Biology Instructional Segment on Genetics

Student Science Performance	
Grade Level: Biology	**Title**
Topic: Sickle Cell & Natural Selection in Populations	**Change With Me**

Performance Expectations (Standard):

SB2. Obtain, evaluate, and communicate information to analyze how genetic information is expressed in cells.

b. Construct an argument based on evidence to support the claim that inheritable genetic variations may result from: new genetic combinations through meiosis (crossing over, nondisjunction); non-lethal errors occurring during replication (insertions, deletions, substitutions); and/or heritable mutations caused by environmental factors (radiation, chemicals, and viruses).

SB6. Obtain, evaluate, and communicate information to assess the theory of evolution.

a. Construct an explanation of how new understandings of Earth's history, the emergence of new species from pre-existing species, and our understanding of genetics have influenced our understanding of biology.

d. Develop and use mathematical models to support explanations of how undirected genetic changes in natural selection and genetic drift have led to changes in populations of organisms. (Clarification statement: Element is intended to focus on basic statistical and graphic analysis. Hardy Weinberg would be an optional application to address this element.)

Lesson Performance Expectations:

Group Performance:

1. Obtain, evaluate, and communicate information to assess the theory of evolution.
2. Students ask questions about the patterns of data shown on the map.
3. Students construct an explanation, in groups, based on valid and reliable evidence obtained to support or refute their claims.
4. Students carry out an investigation on natural selection.
5. Students collect evidence from the rock pocket mouse to support or refute their claims using information found online.
6. Students carry out an investigation to gather evidence about changes in a population after a disturbance
7. Students analyze evidence collected and create a model to demonstrate how changes can occur in a population.

Individual Performance:

1. In groups, students construct an explanation, in writing, to describe the reasons for the changes in the rock pocket mouse population based on evidence collected.
2. Students ask questions about the reason for change in the bison population and use evidence cited in the articles to suggest reasons for the change.

Group Discussion:

1. Students share evidence collected with the class.
2. Students share their explanations in a class discussion.
3. Students share their models with the class.

Materials:

- Per Group: 1 straw, several round beads smaller than straw diameter, several triangle or square beads that get "stuck" in straw.
- Computer with Internet access (Alternatively, instructor may print out maps and research resources per group.)
- Natural Selection Activity: (Per class) You will need 2 yards of each 2 different colors of fuzzy fabric, 3 colors of puffballs (100 of each, 2 colors should match the two colors of fabric), plastic cups (1 per

student), plastic forks, knives, and spoons (Each student should have 1 utensil.)
- Colored pencils

Engaging Learners	**Student Science Performance** ***Phenomenon: Patterns can be seen between the prevalence of sickle cell and the incidence of malaria.*** ***Obtaining*** Obtain Information: Students obtain information about sickle cell in the population by watching a portion of this short video: https://www.youtube.com/watch?v=Zsbhvl2nVNE&t=14s *Teacher hint: For this portion of the lesson stop at the 2 minute mark in the video.* Give students a straw, several round beads that will easily fit through the straw, and several triangle shaped beads that will fit in the straw but may get stuck. Have students use the items to develop a model for sickle cell anemia in humans. ***Evaluating*** Teacher then shows map at the following link: http://highered.mheducation.com/sites/dl/free/0073403466/80893/0209.jpg Students ask questions about the patterns of data shown on the map. Students then carry out research online to make a claim as a reason for the correlation. Students analyze and interpret data on the map and found online to construct an explanation for the causes of sickle cell increasing in areas where malaria incidence is high. *Teacher hint:* *Analyzed data could look like the following:* Given the pattern of data seen in your research, draw a graph that would predict the levels of sickle cell in a country that does not have mosquitoes, and a country that does have mosquitoes that carry the malarial parasite. Explain your prediction for your graph. Show this prediction over a 100 year time period, assuming that malaria began to appear during year 10. At year 20, the country with mosquitoes implements a mosquito eradication program. Draw a new line to show the prevalence of the sickle cell trait over this same time period. Explain your prediction. *Ultimately, students will conclude that Sickle cell is due to a heritable genetic mutation that evolved in response to interactions in ecosystems. Teacher may finish showing the remainder of the video starting at 2 minutes as a conclusion after students share their findings following class discussion.* https://www.youtube.com/watch?v=Zsbhvl2nVNE&t=14s

	Background information for year- long phenomenon: https://www.youtube.com/watch?v=S7EhExhXOPQ At this point students will not know terminology related to alleles and inheritance, mutation, or DNA. This part of the lesson should be viewed on the macro level of evolutionary factors that would make having sickle cell an advantage in areas where malaria prevalence is high. ***Communicating*** Students construct an argument, in groups, based on valid and reliable evidence obtained to support or refute their claims. Students share evidence collected with the class.
Exploring Phenomena	***Phenomenon: The population of mice in New Mexico's Valley of Fire have changed from light brown to dark gray over time.*** ***Obtaining*** Students obtain information by watching a short video on the Rock Pocket Mouse population and carrying out an activity collecting data on changes in the Rock Pocket Mouse population. *Play the following video: https://www.youtube.com/watch?v=sjeSEngKGrg* (Stop at 2:36) ***Evaluating*** Students collect evidence from the rock pocket mouse activity to support or refute their claims using information found online. *Teacher Hint:* *The Rock Pocket Mouse activity is found at the link below:* *Rock Pocket Mouse Activity* *Teacher can continue playing the following video as a preview or review:* *https://www.youtube.com/watch?v=sjeSEngKGrg* Through discussion students should understand that the sickle cell trait allows individuals to increase fitness against malaria. ***Communicating*** In groups, students write an explanation to describe the reasons for the changes in the rock pocket mouse population based on evidence collected. Students share their explanations in a class discussion.

