CIED 4613 Spring 2016

Survival of the Fittest

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Course: Biology	**Lesson Title**: Survival of the Fittest
Time Requirement: 3-50 minute class periods	**Instructional Unit**: Evolution and Natural Selection
Central Focus (Purpose) The purpose of this lesson is to demonstrate the effects environmental factors have on the organisms that live in an environment. Students will participate in a hands-on activity followed by a discussion of findings to give a deeper understanding of the processes that drive natural selection.	

Next Generation Science Standards (NGSS)	
Science Standard	**HS-LS4: Biological Evolution: Unity and Diversity**
Disciplinary Core	**Life Science**
Performance Expectation	**HS-LS4-4: Construct an explanation based on evidence for how natural selection leads to adaptation of populations.**
Scientific and Engineering Practice	**Constructing Explanations and Designing Solutions:** • Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.
Disciplinary Core Idea	**LS4-C: Adaptation:** • Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not.
Crosscutting Concept	**Cause and Effect:** • Empirical evidence is required to differentiate between cause and correlation to make claims about specific cause and effects.

Oklahoma Academic Standards for Science (OASS)	
Science Standard	**HS-LS4-4: Biological Unity and Diversity**
Disciplinary Core	**Life Science**

Performance Expectation	**HS-LS4-4: Construct and explanation based on evidence for how natural selection leads to adaptation of populations.**
Scientific and Engineering Practice	**Constructing Explanations and Designing Solutions:** • Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.
Disciplinary Core Idea	**Adaptation:** • Natural selection leads to adaptation that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. • That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. • Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline- and sometimes the extinction- of some species.
Crosscutting Concept	**Cause and Effect:** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific cause and effect

Connection to Nature of Science	
Tenet	**Explanation of how this lesson address the NOS tenant**
Inferential	Students will make observations during activities and use those observations and the knowledge gained to infer and make predictions of potential effects of environmental change on populations of organisms.

	Learning Objective(s) Associated with Above Standards:	**Evaluation Questions** Create 3 questions with real-world applications of the topic. Of the 3 questions, there should be 1 multiple choice, 1 open-ended explanation question, and 1 table/graph interpretation. Provide answers to all questions.	**Level of Bloom's Taxonomy**	**E Addressed** In which E should the students be focusing on

<table>
<tr><td></td><td></td><td></td><td></td><td>this objective question</td></tr>
<tr><td>*1
NOS</td><td>Students will be able to make logical predictions about changes in a population based on environmental factors.</td><td>1. A plains environment has a rabbit species that can have either brown or white fur. During the winter, the plain gets covered in snow. Which of the following would you expect during the winter?
a. The proportion of brown rabbits in the -population will increase while the proportion of white rabbits in the population will decrease.
b. The proportion of white rabbits in the population will increase while the proportion of brown rabbits in the population will decrease.
c. The rabbit population will remain the same.
d. The rabbit population will decrease for both fur colors.

2.
<table><tr><td></td><td>Summer</td><td>Winter</td></tr><tr><td>Number of Brown Rabbits</td><td>500</td><td>350</td></tr></table>Based on the table above, what can you predict about the environment the brown rabbits live in?
In the winter, the environment changes and the brown rabbits are easier to find and prey on.

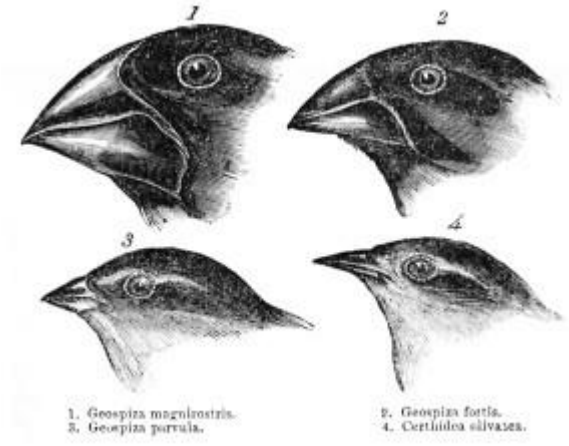
3. Frogs with longer legs can escape from predators easier than frogs with shorter legs. Explain what changes this will cause on the frog population.
Frogs with shorter legs will be eaten more often the frogs with longer legs</td><td>1. Understand

