

HS-LS4-3 Biological Evolution: Unity and Diversity

California Science Test—Item Content Specifications

# HS-LS4-3 Biological Evolution: Unity and Diversity

Students who demonstrate understanding can:

Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.

[Clarification Statement: Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations.] [*Assessment Boundary: Assessment is limited to basic statistical and graphical analysis. Assessment does not include allele frequency calculations.*]

Continue to the next page for the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts.

| Science and Engineering Practices | Disciplinary Core Ideas | Crosscutting Concepts |
| --- | --- | --- |
| Analyzing and Interpreting Data  Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.  Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. | LS4.B: Natural Selection 4. Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information — that is, trait variation — that leads to differences in performance among individuals.  5. The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. LS4.C: Adaptation 4. Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not.  5. Adaptation also means that the distribution of traits in a population can change when conditions change. | Patterns Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. |

## Assessment Targets

Assessment targets describe the focal knowledge, skills, and abilities for a given three-dimensional Performance Expectation. Please refer to the Introduction for a complete description of assessment targets.

### Science and Engineering Subpractice(s)

Please refer to appendix A for a complete list of Science and Engineering Practices (SEP) subpractices. Note that the list in this section is not exhaustive.

4.1 Ability to record and organize data

4.2 Ability to analyze data to identify relationships

### Science and Engineering Subpractice Assessment Targets

Please refer to appendix A for a complete list of SEP subpractice assessment targets. Note that the list in this section is not exhaustive.

4.1.3 Ability to organize data in a way that facilitates analysis and interpretation

4.2.1 Ability to use empirical data to describe patterns and relationships

4.2.2 Ability to identify patterns (qualitative or quantitative) among variables represented in data

4.2.3 Ability to apply concepts of statistics and probability to data

4.2.4 Ability to consider limitations of data analysis (e.g., measurement error, sample selection)

### Disciplinary Core Idea Assessment Targets

#### LS4.B.4

* Describe heritable phenotypic variation among individuals in a population because of mutations and sexual reproduction
* Describe that genetic variation can lead to a variation of expressed traits in individuals in a population
* Describe that the variation of the expressed traits may lead to differences in performance in individuals

#### LS4.B.5

* Describe that traits that positively affect survival are more likely to be passed on to offspring and become more common in a population

#### LS4.C.4

* Describe that the distribution of adaptive traits in a population may change in response to changes in the environment
* Identify conditions of a particular environment that act as a selective pressure on a population

#### LS4.C.5

* Describe that the differential survival and reproduction of organisms with advantageous heritable traits leads to an increase in the proportion of individuals in a population over time
* Identify heritable traits (anatomical, behavioral, and physiological) that provide an advantage in a particular environment

### Crosscutting Concept Assessment Target(s)

CCC1 Identify different patterns at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena

## Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides a description of an advantageous heritable trait and a description of data that have been collected or are expected to be collected:

* Identifies the appropriate way to organize the data to facilitate analysis that supports an explanation about the distribution of the trait in a population (4.1.3, LS4.C.4, LS4.C.5, and CCC1)

Task provides a scenario about an advantageous heritable trait and a data set in the form of a table showing the distribution of the trait over time or varying habitats:

* Describes patterns or relationships in a data set and its corresponding scientific concept, such as natural selection (4.2.1, LS4.C.4, LS4.C.5, and CCC1)

Task provides a description of an advantageous heritable trait and a data set in the form of a graph showing the distribution of the trait over time or varying habitats:

* Connects patterns in the data set and its corresponding scientific concept relevant to the trait (4.2.2, LS4.C.4, LS4.C.5, and CCC1)

Task provides a description of an advantageous heritable trait and a data set related to the frequency of the trait among the population:

* Analyzes data using reasoning, mathematics, or statistics and probability (including mean, median, mode, and variability) to answer a scientific question about the distribution of the trait in a population (4.2.3, LS4.C.4, LS4.C.5, and CCC1)

Task provides a description of an advantageous heritable trait, a data set, and a scientific question being investigated:

* Identifies limitations of data sets or an analysis of the data set, with respect to their ability to answer the scientific question (4.2.4, LS4.C.4, LS4.C.5, and CCC1)

## Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

* A specific phenotype is observed to increase over time in a given population in a given environment.
* Two populations of the same species are in two different habitats. The population in each habitat has a different variation of an advantageous trait.
* Gene frequency data is used to predict whether a specific trait would be adaptive or maladaptive for a particular environment.
* Gene frequency data and quantitative environmental changes are analyzed for correlation.
* A heterozygote advantage is observed within a population.

## Common Misconceptions

Note that the list in this section is not exhaustive.

* Statistics do not really mean anything important.
* Patterns always indicate cause and effect.
* Changes are due to the conscious efforts of organisms.
* Adaptations develop in a single organism over its lifetime.

## Additional Assessment Boundaries

None listed at this time.

## Additional References

HS-LS4-3 Evidence Statement [https://www.nextgenscience.org/sites/default/files/evidence\_statement/black\_white/HS-LS4-3 Evidence Statements June 2015 asterisks.pdf](https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/HS-LS4-3%20Evidence%20Statements%20June%202015%20asterisks.pdf)

The *2016 Science Framework for California Public Schools Kindergarten through Grade 12*

Appendix 1: Progression of the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts in Kindergarten through Grade 12 <https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix1.pdf>

Posted by the California Department of Education, March 2021 (updated February 2024)