Mini-Map for SCI.EE.12.LS.Trait-2

Subject: Science
Life Science (LS)
Grade band: 9–12

Grade-Level Expectation

DLM Essential Element	DLM Disciplinary Core Idea Family[1]	Framework Disciplinary Core Ideas
SCI.EE.12.LS.Trait-2 Use mathematical reasoning to support relationships between changing environmental conditions, adaptation by natural selection, and changes in the distribution of traits within a population.	Life Science – Traits of Organisms	LS3.A: Inheritance of Traits LS3.B: Variation of Traits LS4.B: Natural Selection LS4.C: Adaptation

[1] DLM Science Essential Elements organize Disciplinary Core Ideas (defined in the *Framework for K-12 Science Education*) into DCI families. By combining similar concepts within a domain, science content from the general education standards is reduced in depth, breadth, and complexity to provide access for students that qualify for the DLM alternate assessment.

Linkage Level Descriptions

Initial Precursor	Distal Precursor	Proximal Precursor	Target[2]
Identify when associations between objects in the natural world occur by specifying when a change in one object impacts the other objects.	Compare the occurrences of living things' traits (i.e., the relative number or frequency of traits) in environments to identify associations between those traits and the environments in which they occur.	Use the distribution of traits represented in graphs or tables to determine how traits may vary between different kinds of living things or within a population of the same type of living things.	Compare the distribution of traits in a population across multiple time points to describe and support relationships between a population's environment and adaptation by natural selection (i.e., the process by which advantageous heritable traits are selected for and increase in an environment or disadvantageous heritable traits are selected against and decrease in an environment).

[2] The target linkage level description is a measurement target that describes the expectations (content and performance) of the Essential Element for assessment purposes.

Essential Element Three Dimensions

Each Essential Element is defined in the three dimensions described in the *Framework for K-12 Science Education*: disciplinary core ideas (DCIs), science and engineering practices (SEPs), and crosscutting concepts (CCCs). The table below lists the details of each dimension from the individual DLM Essential Element descriptions, with color-coding of dimensions corresponding to the Next Generation Science Standards (NGSS). The first row (in blue) lists the SEP(s) used to construct the Essential Element and describes ways each SEP could be incorporated. The second row (in orange) describes the science concepts within the DCI family related to this Essential Element. The third row (in green) lists the CCC(s) associated with the Essential Element and explains how each might be incorporated in the grade band (quoted from NSTA, 2013, matrix of CCCs). Note that the SEP is presented first here (rather than second, as it is in the full list of Essential Elements) to reflect the emphasis on practices in instruction and across the linkage levels. The final row (in white) includes examples of how the three dimensions could work together to support instruction for the Essential Element. These examples provide ideas for integrating the dimensions and are not exhaustive, nor are they intended to limit instruction.

Science and Engineering Practices	**Using Mathematics and Computational Thinking:** Mathematical and computational thinking in grades 9–12 builds on K–8 experiences and progresses to analyzing and interpreting data and mathematical concepts to construct meaning about systems in the natural and designed world. • Use mathematical reasoning to construct and support claims about the relationships between variables. • Analyze and interpret data to investigate the relationships and characteristics of the components of a system. **Engaging in Argument from Evidence:** Engaging in argument from evidence in grades 9–12 builds on K–8 experiences and progresses to evaluating information to construct arguments about the natural world. • Use observations, information, data, models, and mathematical reasoning to develop and evaluate claims. • Use information to construct an argument.

Disciplinary Core Ideas	**Traits of Organisms** • The distributions of expressed traits in a population result from (1) the potential for a species to reproduce and increase in number, (2) heritable traits due to reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment. • Adaptation impacts the distribution of traits in a population as changes in conditions occur. o Species' characteristics can change over generations in response to changes in environmental conditions. Environmental changes can occur naturally or due to human activities. o Natural selection may lead to increases and decreases of specific traits in populations over time. o Traits that increase the chance of survival are passed down from parents to offspring through reproduction, becoming more common within the population. Traits that do not increase the chance of survival are not passed down from parents to offspring, becoming less common within the population.
Crosscutting Concepts	**Cause and Effect: Mechanism and Explanation**: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering. • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. • Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. • Systems can be designed to cause a desired effect. • Changes in systems may have various causes that may not have equal effects.

	Scale, Proportion, and Quantity: In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change. • The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. • Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. • Patterns observable at one scale may not be observable or exist at other scales. • Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. • Algebraic 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). **Systems and System Models**: A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems. • Systems can be designed to do specific tasks. • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. • Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. • Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models. **Stability and Change**: For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand. • Much of science deals with constructing explanations of how things change and how they remain stable. • Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. • Feedback (negative or positive) can stabilize or destabilize a system. • Systems can be designed for greater or lesser stability.

How three dimensions support instruction for this Essential Element	Students can use mathematical data to identify cause-and-effect relationships between traits of living things and their chances of survival and reproduction. Students can also recognize that if an environment changes, only some living things survive and reproduce. The concepts of stability and change can also be understood when students examine data about habitats that have changed over time and compare the resulting distribution of traits within a population. For example, some environmental changes will lead to some living things no longer reproducing and passing on traits, while other organisms thrive and increase in population. Students can make connections between how environmental changes impact a population and what traits are passed on as part of a larger system. Students can use observations of the system to determine that different kinds of living things have different traits, or to predict the distribution of traits within a population, depending on environmental conditions and components of the ecosystem. For example, students can observe that some rabbits in a population have darker fur and some have lighter fur, and predict that, in a particular habitat, the rabbits with darker fur will be harder for predators to see, which allows them to live longer and pass on their traits, eventually changing the make-up of the population in the ecosystem. Students can use mathematical reasoning and the concepts of scale, proportion, and quantity to evaluate data about the changing frequency of traits at the population level. Students can use a graph or table to describe changes in the distribution of a single trait over time or the relative distributions of multiple traits. Using data, students can make a claim about how the number of living things in a population with particular traits has been affected by the environment.

Instructional Resources

Resources
Learning modules and additional science instructional resources can be found at https://www.dlmpd.com/science/
A glossary defining key science terms found in the Essential Elements can be found at DLM Glossary for Science Learning Maps.

Link to Text-Only Map

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