

Color Variation Over Time in Rock Pocket Mouse Populations

OVERVIEW

This activity serves to reinforce concepts of variation and natural selection presented in the BioInteractive short film [The Making of the Fittest: Natural Selection and Adaptation](#). If your class covers Hardy-Weinberg equilibrium, you may wish to use another related activity, "[Allele and Phenotype Frequencies in Rock Pocket Mouse Populations](#)."

KEY CONCEPTS

- The environment contributes to determining whether a mutation is advantageous, deleterious, or neutral.
- Mutations that increase fitness of an organism usually increase in frequency in a population.

STUDENT LEARNING TARGETS

- Explain how variation, selection, and time fuel the process of evolution.
- Analyze, organize, and graph data.

CURRICULUM CONNECTIONS

Standards	Curriculum Connections
NGSS (2013)	MS-LS2-2, MS-LS4-4, MS-LS4-6; HS-LS2-2, HS-LS2-6, HS-LS3-3, HS-LS4-4, HS-LS4-5
AP Bio (2015)	1.A.1, 1.A.2, 1.A.4, 1.C.3, 4.B.3, 4.C.3, SP1, SP5
IB Bio (2016)	5.1, 5.2, 10.3, C.1
AP Env Sci (2012)	II.A, II.C, VII.C
IB Env Systems and Societies (2017)	2.1, 3.2
Common Core (2010)	ELA.RST.6-12.3, ELA.RST.6-12.4, ELA.RST.6-12.7; ELA.WHST.6-12.1; MP2, MP3, MP5
Vision and Change (2009)	CC1, CC2, DP1, DP2, DP3

KEY TERMS

adaptation, evolution, mutation, natural selection, trait, variation

TIME REQUIREMENTS

- One 50-minute class period.

SUGGESTED AUDIENCE

- Middle School: Life Science
- High School: Biology (all levels)

PRIOR KNOWLEDGE

Students should understand

- that traits are inherited and that some traits provide organisms with a greater chance to survive and reproduce.
- what a food web is and that organisms fill specific niches in their environments.

MATERIALS

- Rock Pocket Mouse Illustrations (downloadable file on the [activity webpage](#))
- [The Making of the Fittest: Natural Selection and Adaptation](#) video
- Supplies for creating bar graphs (e.g. computer graphing software or graph paper and colored pencils)

TEACHING TIPS

- Download the Rock Pocket Mouse Illustrations file from the [activity webpage](#). Print and cut the illustrations into cards for each group of students, making sure to keep the number (1, 2, 3, 4) at the top of each illustration. Alternatively, the illustrations can be projected to the whole class or uploaded for students to view online.
- You may wish to have students work in pairs.
- Fill a few plastic sandwich bags with 15 grams of paper clips and pass them around so that students will have an idea of how much a rock pocket mouse weighs.
- Before watching the film, be sure that students write down initial thoughts about the order of the illustrations.
- You may want to show the film more than once so students can take notes. Encourage them to write down questions they have.
- Ask students to share how the data table and graph were helpful in confirming the order of the four illustrations.
- Be sure to reinforce the concept that populations evolve over time; individuals do not evolve during their lifetimes.
- Address the common misconception that new traits arise “as needed.” The mutation for dark-colored fur did not evolve in response to the presence of dark-colored volcanic rock. Instead, the new trait arose — in both locations A and B — due to random mutation. You can make sure your students understand this by pointing out that there are dark-colored mutants on the sandy-colored substrate (location A), too.
- Discuss with students why the frequencies of the light-colored and dark-colored mice did not change significantly at location A but did at location B. In location A, the dark coloration was not adaptive, so it did not spread. In location B, however, mice with the dark coloration had a selective advantage over those with light coloration.
- Students may ask why the frequency of dark-colored mice changes slightly at location A. Although some variations may be due to random fluctuations (genetic drift), the variations in this case were most likely caused by sampling errors. In this case, the fur color frequencies were calculated from very small samples (less than 20 mice at each location). Such small samples may not accurately represent the overall population. Larger samples would be needed to calculate the frequencies in the overall population more accurately.

ANSWER KEY

1. The four illustrations provided by your teacher represent snapshots of rock pocket mouse populations. Each illustration shows the color variation at two different locations, A and B, at a particular moment in time. The illustrations may be out of order. Count the number of light-colored and dark-colored mice present at each location at each moment in time. Record your counts in the table below.

