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# K-12 Partnership Lesson Plan

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# *The Hunger Games: Hiding in Plain Sight*

# *Exploring evolution using mimicry*

## Overview

Evolution is one of the most fundamental concepts in biology. The process of evolution by natural selection has produced some of the most spectacular traits found in living organisms. In this lesson students will explore the concept of evolution by natural selection using mimicry as an example. Mimicry refers to a similarity between more than one species for the purpose of protection. For example, a non-poisonous species may closely resemble a poisonous species, and this resemblance protects the non-poisonous species from predators. In this session, students will play a scavenger hunt game using Easter eggs to demonstrate the benefits of mimicry and the conditions under which mimicry can evolve.

**Objectives**

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

* Understand the process of evolution by natural selection and be able to identify/explain its three components
* Understand that populations evolve, not individuals
* Understand that evolution occurs across generations, not within a generation
* Understand the concept of mimicry and how it can evolve
* Relate patterns to theory
* Use evidence and reason to form a conclusion

**Length of Lesson**

50 minutes (35 minutes for activity + 15 minutes for introduction and follow up)

**Grade Levels**

Grades 6-12

**Standards covered (NGSS)**

Disciplinary Core Ideas:

 *Grade level (if your lesson spans multiple grade levels, not needed elsewise)*

* **MS-LS2-4**: construct an argument supported by empirical evidence that changes to physical or biological components or an ecosystem affect populations
* **MS-LS1-4**: use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animal and plants respectively
* **MS-LS1-5**: construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms
* **MS-LS4-4**: construct an explanation based on evidence that describe how genetic variations of traits in a population increase some individuals’ probability of surviving and reproducing in a specific environment

*High School*

* **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-LS4-4**: construct an explanation based on evidence for how natural selection leads to adaptation of populations

Cross Cutting Concepts:

* Patterns
* Stability and change of systems

Science and Engineering Practices

* Developing and using models
* Planning and carrying out investigations
* Engaging in argument from evidence

***Previous Michigan Standards Met:***

* **B1.1**: inquiry, reflection, and social implications- scientific inquiry
* **B3.4**: interdependence of living systems and the environment- changes in ecosystems
* **B3.5x**: interdependence of living systems and the environment- environmental factors
* **B4**.**L4.P2**: genetics- heredity and environment
* **B4.4x**: genetics- genetic variation
* **B5.3**: evolution and biodiversity- natural selection

**Materials**

* Two different colors of hollow, plastic Easter eggs (or other small container). In our demonstration we used 150 Easter eggs: 70 green, and 80 orange.
* Some type of candy
* Small rocks/pebbles
* Stopwatch

**Background**

Evolution by natural selection has produced some of the most remarkable behaviors, anatomical structures, and physiological processes found in living organisms. There are three requirements for evolution by natural selection:

1) Variation in the trait of interest.

2) Individuals possessing a certain form of the trait survive or reproduce better than others (selection).

3) The trait must be heritable (must be passed down from parents to offspring).

 When these requirements are met populations will evolve over time.

One example of a set of traits that are shaped by natural selection is mimicry. Mimicry occurs when one species resembles another for the purpose of protection. This resemblance can be in appearance or behavior. For example, a non poisonous species may look like a poisonous species in order to ward off predators. In this case, the poisonous species that is being mimicked is the referred to as the “model”, and the non poisonous species is the mimic. Individuals that more closely resemble the model will be better protected and thus produce more offspring than individuals that do not resemble the model. As a result, over time the population will evolve to more closely mimic the model species.

One well known example of mimicry is the coral and milk snake. Coral snakes are very poisonous, while milk snakes are non-venomous. Both species are similar in appearance with bands of red, black, and yellow coloration. This similarity in appearance is thought to be a case of mimicry where the milk snake is mimicking the coral snake to scare away potential predators.

