

MS-LS3-1 Heredity: Inheritance and Variation of Traits

California Science Test—Item Content Specifications

# MS-LS3-1 Heredity: Inheritance and Variation of Traits

Students who demonstrate understanding can:

Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.

[Clarification Statement: Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins.] [*Assessment Boundary: Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.*]

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 |
| --- | --- | --- |
| Developing and Using ModelsModeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.Develop and use a model to describe phenomena. | LS3.A: Inheritance of Traits4. Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits.LS3.B: Variation of Traits5. In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism. | Structure and FunctionComplex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function. |

## 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.

2.1 Ability to develop models

### 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.

2.1.1 Ability to determine components of a scientific event, system, or design solution

2.1.2 Ability to determine the relationships among multiple components of a scientific event, system, or design solution

2.1.4 Ability to represent mechanisms, relationships, and connections to illustrate, explain, or predict a scientific event

### Disciplinary Core Idea Assessment Targets

#### LS3.A.4

* Recognize that chromosomes contain genes and that different versions of genes (alleles) exist for different proteins
* Recognize that each distinct gene has a certain sequence (code) which determines the structure of a specific set of proteins
* Recognize that protein structure influences protein function
* Recognize that specific proteins affect the traits of individual organisms
* Describe how mutations in genes can result in changes to proteins
* Describe how changes to proteins can affect observable structures and functions in organisms

#### LS3.B.5

* Explain how genetic mutations can result in trait changes that are beneficial, harmful, or neutral for the organism

### Crosscutting Concept Assessment Target(s)

CCC6 Use complex and microscopic structures and systems to describe how their function depends on the shapes, composition, and relationships among its parts

## Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides a model of normal gene and one with a mutation:

* Explains what the effects of the mutation could be on the resulting protein and a trait of an organism (2.1.1, LS3.A.4, and CCC6)

Task provides a model of a normal gene and/or protein along with a description of a mutation and its result:

* Identifies a model that shows the mutation and/or the resulting proteins (2.1.1, LS3.A.4, and CCC6)

Task provides an incomplete model showing a gene, a resulting protein, the protein’s function, the resulting structural or functional change in an organism, and/or if the trait change is harmful, helpful, or neutral to the organism:

* Selects or adds (by dragging-and-dropping) the missing component(s) to complete the model (2.1.1, LS3.A.4, and CCC6)

Task provides a model of a gene, the resulting protein, how the protein functions, and how it affects the trait of an organism. It also provides a description of a genetic mutation and how it is helpful, harmful, or neutral to the same organism:

* Uses relevant components from a set containing both relevant and irrelevant components to complete a model showing the effects of the mutation on the organism (2.1.1, LS3.B.5, and CCC6)

Task provides a model of a gene, the resulting protein, how the protein functions, and how it affects the trait of an organism. It also provides a description of a genetic mutation:

* Predicts if the mutation is helpful, harmful, or neutral (2.1.3, LS3.B.5, and CCC6)

## Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

* Types of mutations (substitution, insertion, and deletion)
* Effects of mutations on protein structure and function (e.g., sickle-cell anemia)
* Changes to protein structure may be
	+ harmful to the organism (e.g., albinism reducing the ability to camouflage),
	+ beneficial to the organism (e.g., antibiotic resistance increasing survival in the presence of antibiotics), or
	+ have no impact on the organism.

## Common Misconceptions

Note that the list in this section is not exhaustive.

* Genes and proteins are the same things.
* Traits change due to the environment, which in turn changes genes.
* The information in genes provides instructions for rearranging chromosomes into traits.
* Mutations are always harmful to the functioning of an organism.

## Additional Assessment Boundaries

None listed at this time.

## Additional References

MS-LS3-1 Evidence Statement <https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/MS-LS3-1%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>

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