		Illustration Number			
		1	2	3	4
Location A	Number of Light-Colored Mice	11	10	10	11
	Number of Dark-Colored Mice	1	2	2	1
Location B	Number of Light-Colored Mice	2	10	6	2
	Number of Dark-Colored Mice	10	2	6	10

2. Place the illustrations in what you think is the correct order from oldest to most recent. In the space below, write the numbers of the illustrations in the order you decided.

The illustrations are in this order: 2, 4, 3, 1.

3. Explain how you decided which illustration represents the most recent rock pocket mouse population and why you positioned the others in the order that you did.

Any reasonable explanation is acceptable. Students might comment on the fact that the number of light-colored mice has decreased over time, while the number of dark-colored mice has increased.

5. Using what you learned by watching the film, confirm or change the order in which you arranged the illustrations. Once you are satisfied that the order is correct, fill out the data table below using the counts you recorded for the illustrations.

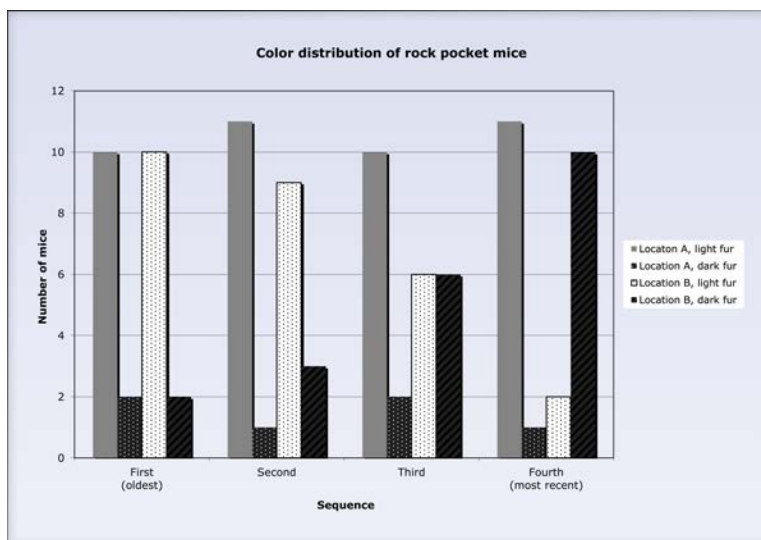
Number of Mice at Different Locations

		Illustration Order			
		Oldest (First) <i>Illustration #2</i>	Second Oldest (Second) <i>Illustration #4</i>	Third Oldest (Third) <i>Illustration #3</i>	Most Recent (Fourth) <i>Illustration #1</i>
Location A	Number of Light-Colored Mice	10	11	10	11
	Number of Dark-Colored Mice	2	1	2	1
Location B	Number of Light-Colored Mice	10	9	6	2
	Number of Dark-Colored Mice	2	3	6	10