Another interesting example of mimicry occurs between different tiger moth species. Tiger moths (along with other flying insects) are preyed upon by bats. Some species of tiger moths are noxious and bad to eat, while others are perfectly edible. Certain noxious species send a warning signal to bats in the form of ultrasonic clicks (which bats detect very well) and bats tend to avoid eating moths producing these clicks. Over evolutionary time, some edible species of tiger moths began producing the ultrasonic clicks as well. This is thought to be a case of mimicry, where the edible species are mimicking the warning sounds of the noxious species in order to avoid being eaten by bats.

Considering these examples, it is clear to see that being a mimic can be very beneficial; however, it is important to keep in mind that the benefits are not always constant. Being a mimic is only beneficial if there are lots of poisonous/inedible model organisms around in the environment. If there are too many mimics and not enough models, predators may evolve to ignore the mimicked behavior or appearance and begin eating individuals indiscriminately.

In this lesson students will explore the concept of evolution by natural selection using mimicry as an example. Students will play the part of predators feeding in an environment with edible and poisonous prey species. Students will be able to observe how mimicry can evolve and how predators evolve in response to mimicry.

### Activities of the session

1. Before the lesson:
	1. Designate a search area for the game (see attached sheet), the size of the area will depend on the size of the class, but should be large enough that Easter eggs are not clumped together.
	2. Prepare your Easter eggs so that the “edible” species is filled with candy and the “toxic” species contains a rock/pebbles. We recommend using green and orange eggs. Green eggs are always edible, while orange eggs can either be toxic or edible (a mimic).
2. Introduce the concept of evolution by natural selection, be sure to emphasize the different components and point out that populations evolve, not individuals (use PowerPoint presentation).
3. Describe mimicry to the students, provide several interesting examples.
4. Explain to the students that they are going to play a scavenger hunt game to demonstrate how mimicry can evolve. Hand out The Hunger Games: Hiding in Plain Sight rule sheet.
5. Assign students different hunting strategies (see rule sheet for the list of strategies)
6. Take students outside to the game field/area and have them spread out along the border.
7. Spread the eggs throughout the area. We recommend using 70 green eggs and 80 orange eggs (20 of those orange eggs are “edible” and filled with candy, 60 of the orange eggs are “toxic” and filled with a rock).
8. Give the students one minute to collect as many eggs as they can (while following their hunting strategy). If a student picks up a “toxic” egg he/she has to freeze and count to 10 before resuming hunting.
9. At the end of the minute ask the students how many edible eggs they were able to collect. Those with 5 or more survive and those with less than 5 die. Additionally, those who have 7 or more not only survive but “reproduce”; the student can bring a “dead” player back into the game, and the new player adopts the “reproducing” student’s hunting strategy.
10. Make sure to ask the students what their hunting strategy was and whether one strategy seems to be particularly effective or ineffective. Ask the students what they think will happen to the population of predators and mimics over time.
11. Repeat steps 6-9 for two more rounds of hunting. Make sure to point out to the students how the predator population is changing. Ask students if they think being a mimic is a good thing, and if they think the proportion of mimics in the population is going to increase or decrease over time.
12. Tell the students that they are now leaping forward in time to a future where the number of mimics is actually greater than the number of toxic individuals. Tell the students that they will all go back to their originally assigned hunting strategies.
13. Reset the eggs in the game area by changing the number of mimics. We recommend using 20 orange “toxic” eggs, and 60 orange mimic/edible eggs.
14. Repeat steps 6-9 using these new egg numbers so that students go through 3 rounds of hunting.
15. Ask the students how the population of predators changed over the 3 rounds. Ask them whether being a mimic was still a good thing.
16. After completing the game have students complete the wrap-up worksheet.

