsibility is to collect the data and share it with those who did participate.*)

1. Holding your "beak" in your hand, gather food and return to your nest to deposit it. Go to the food source to get more food as many times as possible until time is up.

2. When your teacher tells you the round is over, follow Table 1 on the next page to determine if you collected enough food to survive to the next round and reproduce.

Table 1

Food Pieces Collected	Outcome
Fewer than 6	Does not survive
6–11	Survives but does not reproduce
12–17	Survives and produces 1 offspring
18–23	Survives and produces 2 offspring
24–29	Survives and produces 3 offspring

3. In Data Table 1 below, record the initial population size for each beak variation in Round 1 as well as the total population size. (You will need to collect data from your classmates to record these numbers.) Next, use the following formula to calculate the frequency of each variation as a percentage. Enter your results in Data Table 1.

$$\frac{\text{variation population size}}{\text{total population size}} \times 100\% = \text{frequency of variation in total bird population}$$

4. After rounds 2 and 3 are complete, fill in the rest of Data Table 1.

Data Table 1

	Round 1		Round 2		Round 3	
Beak Variation	**Pop. Size**	**% Frequency**	**Pop. Size**	**% Frequency**	**Pop. size**	**% Frequency**
Spoon						
Fork						
Knife						
Total						

5. Fill in Data Table 2 to calculate the change in frequency of each beak variation over rounds 1–3.

Data Table 2

Beak Variation	% Frequency in Round 3 (A)	% Frequency in Round 1 (B)	Change in % Frequency (A − B)
Spoon			
Fork			
Knife			

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6. Now suppose that your island is experiencing a drought. The type of food available for the island's birds to eat has changed. Perform rounds 4–6 in the same way you performed rounds 1–3. Record the results in Data Table 3.

Data Table 3

	Round 4		Round 5		Round 6	
Beak Variation	**Pop. Size**	**% Frequency**	**Pop. Size**	**% Frequency**	**Pop. size**	**% Frequency**
Spoon						
Fork						
Knife						
Total						

7. Fill in Data Table 4 to calculate the change in frequency of each beak variation over rounds 4–6.

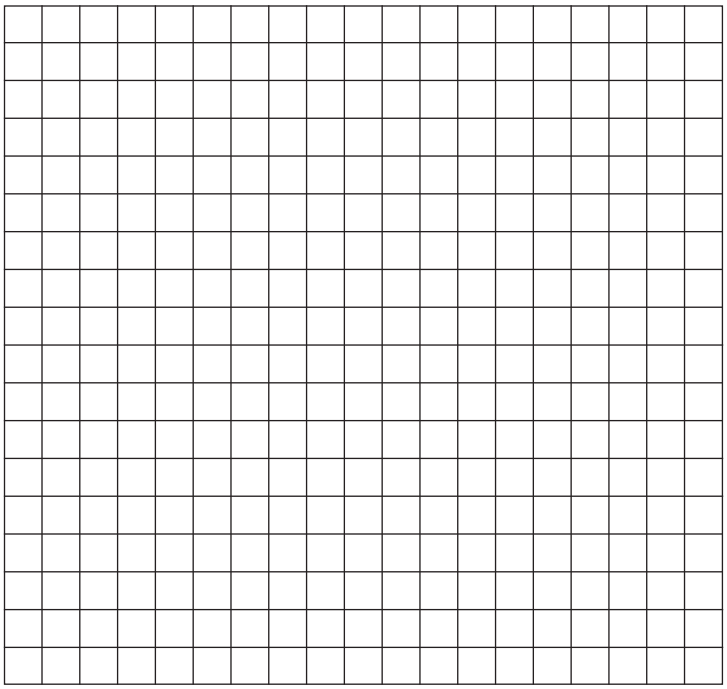
Data Table 4

Beak Variation	% Frequency in Round 6 (A)	% Frequency in Round 4 (B)	Change in % Frequency (A − B)
Spoon			
Fork			
Knife			

Analysis and Conclusions

1. Was there one beak phenotype that was more successful than another in rounds 1–3? If so, which one?

2. On the same *x*- and *y*-axes, plot three line graphs representing the success of each beak variation throughout the six rounds. Plot rounds 1–6 on the *x*-axis. Plot the percent frequency of each variation on the *y*-axis. Be sure to title your graph and label the axes and the three graph lines.



3. Describe the pattern of change for each beak type as displayed in your graph. Identify the most successful beak type or types and suggest reasons for the success.

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4. Did the frequency of the different beak variations change when the food supply changed? Relate this to what you learned about the finches on Daphne Major.

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5. How do you think the results of the Grants' research might have been different if the beak-depth variations were not genetically-based traits (were not passed on from generation to generation)?

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6. Competition and variation are two factors that play key roles in natural selection. Describe how these two factors resulted in natural selection in the population of ground finches on Daphne Major during drought years.

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Extension

Work with a classmate to make a list of ways that the model in this activity simulated natural conditions and ways that the model differed from natural conditions. Suggest one change to the model that could control for an additional variable or more closely simulate the natural world.