

HS-LS3-3 Heredity: Inheritance and Variation of Traits

California Science Test—Item Content Specifications

# HS-LS3-3 Heredity: Inheritance and Variation of Traits

Students who demonstrate understanding can:

Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

[Clarification Statement: Emphasis is on the use of mathematics to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits.] [*Assessment Boundary: Assessment does not include Hardy-Weinberg 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 DataAnalyzing 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. | LS3.B: Variation of Traits7. Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus, the variation and distribution of traits observed depends on both genetic and environmental factors. | Scale, Proportion, and QuantityAlgebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).Connections to Nature of ScienceScience is a Human Endeavor* Technological advances have influenced the progress of science and science has influenced advances in technology.
* Science and engineering are influenced by society and society is influenced by science and engineering.
 |

## 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.

4.2 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.

4.2.3 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

#### LS3.B.7

* Apply concepts of statistics and probability to explain the distribution of expressed traits in a population
* Apply concepts of statistics and probability to explain the impact of environmental factors on the distribution of expressed traits in a population
* Apply concepts of statistics and probability to predict the distribution of expressed traits in a population
* Apply concepts of statistics and probability to understand the interaction between genetic and environmental factors on the distribution of expressed traits in a population
* Identify the limitations of statistics and probability in predicting the distribution of expressed traits in a population

### Crosscutting Concept Assessment Target(s)

CCC3 Use algebraic thinking to examine scientific data and to predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth)

## Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides the genotype of two parents in a cross for a trait with dominant and recessive alleles:

* Calculates the predicted genotypic and/or phenotypic ratios of the offspring (4.2.3, LS3.B.7, and CCC3)

Task provides a data set containing the phenotypes of parents and their offspring for a trait with dominant and recessive alleles:

* Calculates the predicted phenotypic ratio based on the parental phenotypes (4.2.3, LS3.B.7, and CCC3)
* Determines whether the results of the cross are within statistical limits (4.2.3, LS3.B.7, and CCC3)
* Explains the limits of statistical methods in analyzing the data set (4.2.4, LS3.B.7, and CCC3)

Task provides the phenotypic ratio that results from the cross of two parents:

* Uses statistics and probability to determine the most likely genotypes of the parents (4.2.3, LS3.B.7, and CCC3)

Task provides data on parental genotypes for traits with multiple alleles:

* Predicts the possible genotypic and phenotypic combinations of offspring (4.2.3 and LS3.B.7)
* Explains the limits of statistical methods in analyzing the data set (4.2.4, LS3.B.7, and CCC3)

Task provides student with information on the phenotypes of offspring that do not match a predicted ratio:

* Determines that environmental factors impacted gene expression (4.2.3, LS3.B.7, and CCC3)
* Explains the limits of statistical methods in analyzing the data set (4.2.4, LS3.B.7, and CCC3)
* Uses statistics to correctly explain the interaction between genetic and environmental factors on the distribution of expressed traits (4.2.3, LS3.B.7, and CCC3)

## Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

* Both Mendelian and non-Mendelian inheritance patterns (e.g., incomplete dominance, codominance, sex-linked)
* Impact of environmental factors on gene expression
	+ Gradual, long-term changes
	+ Rapid, extreme environmental changes
* Use of Punnett squares to facilitate probability calculations

## Common Misconceptions

Note that the list in this section is not exhaustive.

* Each trait has only two alleles — one dominant, one recessive.
* The environment has no impact on gene expression.
* A dominant trait is most frequent in a population.
* Genotypic and phenotypic ratios are the same.
* Mutations are always bad.

## Additional Assessment Boundaries

None listed at this time.

## Additional References

HS-LS3-3 Evidence Statement [https://www.nextgenscience.org/sites/default/files/evidence\_statement/black\_white/HS-LS3-3 Evidence Statements June 2015 asterisks.pdf](https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/HS-LS3-3%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)