ANSWER KEY

QUESTIONS TO ANSWER WHILE WATCHING THE FILM

a. *What specific trait was studied in this investigation?*

Fur color, specifically melanism, is the trait being studied.

b. *How does this trait affect the survival of the mice in different environments?*

Depending on the color of the substrate, fur color may or may not help rock pocket mice blend in with their environment. On a light-colored substrate, mice with fur that is light in color are camouflaged and are not very obvious to predators. On a dark substrate, mice with dark-colored fur blend in and are better able to avoid predation. Predators readily spot mice with light-colored fur. Mice that survive predation are more likely to live, reproduce, and pass on their favorable trait for fur color.

c. *What is the genetic basis of the trait?*

Mutations in the *Mc1r* gene are responsible for the appearance of dark fur color in this particular population of rock pocket mice.

PART 1: REVIEWING THE PRINCIPLES OF HARDY-WEINBERG

1. *If there are 12 rock pocket mice with dark-colored fur and four with light-colored fur in a population, what is the value of q? Remember that light-colored fur is recessive.*

$q = 0.5$

Explanation: $q^2 = (4/16)$ or 0.25%, therefore q =the square root of 0.25 or 0.5.

2. *If the frequency of p in a population is 60% (0.6), what is the frequency of q?*

$q = 40\%$

Explanation: If the frequency of p in a population is 60%, the frequency of q is 40% since $p + q = 1$

3. *In a population of 1,000 rock pocket mice, 360 have dark-colored fur. The others have light-colored fur. If the population is at Hardy-Weinberg equilibrium, what percentage of mice in the population are homozygous dominant, dark-colored mice?*

$p^2 = 0.04$ or 4%

Explanation: $q^2 = 640/1000 = 0.64$, so $q = 0.8$. Because $p + q = 1$, $p = 0.2$ and $p^2 = (0.2)(0.2) = 0.04$

PART 2: APPLYING HARDY-WEINBERG TO POCKET MOUSE FIELD DATA

1. *Calculate the overall frequencies of light-colored mice and dark-colored mice caught on light-colored substrates.*

Frequency = (number of mice of one color)/(total number of mice)

Frequency of light-colored mice = 120/168 = 71%; Frequency of dark-colored mice = 48/168 = 29%

2. *Calculate the overall frequencies of light-colored mice and dark-colored mice caught on dark substrates.*

Frequency = (number of mice of one color)/(total number of mice)

Frequency of light-colored mice = 3/57 = 5%; Frequency of dark-colored mice = 54/57 = 95%

3. *Using the Hardy-Weinberg equation and data from the table above, determine the number of mice with the* DD *and* Dd *genotypes on the rocky, light granite substrate.*

Frequency of mice with *dd* genotype on light-colored substrate = 71%

Frequency of mice with *DD* genotype on light-colored substrate = 3%

Frequency of mice with *Dd* genotype on light-colored substrate =26%

4. *Using the Hardy-Weinberg equation and data from the table above, determine the number of mice with the* DD *and* Dd *genotypes on the rocky, dark lava substrate.*

Frequency of mice with *dd* genotype on dark-colored substrate = 5%

Frequency of mice with *DD* genotype on dark-colored substrate = 61%

Frequency of mice with *Dd* genotype on dark-colored substrate = 34%

5. *Which fur color seems to have the greatest overall selective advantage? Use data collected from both dark-colored and light-colored substrates to support your answer.*

Dark fur color seems to have the greatest selective advantage. On the light-colored substrate, 29% of the mice have dark fur while only 5% of the mice on the dark-colored substrate have light fur. Also, at collecting site #6, where there is a rocky, light-colored substrate, 43 out of 77 mice collected had dark-colored fur—over half of the sampled population. Dark-colored fur seems to have a selective advantage over light fur color.

6. *According to the film, what environmental change gave a selective advantage for one coat-color over another?*

The color of the landscape changed so that some members of the population were more visible to predators than other members. That is what happened in the rock pocket mouse film. When sections of the landscape became dark in color, the light-colored mice were at a selective disadvantage.

7. *How does this study support the concept that natural selection is not random?*

Evidence that natural selection is not random is the fact that when different genetic mutations produce the same phenotypic results in different areas, these similar adaptations are favored under similar conditions. An example provided in the film is the different populations of rock pocket mice with mutations that result in dark fur color. Dr. Sean Carroll summed it up in the statement: "Evolution repeats itself." This is evidence that natural selection is not random.

8. *To determine if the rock pocket mouse population is evolving, explain why is it necessary to collect fur color frequency data over a period of many years?*

The data collected represents only one moment in time. If the population is evolving, the frequency of the two alleles for fur color will change over time. If the population is not evolving, the frequencies will remain approximately the same.

PART 3: HARDY-WEINBERG EXTENDED

1. *Use the Excel spreadsheet to determine how the selection coefficient (s) influences the phenotype of future generations. Substitute increasingly large numbers for s. Record each new value and describe what happens to the frequencies of p and q over the next five generations.*

When the value of *s* is increased, the value of p increases while the value of q decreases each generation. Students should record the values of *s* and either record or print the values for p and q. During this exercise, the frequency of the dominant phenotype increases as the frequency of the recessive phenotype decreases.

2. *Explain how the selection coefficient and natural selection are related.*

The selection coefficient is a numerical representation of how much of an advantage or disadvantage a particular variation or trait provides an organism. It provides a way to mathematically model and predict evolutionary change.

3. *In areas with primarily dark-colored substrate, dark-colored mice have a selective advantage over light-colored mice. Therefore, mice with one or more copies of the dominant Mc1r D allele have a selective advantage over mice with two copies of the Mc1r d allele.*

In the film, Dr. Sean Carrol says that with a 1% selection advantage, it takes 1000 years for 95% of the mice to have the dominant phenotype. With a 10% selection advantage, it would take just 100 years. Use the Excel spreadsheet to verify these facts.

a. *Find out how many generations following the first appearance of a dark-colored mutation it would take for 95% of the mice to express the dominant dark-colored phenotype given a 1% advantage (s=0.01). Rock pocket mice have approximately one litter of pups a year, so the number of generations will be equal to the number of years. You will not be able to use the graph on the tab called "main page" since it only goes up to 100 generations. So, you will need to look at column D of the worksheet called "main worksheet." Scroll down until the value is greater than 0.95. Record your answer below.*

It would take about 936 generations for 95% of the mice to express the dominant dark-colored phenotype.

b. *Repeat the process for a 10% advantage (s=0.1).*

It would take about 100 generations.

c. *What would the selection coefficient need to be for 95% of the mice to have the dominant phenotype in just 50 years? Record your answer below.*

It would need to be about 0.22, a 22% advantage.

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