**Resources**

* The Hunger Games: Hiding in Plain Sight PowerPoint
* Game rule sheet and wrap-up worksheet (both available on “The Hunger Games” lesson page on the KBS GK-12 website)
* http://en.wikipedia.org/wiki/Mimicry
* http://academic.reed.edu/biology/professors/srenn/pages/teaching/web\_2008/ssmb\_acoustic\_mimicry/index.html
* http://en.wikipedia.org/wiki/Evolution

**Extensions and Modifications**

1. The game can be used to demonstrate the process of predator learning by allowing students to change their strategies between trials.
2. The game can be used to teach the benefits of camouflage by coloring some Easter eggs green (or whatever color best blends with the background).

**Assessment**

 Students will be assessed with thought questions, discussion and a wrap-up worksheet.

Name:\_\_\_\_\_\_\_\_\_\_\_\_\_

**The Hunger Games: Hiding in Plain Sight**

**Background:**

In this activity you get to become a predator searching for prey. The prey is represented by Easter eggs, and there are two species, one is toxic and the other is edible. The toxic species is orange, but the edible species has more variation in its color. Some individuals from the edible species are green, while others mimic the toxic species and are orange. As a predator, you can have one of several different hunting strategies (see below) that determine how likely you are to try to eat an orange individual. Will mimicry benefit the edible species? Will it increase in the population over time? How will predators respond? Let’s find out!

**Instructions:**

* Before beginning the game prepare a set of plastic Easter eggs to represent the prey species. We recommend using 150 Easter eggs, 70 green and 80 orange. The green eggs are all part of the edible species; put a piece of candy into each of these eggs. The orange eggs can be either the toxic species or edible mimics. To start out, put a piece of candy in 20 of the orange eggs (these are the mimics) and a rock/pebble/other inedible object in the remaining 60 orange eggs (these are the toxic individuals).
* Spread the eggs out across a designated area outside in a field/lawn. The area should be large enough that the eggs are not clumped together.
* Assign hunting strategies. The four possible hunting strategies are:

1) Always pick up orange eggs when they are encountered

2) Pick up approximately half of the orange eggs that you encounter

3) Pick up approximately a quarter of the orange eggs that you encounter

4) Never pick up orange eggs

Note that whatever strategy you are assigned remains your strategy throughout the entire activity. Also note that all strategies should pick up green eggs whenever they are encountered.

* Players have one minute to collect as many eggs as they can (while following their hunting strategy). When you pick up an egg, open it up to make sure it is edible (contains candy). If you pick up a toxic species you become “sick” and must freeze and count to 10 before you can resume searching for eggs.
* At the end of 1 minute count up how many edible eggs you collected. If you have 5 or more you survive, if you have less than 5 you die. If you are dead stand off to the side of the game area and form a line with other dead players. If you have managed to collect 7 or more edible eggs not only do you survive, you also reproduce. The person in the front of the line of dead rejoins the game and uses the hunting strategy of the player that brought them back.
* Repeat the egg hunt two more times (make sure you replace all of the collected eggs before beginning a new hunt).
* After completing three egg hunts, answer the following questions:
How has the population of predators changed?

Do you think being a mimic is beneficial?

Who do you think will have more offspring, the green or orange edible eggs?

What do you think will happen to this population over time? Will there be more mimics?

* For the next part of the game change the proportion of mimics in the environment. To do this reset the orange eggs so that 60 are mimics and contain candy, while only 20 are toxic and contain rocks.
* Perform an additional 3 egg hunts following the same rules as above.
* After completing the egg hunts answer the following questions:

How has the population of predators changed?

Is being a mimic still beneficial?

Why are mimics no longer better off than the green eggs?

What do you think will happen to the population of eggs over time?

* Pick up all of the materials and complete the wrap-up worksheet.

Name:\_\_\_\_\_\_\_\_\_\_\_\_\_

**Wrap-up Worksheet**

1) What are the three components of evolution by natural selection?

2) Did the predators in the game evolve over time? How?

3) Did individual predators evolve, or did the population as a whole evolve?

4) Did the egg species evolve during the game? How?

5) Based on the results from the game, when is it best to be a mimic?