Mini-Map for SCI.EE.12.LS.EcoHlth-1

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.EcoHlth-1 Use data to make an argument about the effects of unstable environments on the health of ecosystems.	Life Science – Ecosystem Health	LS2.A: Interdependent Relationships in Ecosystems LS2.C: Ecosystem Dynamics, Functioning, and Resilience LS4.D: Biodiversity and Humans ESS2.A: Earth Materials and Systems ESS2.D: Weather and Climate ESS2.E: Biogeology ESS3.A: Natural Resources

[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]
Predict the likely result of a common action of or on a novel object, based on the characteristics the object shares with a category of familiar objects.	Use information to identify associations between a healthy ecosystem, where many different living things make their habitat, and their ability to find the things they need to live (i.e., space to grow, shelter, water, and food).	Use evidence to make and support claims about the relationships between living and nonliving elements of a habitat, resource availability, growth of organisms, and the size of populations of organisms within an ecosystem.	Use data as evidence to make arguments about the relationships between disturbances within Earth's spheres, resource availability, population growth, biodiversity, and the health and stability of an ecosystem.

[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	**Analyzing and Interpreting Data:** Analyzing data in grades 9–12 builds on K–8 experiences and progresses to analyzing and evaluating to support explanations about relationships and solutions to problems in the natural world. • Represent and analyze data to determine and describe relationships between variables. • Use data to construct and evaluate arguments. • Analyze data to design and evaluate solutions to problems. **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	**Ecosystem Health**
	• A healthy ecosystem can support the needs of diverse populations. Therefore, a healthy ecosystem supports biodiversity.
	• Resource availability determines where animals and humans live.
	• Ecosystems have limits on organisms and populations.
	  o Limits on ecosystems are based on resource availability (both living and nonliving resources).
	  o Limiting factors slow or stop population growth. Examples may include predation, competition, disease, immigration of species, weather, food, and water availability.

	• Unstable environments impact populations of animals and plants. o An unstable ecosystem is unable to resist disturbances and quickly returns to its average state after a disturbance. o Disturbances or disruptions to living and nonliving factors in ecosystems affect the populations living there. o Unstable environments may be caused by a variety of factors such as drought, flood, migration of species, immigration of species, invasive species, disease, or an unhealthy predator-to-prey ratio. o Unstable environments can decrease biodiversity. o Changes in biodiversity affect populations' access to living and nonliving resources. This includes humans. o Human activity can disrupt or disturb ecosystems. o Changes in weather and climate impact ecosystems. • Earth's spheres interact, impacting ecosystems. o The biosphere and geosphere dynamically interact: Living organisms (biosphere) have impacted Earth's spheres (hydrosphere, geosphere, and atmosphere) and vice versa.

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. **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.