2. Understand

3. Understand</td><td>1. Engagement

2. Engagement

3. Elaboration</td></tr>
</table>

		and the population will have more frogs with longer legs.		
2	Students will be able to explain the process of natural selection.	1. Define natural selection. **Natural selection is the process in which organisms become better adapted to the environment, have a better chance of survival, and produce more offspring.** 2. Which of the following is an example of natural selection? **a. A population of frogs begins to have longer legs after several generations in an area with many predators.** b. An individual rabbit suddenly develops white fur in a snowy area. c. An entire population of squirrels suddenly develop shorter tails in an area with fast predators. d. All of the above are examples of natural selection. 3.  Based on the figure above, which bird would have the best chance for survival in an environment where the main food source is large, hard-shelled nuts? Explain your answer.	1.Remember 2.Understand 3.Analyze	1. Explanation 2.Elaboration 3. Explanation

		Bird 1, because it has a larger, stronger beak, so it could break open the shells easier and eat more nuts. Figure from http://thehumanist.com/features/articles/a-short-history-of-evolution-chapter-2-part-1-natural-selection		
3	Students will be able to identify factors that contribute to natural selection.	1. A species of moth in a forest has either light-colored or dark-colored wings. The majority of the population used to have the light-colored wings. However, there has been a shift in the population and there are now more dark-colored moths than light-colored moths. Which of the following is a possible cause of the shift? a. **Soot from nearby factories darkened the trees that the moths land on, making the light colored moths stand out more and be preyed on more often**. b. The moths decided to be a darker color and changed. c. A disease spread through the forest and only affected the light-colored moths. d. All of the above are possible causes. 2. A population of butterflies can have either large wings or small wings. In the past, a majority of the butterflies had larger wings. Recently, there has been a shift so that smaller wings are more common. List a possible reason for this shift. **Some birds in the environment have larger beaks and can eat the larger butterflies easier.** 3.	1. Understand 2.Knowledge 3.Analyze	1. Explanation 2.Explanation 3.Elaboration

		<table><tr><td></td><td>2000</td><td>2003</td></tr><tr><td># of frogs with short legs in population</td><td>145</td><td>125</td></tr><tr><td># of frogs with long legs in population</td><td>122</td><td>148</td></tr></table> Based on the table above, give a plausible explanation for the shift in the frog population. **Answers will vary. One possibility is "The predatory population increased and frogs with longer legs were able to escape more often and reproduce"**		

Resource for the 5E Phase	**Description of Materials**	**Quantity** Per group, /student, or /class	**Advanced Preparations required**
Engagement	PHET Natural Selection Simulator	1/class	Download the simulator from https://phet.colorado.edu/en/simulation/natural-selection and have it open before class. (No installation is required)
Exploration	Fabric (1 sq. yard) with different patterns/colors	1sq yard/ group	Make sure fabric is clean
	Paper dots of colors of several colors (Ex: yellow, red, blue, green, and black)	1 bag/group	Hole-punch the dots from colored paper and bag multiple bags of combined colors. Each bag should have about 50 dots and contain all the colors. They do not necessarily have to have the same amount of each color.

	Extra bags of each color of dot	1/ class/ color	Hole-punch the dots from colored paper. Bag each color individually.
	Cups	1/group	
	Graph paper	1sheet/group	
	Colored pencils	1 small box/group	

Explain what students are expected to know prior to the start of this lesson. In what format did they learn this information?
Students should already know that certain traits in a population increase the probability that individuals with those traits will survive and reproduce. They learned this in middle school, according to the Next Generation Science Standards. Students should also know from previous classes how to record data in a table and how to construct a line graph from data collected.

5E Lesson

Objective Statement(s): Class, we are going to learn about how organisms adapt to their environment through natural selection.

