Unless otherwise specified, "descriptions" referenced in the evidence statements could include but are not limited to written, oral, pictorial, and kinesthetic descriptions.

MS-LS3-2 Heredity: Inheritance and Variation of Traits

Students who demonstrate understanding can:

MS-LS3-2. **Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.** [Clarification Statement: Emphasis is on using models such as Punnett squares, diagrams, and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.]

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

Developing and Using Models

Modeling 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.

Disciplinary Core Ideas

LS1.B: Growth and Development of Organisms

- Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. *(secondary)*

LS3.A: Inheritance of Traits

- Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited.

LS3.B: Variation of Traits

- In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other.

Crosscutting Concepts

Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural systems.

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

1	Components of the model	
	a	Students develop a model (e.g., Punnett squares, diagrams, simulations) for a given phenomenon involving the differences in genetic variation that arise from sexual and asexual reproduction. In the model, students identify and describe* the relevant components, including:
		i. Chromosome pairs, including genetic variants, in asexual reproduction:
		1. Parents.
		2. Offspring.
		ii. Chromosome pairs, including genetic variants, in sexual reproduction:
		1. Parents.
		2. Offspring.
2	Relationships	
	a	In their model, students describe* the relationships between components, including:
		i. During reproduction (both sexual and asexual), parents transfer genetic information in the form of genes to their offspring.
		ii. Under normal conditions, offspring have the same number of chromosomes, and therefore genes, as their parents.
		iii. During asexual reproduction, a single parent's chromosomes (one set) are the source of genetic material in the offspring.
		iv. During sexual reproduction, two parents (two sets of chromosomes) contribute genetic material to the offspring.

3	Connections	
	a	Students use the model to describe* a causal account for why sexual and asexual reproduction result in different amounts of genetic variation in offspring relative to their parents, including that:
		i. In asexual reproduction:
		1. Offspring have a single source of genetic information, and their chromosomes are complete copies of each single parent pair of chromosomes.
		2. Offspring chromosomes are identical to parent chromosomes.
		ii. In sexual reproduction:
		1. Offspring have two sources of genetic information (i.e., two sets of chromosomes) that contribute to each final pair of chromosomes in the offspring.
		2. Because both parents are likely to contribute different genetic information, offspring chromosomes reflect a combination of genetic material from two sources and therefore contain new combinations of genes (genetic variation) that make offspring chromosomes distinct from those of either parent.
	b	Students use cause-and-effect relationships found in the model between the type of reproduction and the resulting genetic variation to predict that more genetic variation occurs in organisms that reproduce sexually compared to organisms that reproduce asexually.