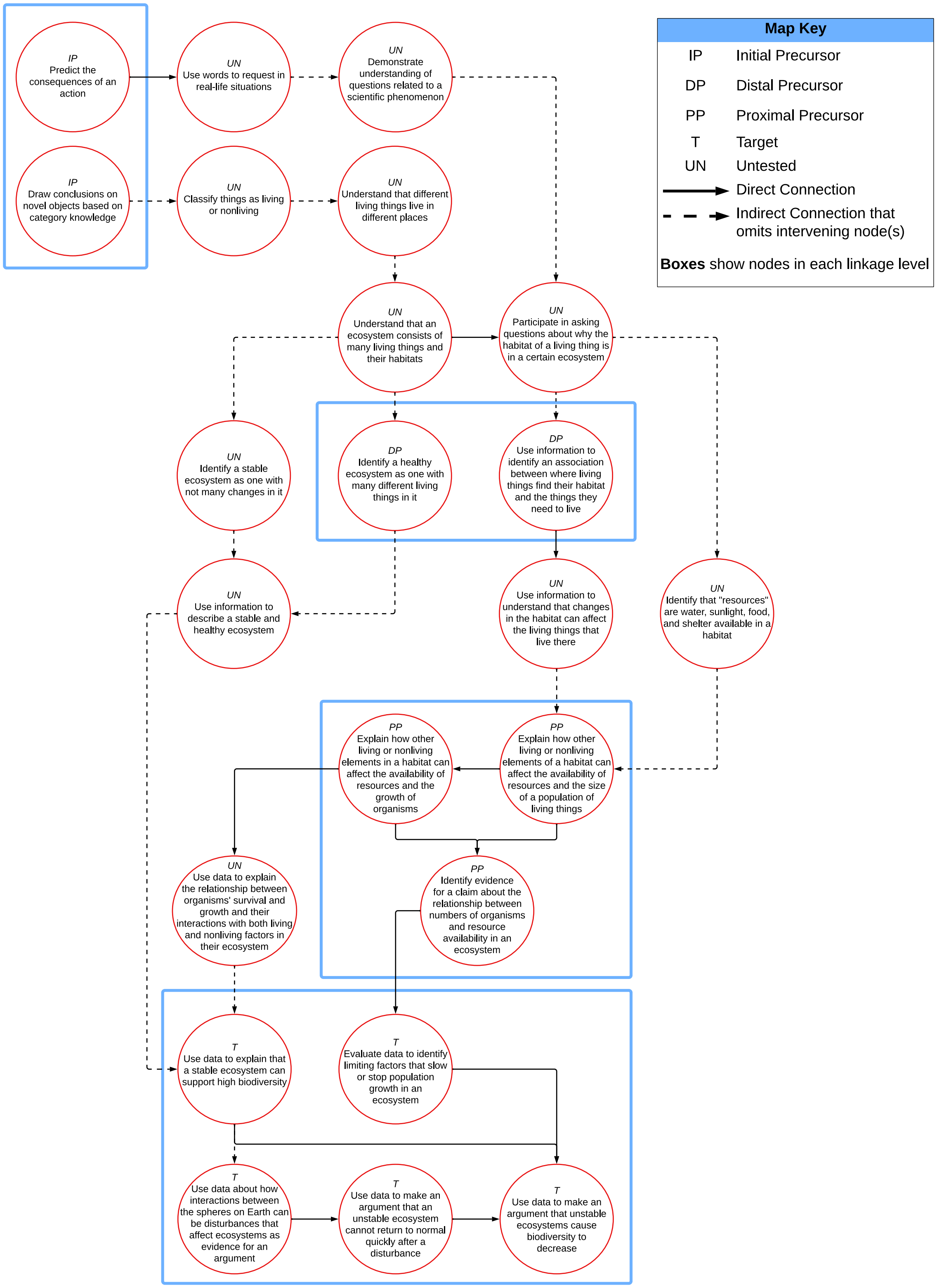
How three dimensions support instruction for this Essential Element	Students can learn about cause-and-effect relationships within systems by analyzing data related to resource availability and population size and diversity within an ecosystem. For example, students can describe how a change in weather affects the availability of plants in an ecosystem, which then affects the animals that eat those plants. Students can understand concepts of stability and change through data related to biodiversity. For example, a decrease in biodiversity is caused by limiting factors such as competition for space, food, and water. The effects of this decrease are a less stable ecosystem with reduced population size. Students can use data to support claims about the effects of limiting factors on population growth or to discover that it may take time for an ecosystem to recover after a disturbance. To learn about systems and system models, students can observe that the system of Earth's spheres interact and impact ecosystems or that human interactions also have an impact on ecosystems. For example, students can analyze data to understand how changes in the Earth's hydrosphere can impact water availability in an ecosystem or use data to support the argument that overfishing can disrupt food chains and affect an entire ecosystem.

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]

SCI.EE.12.LS.EcoHlth-1 Use data to make an argument about the effects of unstable environments on the health of ecosystems.



Mini-Map for SCI.EE.12.LS.Ecosys-1

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.Ecosys-1 Develop a model that describes how matter (plant or animal matter) and energy (i.e., sunlight and food energy) are cycled within an ecosystem.	Life Science – Ecosystem: Cycling of Matter and Flow of Energy	LS1.C: Organization for Matter and Energy Flow in Organisms LS2.A: Interdependent Relationships in Ecosystems LS2.B: Cycles of Matter and Energy Transfer in Ecosystems PS3.D: Energy in Chemical Processes and Everyday Life

[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]
Recognize the patterned arrangement of a sequence or process in the natural world.	Use a food chain to demonstrate that matter and energy from food allows animals to do things to keep them alive.	Use a food chain/web to demonstrate that matter and energy that animals get from eating other animals and/or plants originally comes from the Sun, air, and water in their environment.	Use a model to describe how matter is cycled and energy flows between components of an ecosystem (i.e., environment, producers, consumers, and decomposers).

