

MS-LS4-6 Biological Evolution: Unity and Diversity

Students who demonstrate understanding can:

- MS-LS4-6. Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.** [Clarification Statement: Emphasis is on using mathematical models, probability statements, and proportional reasoning to support explanations of trends in changes to populations over time.] [Assessment Boundary: Assessment does not include Hardy Weinberg calculations.]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Using Mathematics and Computational Thinking

Mathematical and computational thinking in 6–8 builds on K–5 experiences and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.

- Use mathematical representations to support scientific conclusions and design solutions.

Disciplinary Core Ideas

LS4.C: Adaptation

- Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes.

Crosscutting Concepts

Cause and Effect

- Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

Observable features of the student performance by the end of the course:

1	Representation
a	Students identify the explanations for phenomena that they will support, which include: <ol style="list-style-type: none"> Characteristics of a species change over time (i.e., over generations) through adaptation by natural selection in response to changes in environmental conditions. Traits that better support survival and reproduction in a new environment become more common within a population within that environment. Traits that do not support survival and reproduction as well become less common within a population in that environment. When environmental shifts are too extreme, populations do not have time to adapt and may become extinct.
b	From given mathematical and/or computational representations of phenomena, students identify the relevant components, including: <ol style="list-style-type: none"> Population changes (e.g., trends, averages, histograms, graphs, spreadsheets) gathered from historical data or simulations. The distribution of specific traits over time from data and/or simulations. Environmental conditions (e.g., climate, resource availability) over time from data and/or simulations.
2	Mathematical Modeling
a	Students use the given mathematical and/or computational representations (e.g., trends, averages, histograms, graphs, spreadsheets) of the phenomenon to identify relationships in the data and/or simulations, including: <ol style="list-style-type: none"> Changes and trends over time in the distribution of traits within a population. Multiple cause-and-effect relationships between environmental conditions and natural selection in a population. The increases or decreases of some traits within a population can have more than one environmental cause.
3	Analysis
a	Students analyze the mathematical and/or computational representations to provide and describe evidence that distributions of traits in populations change over time in response to changes in

	environmental conditions. Students synthesize their analysis together with scientific information about natural selection to describe that species adapt through natural selection. This results in changes in the distribution of traits within a population and in the probability that any given organism will carry a particular trait.
b	Students use the analysis of the mathematical and/or computational representations (including proportional reasoning) as evidence to support the explanations that:
	i. Through natural selection, traits that better support survival and reproduction are more common in a population than those traits that are less effective.
	ii. Populations are not always able to adapt and survive because adaptation by natural selection occurs over generations.
c	Based on their analysis, students describe that because there are multiple cause-and-effect relationships contributing to the phenomenon, for each different cause it is not possible to predict with 100% certainty what will happen.