ENGAGEMENT		Time in Minutes: 15
Explain what the **Teacher Will Do**	Probing/Eliciting Questions and Correct Responses	Explain what **Students <u>Will Do and the goal of the activity</u>**
• The teacher will project the PHET Natural Selection Simulator so the entire class can view it. (fromhttps://phet.colorado.edu/en/simulation/natural-selection) • Pause the simulation and tell the students that you will be showing a simulation. Demonstrate the different features of the simulation by adding the different mutations and introducing the	What do mutations do to the population? [They add variation to the traits.] Why do the rabbits with long teeth survive better when food is limited? [Because the rabbits with longer teeth can access food better.]	• Students will watch the simulation, make observations of the environmental factors at play in each scenario, and construct predictions of what will happen for each mutation and scenario. • Students will record predictions and observations in StudentEngagementHandout1-SimulationObservations.

environmental factors and changing the location. • Reset the simulation and add a color mutation. • Let the simulation run to raise the population rabbits. Pause the simulation and ask students to predict what will happen if wolves are introduced. Introduce wolves and have students make observations. • Continue this pattern with different factors. • Continue with other situations listed in TeacherEngagementHandout1-NaturalSelectionSimulator Teacher Handout(s): TeacherEngagementHandout1-NatualSelectionSimulator		• The goal of this activity is to provide students with a visual for natural selection and some environmental factors that can drive the process. The activity also encourages them to think about natural selection that will be introduced in the Exploration Phase of this lesson. Student Handouts(s): StudentEngagementHandout1-SimulationObservations
Transition Statement		
We just started learning about different environmental factors through the rabbit simulation. Next we will begin learning about natural selection in the Dot Hunters activity.		

EXPLORATION		Time in Minutes: 35 minutes
Explain what the **Teacher Will Do**	Probing/Eliciting Questions and Correct Response	Explain what **Students <u>Will Do and the goal of the activity</u>**
• The teacher will have students break up into groups of two or three. • Handout bags of mixed dots and a piece of fabric to each group. • Handout and explain the rules in	What would happen if the predator could not see color? [Finding prey would be harder] How would predators find prey that blend into the environment? [By watching for movement, smell, and/or feeling around.]	• Students will read the activity directions in StudentExplorationHandout 1-DotHunters. • Students will observe the color(s) of their fabric and predict which colors will easiest to identify.

StudentExplorationHandout1-DotHunters. • Time each round of hunting for 20 seconds. • The teacher will collect each group's data table and graph at the end of the activity. Exploration Activity adapted from: Waldron I., & Doherty, J. (2016). Evolution by natural selection. *Hands-on activities for teaching biology to high school or middle school students.* Retrieved from http://serendip.brynmawr.edu/sci_edu/waldron/#evolution	Why is blending in so important for some species? [Because it's what allows them to survive and reproduce.] Explain how organisms that do not blend in can adapt and survive. [If an organism cannot blend in, they can adapt by becoming faster or being able to climb/burrow when their predator cannot.]	• Students will spread dots across the fabric and when the teacher says "Go", will collect as many dots as possible in the given amount of time. Collected dots will be placed in their "stomach" (the cup). • At the end of each round, students will record the number of each colored dots collected, or "eaten." They will also record the numbers of each colored dots left on the fabric. All data will be recorded to the table in StudentExplorationHandout 2-DataTable. • For every two dots of each color that "survived", students will add another dot of that color. • This will continue until 10 rounds are completed. Students will then graph their data as a line graph on the graph paper. • The goal of this activity is to provide students with a hands-on experience representing predator/prey relationships in terms of population phenotypic adaptations. Student Handout(s):

		StudentExplorationHandout1-DotHunters StudentExplorationHandout2-DataTable
Transition Statement		
We just explored how it is to hunt through Dot Hunters. Next, we will discuss your results in terms of dot populations.		

EXPLANATION		Time in Minutes: 30
What the **Teacher Will Do**	Probing/Eliciting Questions and Correct Responses	Explain what **Students Will Do and the goal of the activity**
• The teacher will return the fabric, data tables, and graphs to each group and explain that there will be a discussion over each team's hunting.	What differences would you see if you placed mostly red dots on a mostly blue fabric? [The red dots would be picked up more frequently/the fastest.] How would it look if we took the dots from one fabric after the ten rounds and put them on a different fabric? [The dot color proportion would change depending on which fabric they were put on.] Why did your dot hunting slow down (or not) as the generations passed? [Because the population became more adapted and more dots blended in.] Explain what would happen if one of the dots developed a mutation that allowed them evade predators even more. [If there was a beneficial mutation, the individual would be more likely to reproduce and the mutation would carry on to the offspring.]	• Students will show the class their fabric and explain the patterns in their data (which colors tended to survive, which colors tended to reproduce, if the number of dots eaten each time were constant or changed throughout the generations). • The goal of this activity is to give students a discussion over natural selection and adaptation to help give them a deeper understanding and fill in any gaps the students might have in their knowledge.

