# A Cases for Evolution Education Question Guide

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## The Case of Fur Color Evolution in Beach Mice

This Evo-Ed case consists of five modules that support the teaching and learning of biology in the framework of evolution of fur color in the beach mouse, *Peromyscus polionotus*. Together, the modules present evidence that evolution occurs because of:

1) competition for resources and differential reproductive success in populations

2) heritable genetic variation and resulting differences in gene expression.

The following questions and activities are designed to guide students' learning as they engage in the modules of this case. They can also be used as learning objectives. That is, "students will be able to" accomplish each of these as objectives.

The modules and activities are presented in the order in which they appear in the case and can be used as in-class activities, homework and/or formative assessments.

The background information on this case, and accompanying slides can be found at:
→ www.evo-ed.org/Pages/Mice

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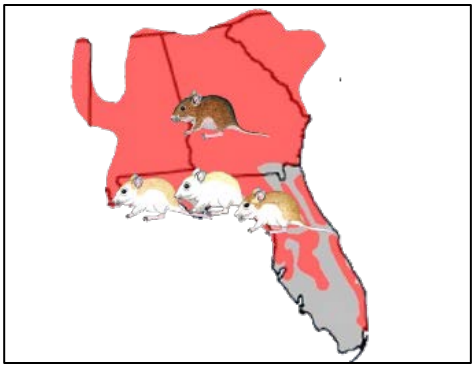
### Natural History and Ecology of Fur Color in Beach Mice



1) Develop a hypothesis that accounts for the distribution of mouse coat colors in Florida.

2) Use the simulation *Colonizing the Beach* to collect and analyze data on the number of light and dark mice under all conditions, with and without: owl, barrier, migration. Explain how each of these (predator, barrier and migration) affects the distribution of different colors of mice. This activity could also include population genetics (below)

3) Use the different backgrounds to "hunt" mice (*Mouse Hunter*). Explain your results in terms of predator/prey relationship and natural selection.

4) Using information from both *Mouse Hunter* and *Colonizing the Beach*, explain what would happen if owls suddenly died off in areas with both light and dark sand.

5) An oil spill leads to darkening of the Florida beaches. In terms of predation, construct an explanation for both the short and long term fate of the beach mice.

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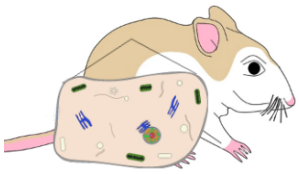
## Cell Biology of Fur Color in Beach Mice



1) Explain the relationship between levels of cAMP and melanin that is made in melanocytes (skin cells).

2) Build and explain a model of receptor/ligand interactions, using MC1R as the cell membrane receptor and α-MSH as the ligand. Explain and how this particular interaction affects melanocyte cell function.

3) Propose a cellular mechanism for the occurrence of white hair in beach mice.

4) Compare and contrast general and specific functions of a cell, using melanocytes as a model.

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## Genetics of Fur Color in Beach Mice

1) Develop a simple whiteboard animation or model showing how a small change in DNA can lead to a change in gene expression and cell function. Provide both general changes and the specific one in this case (*mc1r*).

2) Provide evidence from this case (see also clam toxin Evo-Ed case) that a single nucleotide change in a gene can alter protein synthesis and cellular function.

3) Explain why changes in nucleotides in a gene do not always lead to changes in protein synthesis.

4) Evaluate and explain whether or not the mutation in this case is "good" or "bad".

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## Population Genetics of Fur Color in Beach Mice

| | Average Color Scores for: | | |
|---|---|---|---|
| **Body Part** | **RR Individuals** | **RC Individuals** | **CC Individuals** |
| Rostrum | 2.00 | 1.81 | 0.81 |
| Whisker | 1.42 | 1.00 | 0.45 |
| Cheek | 1.28 | 1.25 | 0.69 |
| Eyebrow | 1.83 | 1.54 | 0.79 |
| Ear | 1.13 | 0.80 | 0.28 |
| Ankle | 1.06 | 0.82 | 0.29 |
| **Average** | 1.38 | 1.11 | 0.47 |

1) There are three combinations of alleles for the *mc1r* gene (RR, RC, CC). Determine MC1R synthesis for each combination and how they relate to coat color expression.

2) Score a set of "new" mouse fur patterns and predict frequency of RR, RC, CC.

   Example image for scoring: The Jackson Laboratory: JAX Mice Coat Color Guide

   https://www.pinterest.com/pin/419819996483539120/

3) Defend or refute this statement: R and C alleles show a typical dominant/recessive relationship.

4) Construct an explanation for a steady increase in R alleles in a defined population of beach mice over time.

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