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# K-12 Partnership Lesson Plan

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# *Natural Selection in the Classroom*

# *Semester-long projects that will allow students to see evolution in action*

## Overview

In this lesson, teachers explore potential semester to year-long evolution lessons that will enable the development of classroom lessons about evolution by natural selection. These lessons consist of long-term studies where change in populations over time is observed rather than simulated.

**Objectives**

At the conclusion of the lesson, students will be able to:

* Develop a long-term natural selection lesson for the classroom
* Plan for the effective measurement of traits and fitness
* Discuss and teach the 3 requirements for evolution by natural selection: phenotypic variation, relationship between a trait and fitness, and heritability of the trait

**Length of Lesson**

The lessons discussed are designed to be semester to year long, long-term experiments. The long duration is necessary in order to see a response to selection

**Grade Levels**

This lesson is intended for either an Intro Biology or Advanced Biology class. Adjustments are suggested for younger students as well.

**Standards covered**

Disciplinary Core Ideas:

* **HS-LS4-2:** construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment
* **HS-LS4-3**: apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait
* **HS-LS4-4**: construct an explanation based on evidence for how natural selection leads to adaptation of populations

Cross Cutting Concepts:

* Patterns
* Cause and effect
* Structure and function

Science and Engineering Practices

* Asking questions and defining problems
* Planning and carrying out investigations
* Analyzing and interpreting data
* Engaging in argument from evidence
* Obtaining, evaluating, and communicating information

***Previous Michigan Standards Met:***

* **1.1**: constructing new scientific knowledge
* **3.3**: heredity
* **3.4**: evolution

**Materials**

FOR PLANT EXPERIMENTS

* Plants with variable traits (“Confetti Mix” rapid-cycling *Brassica* available from Carolina Biological lab are a good choice)
* Pots and potting soil
* Tools to measure whatever traits the students select; rulers are sufficient for many traits
* Grow lights or a window with sufficient natural light

FOR SNAIL EXPERIMENTS

* Snails and crayfish (available from Carolina Biological Lab)
* 10-gallon fish tanks
* Rulers
* Calipers

**Background**

Three things are necessary for evolution by natural selection to occur. 1) The trait under consideration must be variable, e.g. mice with longer and shorter tails. 2) There must be a relationship between the trait and fitness, e.g. mice with shorter tails produce more offspring. 3) The trait must be heritable, i.e. have a genetic basis, e.g. long-tailed mice have long-tailed offspring.

Natural selection can be imposed by a wide variety of agents, biotic and abiotic: climate, soil, predators, competition for resources, competition for mates. Stronger selection can produce faster evolution, but often many generations are required for evolution to be visible to us.

People often purposefully impose selection on other living things, too: we call this artificial selection. It is most visible in domesticated animals and plants, from widely differing dog breeds (still all one species!) to the variety of roses we plant in our gardens. Although artificial selection produce change much faster, and may not make organisms that are well suited to life away from human beings, the basic process is the same as natural selection.

### Activities of the session

The activities are divided into artificial selection and natural selection. The artificial selection experiments are faster and will likely show a more dramatic result, but require more hands-on work and may not communicate as clearly to the students the connection between a trait that increases fitness and the increase of that trait in the population.

ARTIFICIAL SELECTION

First grow the plants. It is important to have plants that are variable for many different traits; an F2 hybrid cross population is great for this, but the rapid-cycling *Brassica* mix available from Carolina Biological Lab is just as good.

Next, have students choose traits they are interested in measuring. They can break up into small groups, with each group measuring a different trait. If there is time, they should come up with a hypothesis about how different extremes of their trait might be adaptive (e.g., “Hairy leaves might be resistant to herbivores, but hairless leaves might get more light for photosynthesis.”). The students should measure the trait they are interested in on as many different plants as possible. If they take multiple measures on the same plant, those should be averaged to get a trait mean for that individual.

Have groups make a graph of the distribution of their trait of interest and share it with the class.

Now to the artificial selection part of the lesson: students should take the 1/3 of plants at the extreme of their distribution and cross them. This may require a short lesson on plant reproduction if the students have forgotten – the best way to pollinate is to use forceps to take the anther of one plant and wipe it on the stigma of another. One plant may have several different crosses performed on it, so be sure to label the flower each cross is performed on with a small piece of tape around the pedicel (stem just below the flower).

Once the fruits have ripened, plant the seeds in carefully labeled pots. When those plants have grown and begun to flower, measure the same traits on them and plot the distributions again. Ask the students to predict what will have happened to the trait distributions – they should have moved in the direction of artificial selection. Be sure to use **at least** 10 plants in each set of crosses each generation to prevent inbreeding depression.

NATURAL SELECTION

These experiments are trickier to set up, but the payback in learning is tremendous.

Set up several tanks with snails from Carolina Biological. In this experiment, the crayfish are the agents of selection on the snails. Ask the students to think about what traits crayfish as predators might select for in their snail prey. Some ideas are better hiding behavior, larger shells, and thicker shells. Ask the students how they would measure the traits they think are important.

Once students have chosen traits, again ask them to measure and plot the distribution of the traits. Then introduce the crayfish to the tanks, and let the natural selection experiment begin! One crayfish per tank should be enough; monitor the tanks to be sure there are enough snails that the crayfish do not eat them all, but leave a group to breed. The longer you can leave this experiment to run, the better.

At the end of the semester or year, ask the students to measure the traits in the snails now in the tank and plot the distribution. The snails should have reproduced during this time, and students should have noticed this by the appearance of small, growing snails in the tanks. Any change in the mean trait from the beginning to the end of the experiment should be the result of natural selection from the crayfish predators.

**Resources**

* Introduction to selection powerpoint lecture (found on the “Natural Selection in the Classroom” lesson page on the GK-12 website)
* Artificial selection worksheet (located on website)

**Extensions and Modifications**

Simplifications of the artificial selection experiment can be used to teach about variation in natural populations (do the trait measurements and distributions within a single generation), plant reproduction (performing pollinations and watching fruits form), and heritability (crossing like to like, or like to unlike, and looking at the appearance of the offspring).