Transition Statement
We just discussed your results from "Dot Hunters". Next we will look at how natural selection affects organisms in natural environments.

ELABORATION/EXTENSION		Time in Minutes: 20
What the **Teacher Will Do**	Probing/Eliciting Questions and Student Responses	Explain what **Students <u>Will Do</u> <u>and the goal of the activity</u>**
• The teacher will hand out StudentEalborationHandout 1-FrogScenario to the students. • The teacher will answer any questions the students may have regarding the assignment. Teacher Handout(s): TeacherElaborationHandout1-FrogScenarioAnswers	What benefits do longer legs provide to frogs? [Longer legs allow them to jump further and escape predators with more ease.] How would an adapting frog population affect the population of their predators? [By making it harder for the predator to consume them, so the predator would have to adapt, as well.] Why would jumping not always be a good strategy for survival? [Because the predator could have poor eyesight or the frog could blend in, therefore, jumping would allow it to become more visible.] Explain a reason that longer legs on a frog can be harmful. [If a frog has longer legs, there is more for predators to catch.]	• Students will read the scenario on StudentElaborationHandout 1-FrogScenario. • Students will predict what potentially could have caused the changes in the frog populations. • Students will write a one paragraph explanation based on evidence to provide a possible explanation of the given scenario. Student Handout(s): StudentElaborationHandout1-FrogScenario

Final Transition Statement
We just discussed the real-life frog example of adaptation. Next we will test your knowledge of natural selection with a quiz.

EVALUATION (Summative)	Time in Minutes: 50
Describe the Assessment	Explain what **Students <u>Will Do</u>**
• This assessment will measure students'	• The students will answer the questions on the test to the best of their ability independently.

knowledge of natural selection. • The teacher will hand out StudentEvaluationHandout1-Quiz Answers to the quiz will be on TeacherEvaluatinHandout1-QuizAnswers. Teacher Handout(s): TeacherEvaluationHandout1-QuizAnswers	Student Handout(s): StudentEvaluationHandout1-Quiz

List three Common Misconceptions, identify how each misconception is addressed, and where, in the lesson, is this misconception addressed:

1. Each individual goes through natural selection and adapts individually to the environment.
2. Individuals choose to adapt of their own will.
3. Natural selection always leads to improvement.

All misconceptions were obtained from:
Yates, T. B., & Marek, E. A. (2015) A study identifying biological evolution-related misconceptions held by pre-Biology high school students. *Creative Education, 6,* 811-834

Theoretical Principles and/or Research–Based Best Practices.

This lesson is both inquiry- and standards-based. It provides scenarios for students that allow them to explore natural selection and adaptation through activities and exploring as opposed to a simple lecture. Both the content and the standards for this lesson come from solid foundations based off of research (Quinn, 2012).
According to the *Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (2012), students should have an understanding that environmental changes can pose biological and physical challenges to organisms, causing a shift in the population's behavior or appearance through Natural Selection. By the time they graduate high school, students should recognize that natural selection is influenced by a number of factors and that it typically leads to a better-suited population. (Quinn, 2012). This lesson addresses several of those factors and effects through a more hands-on approach and discussion.

Quinn, H., Schweingruber, H., & Keller, T. (2012). *Framework for k-12 science education: Practices, crosscutting concepts, and core ideas*. Washington, DC: The National Academies Press

List 3 Multiple Intelligences. Explain how the lesson addresses each Intelligence.

1. **Kinesthetic-** Students will be acting out the part of a predator and collecting their dot "prey".

2. **Visual-** Students will watch the Rabbit Natural Selection simulation and see it at work.
3. **Auditory-** Students will participate and listen to a discussion over their results from the "Dot Hunters activity.

