BIO FAX!

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Beaks

Flinn STEM Design Challenge™

Introduction

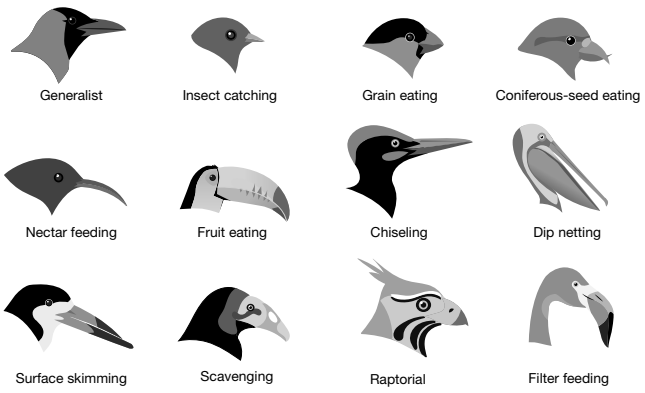
Natural selection is the theory that explains how slight differences among members of a population can be advantageous to survival and reproduction of that population. Those differences are passed on to offspring, with the most beneficial traits increasing in frequency within the population. Over time, changes become noticeable among the population.

Concepts

- Microevolution
- Natural selection
- Engineering Design

Background

Evolution on the smallest scale is called *microevolution*. It is the change of allele frequency from generation to generation within a population. A *population* is a local group of individuals of the same *species* with the potential to mate and produce viable offspring. The individuals that reproduce successfully pass their unique genetic material to the next generation. Those that do not reproduce die prior to passing on their genetic material.



Alleles are alternative forms of a gene. All the genes within a population are known as the *gene pool*. The gene pool is where the genetic variation is stored and pulled from for future generations. The gene pool varies based on how environmental factors impact natural selection. For example, if the environment "selects" for traits, and the conditions increase the ability to survive and reproduce, then those traits become more common, indicating a change in the gene pool.

A terrific example of microevolution occurs regularly on the Galapagos Islands. This is the same set of islands where Charles Darwin studied. The data he collected helped form his ideas of evolution through natural selection. Currently, there are 13 different species of finches that call the Galapagos Islands home. They are distinguished primarily by their beaks, each suited for a different food source. The medium ground finch, *Geopiza fortis* is a medium-sized bird with a blunt beak suited for crushing small seeds. All the finches will dine on small, soft seeds, but some—those with slightly bigger beaks—can eat larger, tougher seeds as well. In this activity, you will be given a finch "beak" and participate in a simulation to show how variation within the gene pool can be caused by environmental changes from generation to generation. You will then design and construct a finch beak to see if it can survive generationally and through environmental changes.

Materials

Calculator
Food items
Forceps
Fork
Skewer, bamboo
Weighing dish

Safety Precautions

This classroom activity is considered nonhazardous. Follow all standard laboratory and classroom safety guidelines. Students must walk to and from their nests and walk with their beaks down.

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Procedure

Part A. Predetermined Beaks

Feeding Rules:

a. You may not use your hands except to hold the "beak."

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

c. You may not move your nest to another location once you have selected your location.

d. When time is called, you must stop where you are. If you have food in your "beak," you may place it in your nest.

e. Do NOT eat any of the food items.

f. You can use your fingers to remove "food" from your "beak" to your nest.

Generations 1–3

1. Obtain one of the "beaks" from the designated beak area.
2. At each lab station, there is one weighing dish for each student. This is your nest. All food items must be placed inside your nest.
3. Find a location in the room to place your nest.
4. In Generation 1, only one "beak" of each type will participate. Anyone not participating is required to assist with data collection, clean up and replenish food.
5. Once time has started, walk from your nest to the feeding site and obtain food. Once the food item(s) is secure in your beak, walk back to your nest and place it inside your nest. *Note:* The beak is used to obtain and carry food, no hands.
6. Continuing adding food to your nest until time is called.
7. Using the Beak Survival table below, determine the number of "beaks" that will participate in Generation 2.

Beak Survival

Food Items Collected	Outcome
Fewer than 10	Does not survive
10–20	Survives but does not reproduce
21–30	Survives and produces 1 offspring
31–40	Survives and produces 2 offspring
41–50+	Survives and produces 3 offspring

8. Return food to the feeding site—this simulates nutrient cycling. Birds that do not survive do not return their food, rather put the food in a designated container.
9. Repeat steps 1–8 for Generations 2 and 3.

Generations 4–6

10. For the next three generations, the food source has changed due to environmental conditions.
11. All the "beaks" from Generation 3 will participate in Generation 4.
12. Follow steps 1–9 for generations 4, 5 and 6.
13. Follow the same rules as generations 1, 2 and 3.

Part B. Beak Design Challenge

Utilizing what you learned from Part A, design a bird beak that you believe will allow for the greatest survival chances. Remember, with natural selection if you increase your chance of survival, you live long enough to reproduce and therefore allow your traits to be passed on to your offspring. Here are a few rules and hints to consider while designing:

1. Different food items will be used during the design challenge.
2. You want a beak that can withstand changes to environmental conditions.
3. The beak you design must be "beak-like." For example, there needs to be a hinged jaw and it must open and close like a beak.
4. You can use any materials you want however, it must be a modified or original design. For example, you cannot bring in a kitchen spoon unless it was modified to behave like a beak.

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5. The size of the beak needs to fit within the following parameters (unless otherwise given by your instructor):
   a. length—under 10 cm
   b. width—under 3 cm
   c. height—under 5 cm
6. Because each beak will be unique, changes in the number of birds with a particular beak type cannot be modeled. Therefore, the "best beak" will be determined by process of elimination, see Beak Design Challenge Survival rules below.

Beak Design Challenge

Survival Rules

Generation	Food Items collected to Survive
1	More than 20
2	More than 40
3	More than 60
All students return to the ecosystem before generation 4 due to migration.	
4	More than 20
5	More than 40
6	More than 60

Tips

- The beaks students use and create represent beaks for the same bird species, just with variations among them.
- Allow 30–60 seconds for feeding depending on the laboratory setting.
- Feeding sites can be a large area, like the teacher lab station, or there can be smaller areas within the laboratory. The supplies can easily be pushed off flat surfaces creating a mess and safety hazard. Placing food items onto large trays will minimize such issues.
- Start with soft foods at the feeding site(s) for the 1st, 2nd and 3rd generations and switch to hard foods in the 4th, 5th and 6th generations.
- Soft food items could include cotton balls, pom poms, foam peanuts. Hard food items could include tooth picks, pebbles, and beans.
- Utilize different food items during the Beaks Design Challenge.
- For the Beaks Design Challenge, have all the students start during generation 1 and return for generation 4. Explain that since there are fewer birds competing for food, other birds would have the opportunity to migrate in. This will allow for maximum participation throughout the activity.
- The switch to hard food is representative of a drought as an environmental change.
- Extensions and/or modification to this activity are many. For example, students could bring in different food items that challenge each other's beak. As a class, group the beaks prior to Part B and then the procedure from Part A could be followed to show variation while practicing or reviewing classification. Another extension could be to require each beak to obtain at least one particular food item in order to survive and reproduce. (For example, each beak must have a fishing lure in the nest; this could represent protein required during the breeding season for robin red breasts.) This could be required in both Part A and Part B.

The *Beaks—Flinn STEM Design Challenge*™ is available from Flinn Scientific, Inc.

Catalog No.	Description
FB2130	Beaks—Flinn STEM Design Challenge™
AP5429	Demonstration Tray, Large

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