Lesson Plan
Modeling Natural Selection

Stage 1 – Desired Results

Content Standard(s):

Life Science
Grade 8 MS-LS4 Biological Evolution: Unity and Diversity

MS-LS4-4. Explain the mechanism of natural selection, in which genetic variations of some traits in a population increase some individuals' likelihood of surviving and reproducing in a changing environment. Provide evidence that natural selection occurs over many generations.

Understandings:
Students will understand that…

- natural selection leads to evolution of species and occurs over many generations.
- Natural selection is random.

Essential Questions:

- Why does variation change an individual's chance of survival?
- How does natural selection bring about a change in the genetic makeup of a population?
- How does changing environmental conditions affect natural selection in a model?

Student objectives
Students will know….

- that variations exist between individual members of a species.
- that adaptation by natural selection over generations is one way in which species change over time in response to changes in their environment.
- that traits that support survival and reproduction in the new environment become more common; and traits that do not are suppressed, thus changing the distribution of traits in a population.

Students will be able to…

- give examples of variations and how a specific variation or trait impacts an organism's chance of survival.
- make a model showing how a variation can change a population over time.

Stage 2 – Assessment Evidence

Students will analyze class data collected using i-sense and answer the following questions:

1. How many brown mice were produced in the first generation? How many white mice?
2. If the events in Part 1 occurred in nature, how might your data change? How would the group of mice change over time?
3. How did the results in Part 2 differ from the results in Part 1?
4. How did the proportion of brown mice produced in the third and fourth generations compare to the proportion produced in the first generation? Can you explain the reason for the difference?
5. Which allele, ***W*** or ***w***, was removed from the gene pool by predation?
6. How does this model illustrate the concept of evolution by natural selection? Explain your answer.
7. Can you explain how extinction of a species can happen based on what you learned in this lab?
8. If the main predator of mice in this white sand desert were an animal that hunted by smell rather than sight, would you expect the same results as this model produced? Explain your reasoning.

Challenge: In this experimental model, the total number of mice decreases each generation. Do you think this represents what would occur in a real situation? Explain, using evidence gained using this model. Can you propose a way that you could change the model to make it more realistic?

Self-Assessments	**Other Evidence (assessments)**
Student will use i-sense program to find the best graph that would represent the patterns found in the mice population over all four generations.	Students will collaborate to interpret the data presented in i-sense and discuss their self-assessments.

Stage 3 – Learning Plan

Learning Activities:

In the process of natural selection, organisms that are better adapted to their environment than other members of their species reproduce more successfully. This difference in reproduction causes evolution - a gradual change in the genes of a population. In this lab, students will examine how natural selection results in evolution in a small population of brown and white mice in different environments. (Students' prior knowledge includes the following standards, which will help them to think about the pre-lab questions).

Life Science
Grade 8 MS-LS3 Heredity: Inheritance and Variation of Traits

MS-LS3-1. Develop and use a model to describe that structural changes to genes (mutations) may or may not result in changes to proteins, and if there are changes to proteins there may be harmful, beneficial, or neutral changes to traits.

MS-LS3-3(MA). Communicate through writing and in diagrams that chromosomes contain many distinct genes, and that each chromosome pair contains two alleles that can be the same or different from each other. Illustrate that each gene holds the instructions for the production of specific proteins, which in turn affects the traits of an individual.

MS-LS3-4(MA). Develop and use a model to show that in sexually reproducing organisms individuals have two of each chromosome, and hence two alleles of each gene, one acquired (randomly) from each parent.

In pairs, students will discuss the following prior to the lab. This will assess prior knowledge and experiences, and uncover any misconceptions they may have that genetic mutations arise in response to the environment.

- What advantage does a white mouse have over a brown one in a white sand dune environment?
- In this experiment, do you think chance is a factor in determining whether or not a brown mouse survives? Explain.
- Do you expect the proportion of brown mice to white mice to increase from generation to generation? Explain your answer.
- In this experimental model, two variables interact to influence the responding variable. What are these two independent variables?
- What is the responding variable?

Building the model:

1. Using 50 dark colored pieces of construction paper, mark 25 of them with "W", representing the allele that codes for white fur, which is dominant. Mark the other with "w" to represent the allele that codes for brown fur, which is recessive.
2. Using 25 index cards for "events", mark 18 of them with an "C" to represent predators that kill mice which contrast with the environment. The remaining 7 are labeled as follows: 5 with an "S" for the survivor; 1 with "D" for a Disease which kills the mouse; and 1 with "P" for the predator that kills mice of all colors.
3. Shuffle the dark cards so that the "W" and "w" are mixed together at random. ***(Discuss how this is meant to model real life.)*** Place the stack of them face down on the table.
4. Shuffle the "event" (index) cards and place the pile face down next to the dark cards.

Using the model:

1. Draw the top two cards from the stack of dark cards. If you draw ***WW*** or ***Ww***, you have a white mouse. (Remind students about their prior knowledge of Punnett squares and dominant/recessive alleles.) ***ww*** is a brown mouse. Record the color fur of your mouse. This is the first mouse of Generation 1. Continue until 25 mice are selected and record the number of each color mouse in generation 1 of the data table. Shuffle all brown cards in one pile.
2. Next, use the model to study the survival of your mouse, first, in a white sandy desert. Draw an index card. If you choose a card with a "C" and you have a brown mouse, the mouse will be caught and eaten by the predator. If you had a white mouse, the mouse will escape the predator by camouflaging in the white sand and live. If you choose any other card, follow the directions. Record the fate of your mouse. Did it live or die? If your mouse survived, return the dark cards to the bottom of the pile. If it died, set those cards aside. (Keep a separate pile of "dead" mice.) Return the index card to the bottom of the index card pile. Your survivors constitute generation 2.
3. With the survivors, shuffle all cards together and begin to choose two cards to find out the fate of the mice that will go on to reproduce the next generation. Record the number of brown and white mouse survivors. Then shuffle them all into one stack to become your next generation.
4. Repeat steps 1 - 3 as many times as you have allele pairs remaining. (Remind students that alleles chosen are random again, simulating nature.)
5. Continue this process until you have completed 4 generations.

Use the following table to record your results:

Type of Environment: White Sand				
Generation	Number of White Mice	Number of Brown Mice	Survivors	
			White Mice	Brown Mice
1			-	-
2				
3				
4				

<u>Record your group's results in i-sense using the contributor key.</u>

If time allows, repeat this entire lab, but simulate the changes in the population if the environment was a dark forest floor instead of a white sandy beach.

Type of Environment: Dark Forest Floor				
Generation	Number of White Mice	Number of Brown Mice	Survivors	
			White Mice	Brown Mice
1				
2				
3				
4				

http://peppermoths.weebly.com/
If computers are available, students can use this simulation to review another example of modeling natural selection in a peppered moth population.

http://learn.genetics.utah.edu/content/variation/sources/
This link is a powerpoint presentation explaining sources of variations, to dispel any misconceptions that mutations are the result of changes in environment, rather than natural selection operating on a population and genetic makeup changes over time.

These are both good extension activities that can be used during this unit.