Academic Language/terminology (Term and definition):

1. **Natural selection**- the process in which organisms become better adapted to their environment, have a better chance at survival, and produce more offspring.
2. **Adaptation**- an inherited trait that allows an organism to survive and reproduce.

Differentiation and Other Modifications:

1. Create a numbered background and numbered dots instead of colored dots to help students with color blindness.
2. Allow students with verbal disabilities to write their part of the discussion.
3. Create procedure steps for activities using pictures to help students that struggle with reading.

Safety Concerns:

1. No horseplay during activities.

***Historical - Background content**

Natural selection is a relatively new topic in the history of Biology. Back in 350 BC, it was believed that species were completely unchanging and that individuals among species were identical to one another (Hoefnagels, 2012). Later on, fossils were discovered and found to be evidence that there was once different species that went extinct over the course of life on Earth. Then, scientists began to discover that species change over time (Hoefnagels, 2012). Even then, the mechanisms that caused the changes were disputed.

The first scientist to theorize about the processes that drive change was Jean Baptiste Lamarck. Lamarck hypothesized that traits were acquired through repeated use, that unused traits were lost over the lifetime of the individual, and that the acquired traits were passed on to the individual's offspring (Hoefnagels, 2012). For example, if you removed the tails of mice, then the offspring of the tail-less mice would not have tails. Lamarck's idea was later disproved and is no longer considered.

The currently supported mechanism for species adaptation is natural selection. Natural selection was first theorized by Charles Darwin as he sailed around South America aboard the HMS *Beagle* (Hoefnagels, 2012). Darwin observed the finches of the Galapagos Islands and noticed the different beaks the birds had on different islands. Some birds ate large seeds, some ate fruits, some ate insects, and so on. Darwin identified fourteen different types of finches, all similar yet with slight differences from one another (Hoefnagels, 2012). He hypothesized that a population of one finch had, several hundred years prior, spread out from the mainland to different islands with different food sources and that their beaks adapted to fit the food source on the island they settled on, creating different populations with different beaks (Hoefnagels, 2012). Darwin originally used the term "natural selection" as "preservation of favourable variations and the rejection of injurious variations" which has been altered to now say "environmental factors cause the differential

reproductive success of individuals with particular genotypes" (Hoefnagels, 2012). Natural selection has held strong in over the past century and a half and has yet to be completely disproven.

Hoefnagels, M. (2012). *Biology: Concepts and investigations*. New York, NY: McGraw-Hill

StudentEngagementHandout1-SimulationObservations

Name: _____

What do you predict will happen if wolves are introduced to the rabbits' environment?

Record your observations of what happened when wolves were introduced.

What do you predict will be different if the rabbits lived in the arctic instead of the equator?

Record your observations of what happened when the rabbits were placed in the arctic.

What do you predict will happen if wolves are introduced now?

Record your observations of what happened when wolves were introduced to the arctic.

What do you predict will happen if the food source is limited?

Record your observations of what happened when the food source was limited.

StudentExplorationHandout1-DotHunters

Dot Hunters

You are now a predator! Your prey? Little, colored dots. Your teacher will hand you out your new home environment (fabric) and your future prey (a bag of dots). Here is how it will work:

Materials

1. 1 square yard of fabric
2. 1 Bag of dots
3. 1 Cup
4. Data table
5. Graph paper
6. Colored pencils

Procedure

1. When told, empty your bag of dots onto your fabric and spread them out evenly.
2. When your teacher says “Go!” collect the dots you can see for 20 seconds and put them in your cup.
3. After the 20 seconds are up, count up the dots of each color left on the fabric and record those numbers in your data table.
4. For every 2 dots of each color left on the fabric, add 1 more dot of that of that color from the extra bags provided by your teacher. (Ex: if there are 5 red dots remaining on the fabric, add 2 red dots from the extra red dot bag).
5. Empty the dots from your cup into the bag they came from and prepare to hunt again.
6. Repeat steps 2-6 until you have completed 10 rounds of dot hunting.
7. Clean up the remaining dots and return all your materials to the teacher.
8. Create a line graph on your graph paper of the population of each colored dot left at the end of each generation. Make one line for each color dot using a colored pencil of the same or a similar color.