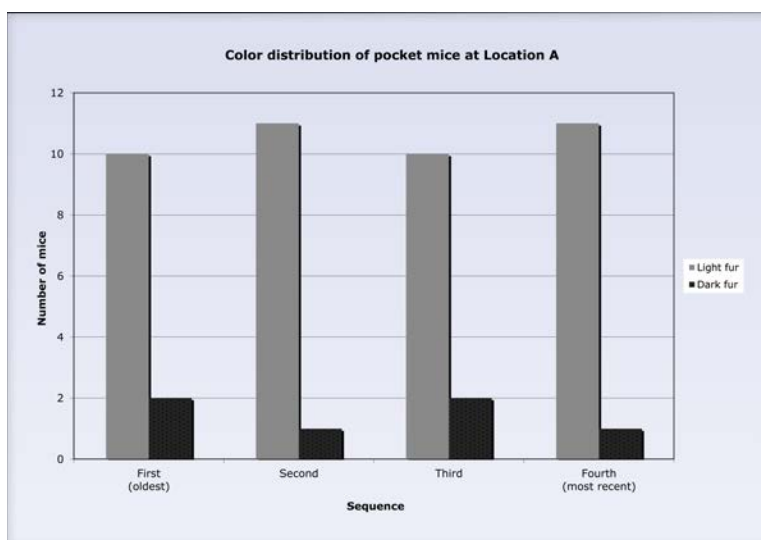
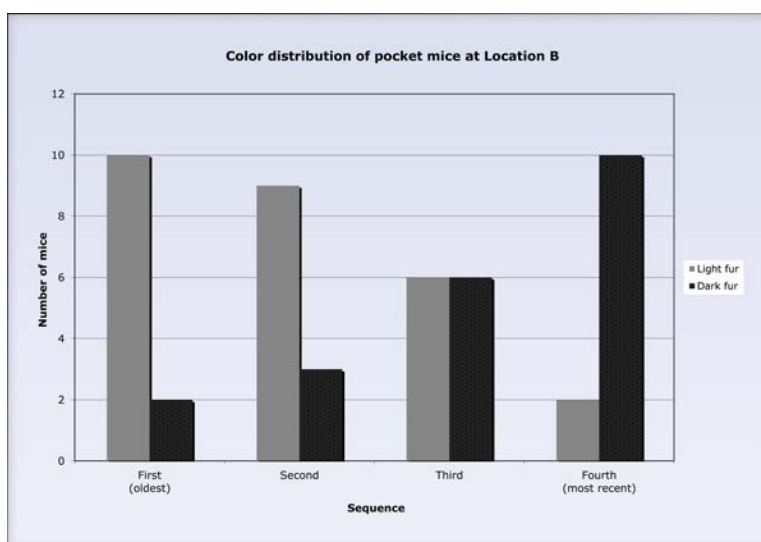
6. Create a bar graph based on the data that shows the distribution of the mice at locations A and B through time. Be sure to provide an appropriate title for the graph, and titles and labels for the x- and y-axes. You may plot all of your data for both A and B on one bar graph or split A and B into two graphs.

The graphs should represent the students' data. Even if they miscounted, the trends should be apparent. Make sure that the axes are labeled and that the graphs have been given appropriate titles. A completed data table and sample graphs are shown below. Students may choose to plot A and B together for each time period, or they may plot A and B separately. Either is fine.

Graph where A and B are plotted together:



Graphs where A and B are plotted separately:



7. Explain why a rock pocket mouse's color influences its overall fitness. Remember that "fitness" is defined by an organism's ability to survive and produce offspring in its environment.

Student explanations should include coat color as an important means of camouflage for the rock pocket mice.

8. Explain the presence of dark-colored mice at location A. Why didn't this phenotype become more common in the population?

The dark-colored mice arose in the population at location A by random mutation. The phenotype did not become more common because it did not afford a selective advantage to the mice.

9. Write a scientific summary that describes changes in the rock pocket mouse populations at location B. Your summary should include:

- a description of how the population has changed over time
- an explanation of what caused the changes
- a prediction that describes what the population will look like 100 years in the future
 - Base your prediction on trends in the data you have organized. You can assume that environmental conditions do not change over the 100 years.

Check that students have included the following points:

- *Originally, location B had a sandy-colored substrate. In this environment, light-colored mice had a selective advantage because they could better avoid predation.*
- *Location B became covered in dark-colored volcanic rock, which means that dark-colored mice now had an advantage over light-colored mice in that environment.*
- *Over time, dark-colored mice became more common at location B because more of their offspring survived to reproduce and pass on their genes, including genes for fur color.*
- *In 100 years, the population at location B will likely consist of mostly dark-colored mice. There may be a small number of light-colored mutants.*

10. Use the data and what you have learned about evolution to explain how mutation is a random process, but natural selection is not random.

Student answers should point out that the dark-colored mutation was present in environments without any volcanic activity (shown by location A), indicating that the mutation arose randomly. However, the dark-colored phenotype became more common once there was a selective advantage for it (shown by location B), which indicates that selection is not random.

AUTHOR

Mary Colvard, Cobleskill-Richmondville High School (retired), New York

Edited by Melissa Csikari, Esther Shyu, and Aleeza Oshry, HHMI

Field tested by James Coleman, Newman High School; Marjorie Davis, Mount Saint Joseph Academy; Beth Dixon, Western Sierra Collegiate Academy; Christina McCoy-Crawford, First Baptist School; Tamara Pennington, Windsor High School