Explaining Phenomena	**Student Science Performance** ***Evaluating*** Students carry out an investigation on natural selection by playing a game with puff balls and colored backgrounds. Students are given various "feeding apparatus" (plastic spoon, fork, or knife). Based on beneficial characteristics, those best suited to the environment will survive. *Teacher Hint:* *In order to play the game, you will need 2 yards of each 2 different colors of fuzzy fabric, 3 colors of puffballs (100 of each, 2 colors should match the two colors of fabric), plastic cups (1 per student), plastic forks, knives, and spoons (Each student should have 1 utensil.)* *The game should illustrate natural selection where all 3 colors of puffballs are spread out on the background. Students use the utensils as their "feeding apparatus" scooping up puffballs and placing them in their cup until time is called. (Play should run for about 20 seconds for each generation.) If a student does not get any puffballs, they did not eat and therefore are out of the game as they did not survive. Play continues for several generations. Have students record their data for the number of puffballs surviving on background at the end of each round. Students can then graph their data.* Students use data to revise their explanations to allow for how changes occur in a population under selective pressure. Questions to initiate class discussion: What is evolution? What causes evolution to occur? What is natural selection? How does natural selection increase favorable traits in a population? Why were specific color of mice in higher numbers in each area? How does a mouse's color affect its fitness? ***Communicating*** Students revise their explanations to include changes in any trait in any population based on the mechanism behind the change.
Assessment of Student Learning *Instructor provides feedback on written explanations.*	
Elaborating Scientific Concepts and Abilities	**Student Science Performance** ***Phenomenon: North American bison today are different from their wild ancestors.*** ***Obtaining*** Students obtain information by reading an article about the change in the American bison population over time. Article 1: Bison Conservation (National Park Service) Article 2: Great American Bison (PBS - GPB)

	Students ask questions about the reason for change in the bison population and use evidence cited in the articles to suggest reasons for the change. *Teacher Hint:* *Students should know and understand that the changes in the bison population are due to random chance or Genetic Drift whereas the changes in the Sickle Cell trait in the human population are due to natural selection.* ***Evaluating*** Students carry out an investigation to gather evidence about changes in a population after a disturbance such as the mass hunting that sharply declined the bison population. *Teacher Hint:* *Use a bag of mixed small candies to fill up a dried out water bottle to represent the original population of bison. Students pour enough of the candy into the bottle cap to fill the cap. The candy in the cap represents the new population of survivors after a disturbance. Students then reproduce the colors of the candies remaining over several generations. Students then compare the percentage of each color in the original population to the surviving population after the disturbance.* Q: How does the bottleneck effect demonstrate genetic drift? Q: How does genetic drift in bison compare to the environment selecting for or against a trait such as sickle cell. ***Communicating*** Students report their findings to the class.
Assessment of Student Learning Students complete formative quiz on natural selection and genetic drift. Students are provided feedback.	
	Student Science Performance
Evaluating Learners	***Evaluating*** Students analyze evidence collected and develop a model to demonstrate how changes can occur in a population. *Teacher Hint:* *Student models should demonstrate how changes in a population can occur by both directed and undirected processes. (Natural Selection and Genetic Drift.)* ***Communicating*** Students share their models with the class. Students revise models based on the class discussion.

Assessment of Student Learning *Students submit models as part of a culminating assessment. A rubric may be used to score models.*	
SEP, CCC, DCI	**Science Essentials** National Research Council. (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas.*
Science Practices	• Students obtain, evaluate, and communicate information... • Students ask questions… • Students analyze and interpret data… • Students construct an explanation… • Students carry out an investigation... • Students engage in argument from evidence…
Crosscutting Concepts	• Patterns • Stability & Change
Disciplinary Core Ideas	**LS4B: Natural Selection** • Natural selection occurs only if there is both: (1) variation in the genetic information between organisms in a population (2) variation in the expression of that genetic information—trait variation—that leads to differences in performance among individuals • Traits that positively affect survival are more likely to be reproduced and are more common in the population. **LS4C: Adaptation** • Natural selection is the result of four factors: (1) the potential for a species to increase in number (2) the genetic variation of individuals in a species due to mutation and sexual reproduction (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment • Natural selection leads to adaptation—to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. • The 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. • Adaptation also means that the distribution of traits in a population can change when conditions change.