StudentExplorationHandout2-DataTable

Name:_____

Fabric:_____

Dot Color	# After Hunt 1	# After Hunt 2	# After Hunt 3	# After Hunt 4	# After Hunt 5	# After Hunt 6	# After Hunt 7	# After Hunt 8	# After Hunt 9	# After Hunt 10
Blue										
Green										
Red										
Yellow										
Black										

StudentElaborationHandout1-FrogScenario

Jumping Frogs

In the city of Stillwater, Oklahoma, there are several different types of environments. All have different factors, as environments do. Blandchard's Cricket Frogs live in two different environments. The first Sandborn Lake, has a large fish population. These fish prey on both Blanchard's Cricket Frog tadpoles and adult frogs. Research has shown the average leg length for adult Blanchard's Cricket Frogs at Sandborn Lake to be about 14.33 millimeters. The second environment to find Blanchard's Cricket Frogs in Stillwater is the Experimental Ponds. The fish population at the Experimental Ponds is lower than at Sandborn Lake. The frogs there have less threat of predation. Research has shown that the average leg length of Blanchard's Cricket Frogs at the Experimental Ponds to be about 13.51 millimeters. Could this difference in leg length be the result of natural selection? Why or why not? Write one paragraph explaining your answer.

StudentEvaluationHandout1-Quiz

Name:_____

Natural Selection Quiz

1. Define natural selection:

2. A plains environment has a rabbit species that can have either brown or white fur. During the winter, the plain gets covered in snow. Which of the following would you expect during the winter?
    a. The proportion of brown rabbits in the population will increase while the proportion of white rabbits in the population will decrease.
    b. The proportion of white rabbits in the population will increase while the proportion of brown rabbits in the population will decrease.
    c. The rabbit population will remain the same.
    d. The rabbit population will decrease for both fur colors.

3. A species of moth in a forest has either light-colored or dark-colored wings. The majority of the population used to have the light-colored wings. However, there has been a shift in the population and there is now more dark-colored moths than light-colored moths. Which of the following is a possible cause of the shift?
    a. Soot from nearby factories darkened the trees that the moths land on, making the light colored moths stand out more and be preyed on more often.
    b. The moths decided to be a darker color and changed.
    c. A disease spread through the forest and only affected the light-colored moths.
    d. All of the above are possible causes.

4. A population of butterflies can have either large wings or small wings. In the past, a majority of the butterflies had larger wings. Recently, there has been a shift so that smaller wings are more common. List a possible reason for this shift.

5.

	2000	2003
# of frogs with short legs in population	145	125
# of frogs with long legs in population	122	148

Based on the table above, give a plausible explanation for the shift in the frog population.

6. Which of the following is an example of natural selection?
    a. A population of frogs begins to have longer legs after several generations in an area with many predators.
    b. An individual rabbit suddenly develops white fur in a snowy area.
    c. An entire population of squirrels suddenly develop shorter tails in an area with fast predators.
    d. All of the above are examples of natural selection.

7. Frogs with longer legs can escape from predators easier than frogs with shorter legs. Explain what changes this could bring to the frog population.

8.

	Summer	Winter
Number of Brown Rabbits	500	350

Based on the table above, what can you predict about the environment the brown rabbits live in?

9. Define an adaptation:

10. Name an adaptation a mice might have in a forest with a high owl population.

TeacherEngagementHandout1-NaturalSelectionSimulator

Pre-Activity Directions

1. Download the PHET Natural Selection Simulator from https://phet.colorado.edu/en/simulation/natural-selection
2. Open before class.

Activity Directions

1. Pause the simulation so it does not run while you explain the activity.
2. Explain that the simulation will run and the rabbits will reproduce. Demonstrate the different features (mutations, wolf introduction, food limit, and environment change) and reset the simulator.
3. Add a fur color mutation. Allow the simulation to run for a few generations to build up the population and ask the students to predict what will happen if wolves are introduced. Have them record their prediction on StudentEngagementHandout1-SimulationObservations
4. Add wolves to the environment and have the students make observations. They should observe that the white rabbits were eaten more often than the brown rabbits.
5. Let the population build again as you ask the students to predict what will happen if the rabbits lived in the arctic. Have them record their predictions again.
6. Change the environment to the arctic and have students make observations. They should observe that the brown rabbits now stand out on the snow and the white rabbits now blend in.
7. Ask the students to predict what will happen if wolves are introduced.
8. Add wolves again and have the students make and record observations. They should observe that the brown rabbits were eaten more frequently this time.
9. Reset the simulator.
10. Add the long teeth mutation and let the population build while you ask the students to predict what will happen if the food source is limited. Have them record their predictions.
11. Add the food source limit and have students make and record observations. They should observe that more rabbits with long teeth survived than rabbits with short teeth.
12. Add more scenarios for observation if you desire and if time allows.

