Teaching Guide for: Genetics of Morphology

Speaker: Hopi Hoekstra
Video link: https://youtu.be/uM4LxBG74ag

Major topics

- Evolution
- Genetics

Overview

Hoekstra explains how members of her lab studied the effects of a phenotypic adaptation, in this case coat color, on the ability of mouse populations to survive in different habitats. By crossing mice with light and dark coats and analyzing the genomes of the offspring, Hoekstra and her colleagues were able to identify several genes, and specific mutations in those genes, that determine coat color. Amazingly, one of the same mutations may have determined coat color in ancient mammoths!

Sub topic

- Mechanisms of genetic change

Multiple-choice questions

1. Dr. Hoekstra discusses coat color phenotypes that have been documented in laboratory mice populations, which are not found in the wild. How did these phenotypes come to be present in the laboratory mice populations?

a. Mutations in genes responsible for coat color
b. Selective breeding for certain color phenotypes
c. Interbreeding between laboratory mice and other laboratory rodent populations
d. The coats are died unique colors to distinguish them from one another

2. Dr. Hoekstra performed an experiment in which she 'released' light and dark plastic mice into light and dark habitats and documented the number of predator attacks on cryptic combinations (when mice were well camouflaged in the environment) and non-cryptic combinations (when mice were not well camouflaged). Which combination(s) of mice color and habitat color resulted in the highest level of predation?

a. Light mice in dark habitats
b. Dark mice in light habitats
c. Light mice in light habitats
d. Dark mice in dark habitats
e. Cryptic combinations had consistently higher predation than non-cryptic combinations
f. Non-cryptic combinations had consistently higher predation than cryptic combinations

3. Dr. Hoekstra's study on mice coloration in different habitats showed that mice with coat colors that match the background habitat have, on average, a _____ higher chance of survival than mice with coat colors that are conspicuous.

a. 0%
b. 25%
c. 50%
d. 75%
e. 100%

4. From the coat color patterns of the hybrid offspring of field and beach mice, Dr. Hoekstra estimates that about 3-5 genes contribute to coat color. How does she know that coat color is not controlled by a single gene?

a. The hybrid mice display a continuum of coat color patterns that span the two extremes exhibited by the parent mice
b. The majority of hybrid mice exhibit a coat color that is intermediate between the two parent mice
c. Some of the hybrid mice exhibit the same coat color patterns as the parent mice
d. Some of the hybrid mice exhibit unique coat color patterns not previously seen in either of the parent mice populations
e. All of the above

5. From the coat color patterns of the hybrid offspring of field and beach mice, Dr. Hoekstra estimates that about 3-5 genes contribute to coat color. How does she know that coat color is not controlled by hundreds of genes?

a. The hybrid mice display a continuum of coat color patterns that span the two extremes exhibited by the parent mice
b. The majority of hybrid mice exhibit a coat color that is intermediate between the two parent mice
c. Some of the hybrid mice exhibit the same coat color patterns as the parent mice
d. Some of the hybrid mice exhibit unique coat color patterns not previously seen in either of the parent mice populations
e. All of the above

6. Dr. Hoekstra also compared coat color variation in different populations of beach mice along the Atlantic Coast and the Gulf Coast of Florida and determines that light coloration evolved separately in these two populations. What is her evidence for determining that light coloration evolved independently in these two groups?

a. The Gulf Coast beach mice are more closely related to field mice from the Panhandle of Florida than they are to Atlantic beach mice
b. The Atlantic beach mice are more closely related to mice from Central Florida than they are to Gulf Coast beach mice

c. The Gulf Coast mice have a particular mutation in the Mc1r gene that produces light coat color and the Atlantic beach mice do not have this mutation

d. The mutations that the Atlantic beach mice carry in the Mc1r gene do not affect the gene's activity, so this gene is not responsible for lighter coloration in these mice

e. All of the above

7. Consider all the conditions required for a population to be in Hardy-Weinberg Equilibrium. How do the mice populations described in these experiments violate these requirements?

a. Mutations have occurred in genes responsible for coat color

b. Natural selection favors light-color genotypes in beach habitats

c. Natural selection favors dark-color genotypes in field habitats

d. The mice migrated from mainland areas of Florida to islands and beaches along the Gulf and Atlantic coasts

e. All of the above

Relevant literature

Manceau, M., V.S Domingues, C.R. Linnen, E.B. Rosenblum and H.E. Hoekstra. 2010. Convergence in pigmentation at multiple levels: mutations, genes and function. Philosophical Transactions of the Royal Society 365:2439-2450.

Hoekstra, H.E., Hirschmann, R.J., Bundey, R.J., Insel, P. and J.P. Crossland. 2006. A single amino acid mutation contributes to adaptive color pattern in beach mice. Science 313:101-104.

Steiner, C.C., J.N. Weber and H.E. Hoekstra. 2007. Adaptive variation in beach mice caused by two interacting pigmentation genes. PLoS Biology 5(9):1880-1889.

Vignieri, S.N., J. Larson and H.E. Hoekstra. 2010. The selective advantage of cryptic coloration in mice. Evolution 64:2153-2158.

Related resources

This video is included in Session 3 of iBiology's Evolution Flipped Course, which has additional downloadable teaching guides and recommended videos. We encourage educators seeking more materials to visit the course page.

Acknowledgments

We thank Dr. Laci Gerhart-Barley for sharing her multiple-choice questions for this video. For more information on how to implement this video in your teaching through homework assignments, check out Dr. Gehart Barley's publication and webinar with Dr. Brittany Anderton, Associate Director of iBiology.