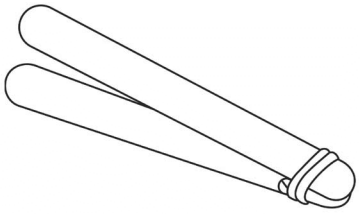
Birds, Beaks, and Natural Selection—A Simulation

In this simulation, students gather data to see how beak mutations can influence natural selection.

Objective
Students learn about the role of mutations in natural selection and evolution.

Procedures
1. The three to four students in your group represent individual wading birds within a population of 100 birds. This population of wading birds has a wild-type beak that will be made of tongue depressors.

2. Look at the wild-type beak model and construct a similar beak by wedging the screw 2 cm from the tips of the tongue depressors and using the rubber band to wrap the ends of the tongue depressors, making the beak like tongs.



3. You will simulate the wading birds feeding.
   - Add to your aquarium four of each type of food for each person in your group.
   - Take turns feeding for 15 seconds to see how many of each type of food you get, using the feeding rules.
     –Pick up only one piece of food at a time.
     –Don't use the edge of the aquarium to hold food.
     –Don't put your hand below water.
   - Replace food before the next feeding trial.
     –Wipe up any water on floor between trials.
   - Each member of the group should do three trials of feeding; after each trial, record the results in the "Bird Beak Data Sheet."

4. Calculate and compare the average number of food pieces and types of food captured by your team members.

5. Now assume that three to four birds (your team members) in your population will undergo mutations in the genes that code for beak length. Each student will pick a mutation handout that will explain the kind of mutation and how it will affect the beak size of your offspring.

6. Follow the instructions on your mutation sheet. If you received a beak mutation that requires a change, you will need to create the new beak for your offspring. For long beak mutations, use the extra-long glued tongue depressors, a screw, and the rubber band to make the beak tong-like. For short beak mutations, cut the wild-type beaks exactly in half using the scissors. Some mutations do not affect your offspring's beak; you will use the same wild-type beak. Answer these questions with your group:
    - What was the significance of having only four individuals within a population of 100 wading birds have a mutation?
    - Why did some mutations lead to a change in beak length and some not?

7. You will now feed as your offspring, Generation 1. Because this time *all members of a group will feed at once*, two teams will work together during the feeding of the offspring. While one group feeds, the other group will time and monitor the feeding. Then teams will switch roles. There will be three feeding trials of 15 seconds each, following the feeding rules, and food will be replaced between trials. Record your feeding data on the "Bird Beak Data Sheet" after each trial.

8. Determine the survival rate of your offspring by following the directions below and record results in the "Bird Beak Data Sheet" in the Generation Results column. Guidelines for determining offspring survival:
    - If offspring consumed less than half of the parent's average number/amount of food minus 2, they will die. For example, if offspring consumed 4 pieces of food and parent's average number/amount of food was 14, then they will die. (4 is less than 5x14-2=5)
    - If offspring consumed between half parent's average minus 2 to half of the parent's average, they will survive and reproduce 1 offspring.
    - If offspring consumed more than half the parent's average, they will survive and reproduce 4 offspring.

9. Compare your data and discuss the following questions in your group and record responses below.
    - What happened when the offspring with changed beaks and the offspring with wild-type beaks fed together?
    - For each type of beak, which food types were consumed? Which types were consumed the most?

- Based on the number of food items consumed, which birds survived? Which birds survived and produced the most offspring?
- Why might some surviving birds produce different numbers of offspring?
- What other factors besides beak length affected feeding in your population?
- What would you expect to happen to the population if the second generation were allowed to feed and reproduce under the same conditions?
- How did this simulation demonstrate natural selection?
- What is the role of mutations in natural selection?
- What is the role of sexual reproduction in natural selection?
- Which does natural selection act upon: the genotype or phenotype of traits?
- Explain the significance of the following statement: Natural selection operates on individuals, but evolution occurs at the level of the population.
- How is this simulation like the real world and how is it different in relation to feeding, mutations, beak lengths, and reproduction?