TeacherElaborationHandout1-FrogScenarioAnswers

Possible answers to the Frog Scenario Prompt:

“Yes, the difference could have been caused by natural selection. In Sandborn Lake, there is more fish to feed on the frogs. Frogs with longer legs might stand a better chance of escaping the predators. Then, they would breed and produce more frogs with longer legs. The predation risk is not as high at the Experimental Ponds so there is not as much pressure for longer legs. Therefore, there are more frogs with shorter legs.”

“No, the difference may not have been caused by natural selection. Other things could have caused the difference. For example, frogs of different leg lengths could have started the populations at the different areas. Short-legged frogs could have started the Experimental Pond population while long-legged frogs could have started the Sandborn Lake population. There could also have been a flaw on the scientist’s part when calculating the averages.”

Answers do not have to match these exactly. Answers should just show an understanding of natural selection processes and/or that other factors can influence population shifts.

TeacherEvaluationHandout1-QuizAnswers
Name:_____

Natural Selection Quiz

1. Define natural selection:

   Natural selection is the process in which organisms become better adapted to the environment, have a better chance of survival, and produce more offspring.

2. A plains environment has a rabbit species that can have either brown or white fur. During the winter, the plain gets covered in snow. Which of the following would you expect during the winter?
   a. The proportion of brown rabbits in the population will increase while the proportion of white rabbits in the population will decrease.
   b. **The proportion of white rabbits in the population will increase while the proportion of brown rabbits in the population will decrease**.
   c. The rabbit population will remain the same.
   d. The rabbit population will decrease for both fur colors.

3. A species of moth in a forest has either light-colored or dark-colored wings. The majority of the population used to have the light-colored wings. However, there has been a shift in the population and there is now more dark-colored moths than light-colored moths. Which of the following is a possible cause of the shift?
   a. **Soot from nearby factories darkened the trees that the moths land on, making the light colored moths stand out more and be preyed on more often.**
   b. The moths decided to be a darker color and changed.
   c. A disease spread through the forest and only affected the light-colored moths.
   d. All of the above are possible causes.

4. A population of butterflies can have either large wings or small wings. In the past, a majority of the butterflies had larger wings. Recently, there has been a shift so that smaller wings are more common. List a possible reason for this shift.

Some birds in the environment have larger beaks and are more capable of consuming larger butterflies.

5.

	2000	2003
# of frogs with short legs in population	145	125
# of frogs with long legs in population	122	148

Based on the table above, give a plausible explanation for the shift in the frog population.
Answers will vary. One possibility is "The predatory population increased and frogs with longer legs were able to escape more often and reproduce"

6. Which of the following is an example of natural selection?
   a. **A population of frogs begins to have longer legs after several generations in an area with many predators.**
   b. An individual rabbit suddenly develops white fur in a snowy area.
   c. An entire population of squirrels suddenly develop shorter tails in an area with fast predators.
   d. All of the above are examples of natural selection.

7. Frogs with longer legs can escape from predators easier than frogs with shorter legs. Explain what changes this could bring to the frog population.

   Frogs with shorter legs will be eaten more often the frogs with longer legs and the population will have more frogs with longer legs.

8.

	Summer	Winter
Number of Brown Rabbits	500	350

Based on the table above, what can you predict about the environment the brown rabbits live in?

In the winter, the environment changes and the brown rabbits are easier to locate and prey on.

9. Define an adaptation:

An adaptation is an inherited trait that allows an organism to survive and reproduce.

10. Name an adaptation a mice might have in a forest with a high owl population.

Answers may vary. Could be (but not limited to) "The mice only come out in the day." Or "The mice develop a fur color that better matches the environment."