[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	**Developing and Using Models:** Modeling in grades 9–12 builds on K–8 experiences and progresses to developing, using, and evaluating models (e.g., maps, diagram, drawing, physical replica, diorama, graphs, dramatization, storyboard) that represent relationships, events, and systems in the natural world. • Develop, use, and evaluate models to describe relationships between variables and components of a system. • Use models to construct and evaluate explanations in the natural world.
Disciplinary Core Ideas	**Ecosystem: Cycling of Matter and Flow of Energy** • Matter and energy flow through living systems. • Matter and energy are cycled and transferred from one system to another. • Food webs model how matter and energy are transferred among producers, consumers, and decomposers as the three groups interact within an ecosystem. • The energy released from food was once energy from the Sun that was captured by plants in the process that forms plant matter (from air and water) (see SCI.EE.12.LS.Plant-1). • As food matter is transferred among organisms in a living system, the matter is broken down and rearranged into new groupings of atoms (see SCI.EE.12.PS.Matter-2). This process provides organisms with matter and energy for life.

Crosscutting Concepts	**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. **Energy and Matter: Flows, Cycles, and Conservation:** Tracking energy and matter flows into, out of, and within systems helps one understand their system's behavior. • The total amount of energy and matter in closed systems is conserved. • Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. • Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems. • Energy drives the cycling of matter within and between systems. • In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.
How three dimensions support instruction for this Essential Element	Students can use system models to develop a model of an ecosystem that describes the cycling of matter and energy through that system. Students can make connections between energy and matter flowing through living systems, being transferred from one system to another, and eventually recycled. These system interactions can be described in student-created models, such as a food web, that students can use to note where energy and matter flow into, out of, and within the model. For example, students note that energy transfer occurs when plant and animal matter is broken down when eaten and energy is released.

Instructional Resources

Resources
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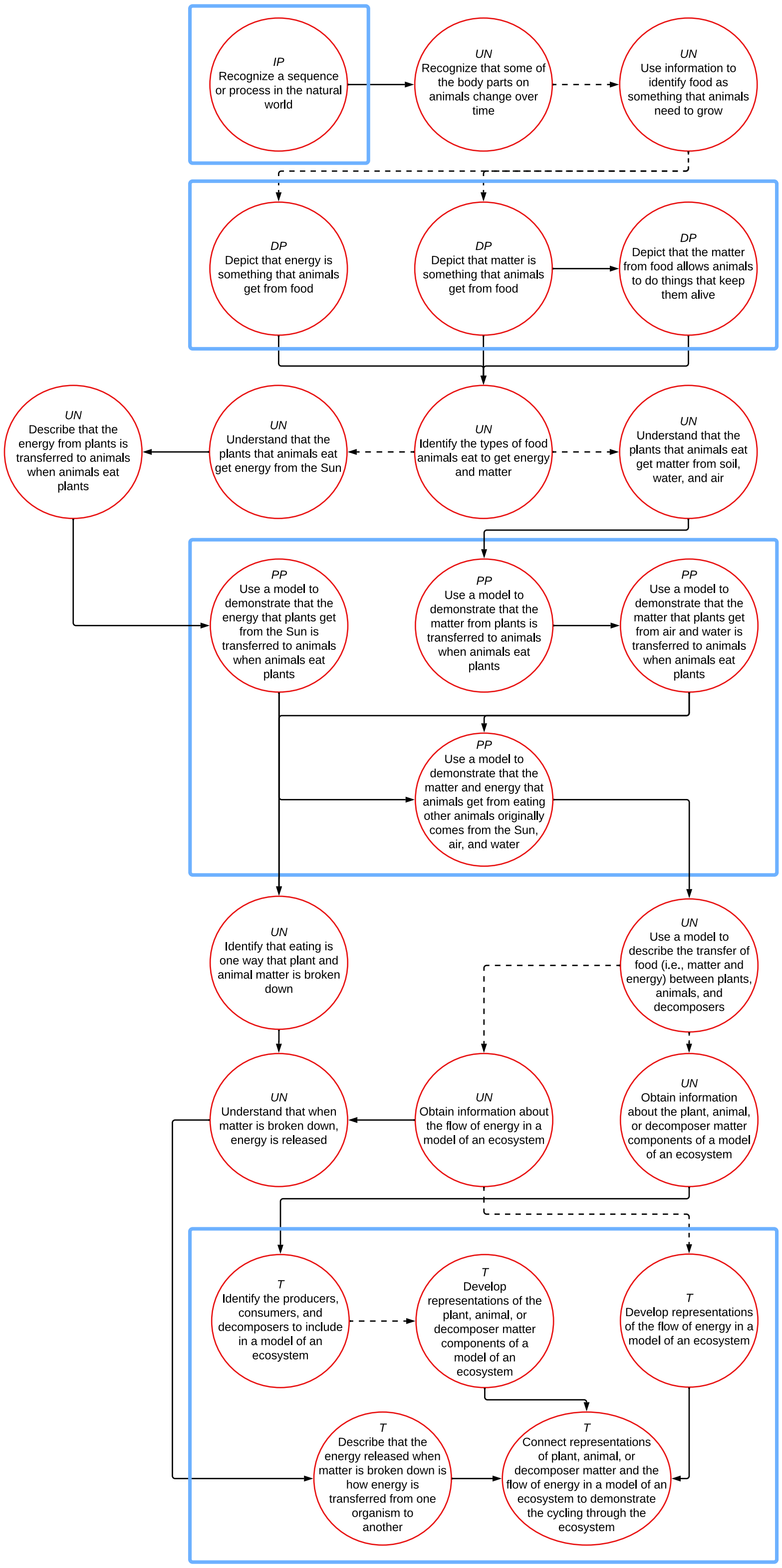
[Link to Text-Only Map](#)

SCI.EE.12.LS.Ecosys-1 Develop a model that describes how matter (plant or animal matter) and energy (i.e., sunlight and food energy) are cycled within an ecosystem.



Map Key	
IP	Initial Precursor
DP	Distal Precursor
PP	Proximal Precursor
T	Target
UN	Untested
⟶	Direct Connection
- - →	Indirect Connection that omits intervening node(s)

Boxes show nodes in each linkage level

Mini-Map for SCI.EE.12.LS.Org-1

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.Org-1 Use a model to construct an explanation of how systems of specialized cells within organisms work together to perform essential functions of life.	Life Science — Organisms: Structure and Function, Growth and Development	LS1.A: Structure and Function LS1.B: Growth and Development of Organisms

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Linkage Level Descriptions

Initial Precursor	Distal Precursor	Proximal Precursor	Target[2]
Identify parts of a sequence, process, or scientific phenomenon.	Use representations to identify the different levels that comprise an organism's body system (i.e., the body is a system made of subsystems which are made of external and internal body parts).	Use representations to describe a body system as made up of internal and external organs with specific functions that interact with each other.	Use a model to explain how systems of specialized cells have different functions and work together (i.e., specialized cells that form tissues, tissues that form organs, and organs that make up organ systems) to keep organisms alive.

[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

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Science and Engineering Practices	**Developing and Using Models:** Modeling in grades 9–12 builds on K–8 experiences and progresses to developing, using, and evaluating models (e.g., maps, diagram, drawing, physical replica, diorama, graphs, dramatization, storyboard) that represent relationships, events, and systems in the natural world. • Develop, use, and evaluate models to describe relationships between variables and components of a system. • Use models to construct and evaluate explanations in the natural world. **Constructing Explanations and Designing Solutions:** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to constructing and evaluating explanations about processes or relationships in the natural or designed world. • Gather and use information to construct descriptions and explanations of processes and relationships in the natural world.
Disciplinary Core Ideas	**Organisms: Structure and Function, Growth and Development** • Living things are made up of a system of specialized cells. • Groups of cells work together to form systems of cells (examples of tissue could include muscle or nerve). • Systems of cells form organs (e.g., heart, lung, ear) and organ systems (e.g., circulatory system, respiratory system). • Organs and organ systems perform specific body functions. • Organs and organ systems interact to perform life functions of an organism.

Crosscutting Concepts	**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. **Structure and Function:** The way an object is shaped or structured determines many of its properties and functions. • Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. • The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.
How three dimensions support instruction for this Essential Element	Students can use system models to investigate the body as a kind of system. Using a model, students can represent the functions of common organs, such as the heart or stomach. Students can explain how organs work as a system to keep organisms alive. Students can observe through models that organ systems are made up of organs, organs are made of tissues, tissues made of cells, and that each component has different specialized functions. From here, students can understand the structure of external and internal organs and how the organs' structures relate to their functions.

Instructional Resources

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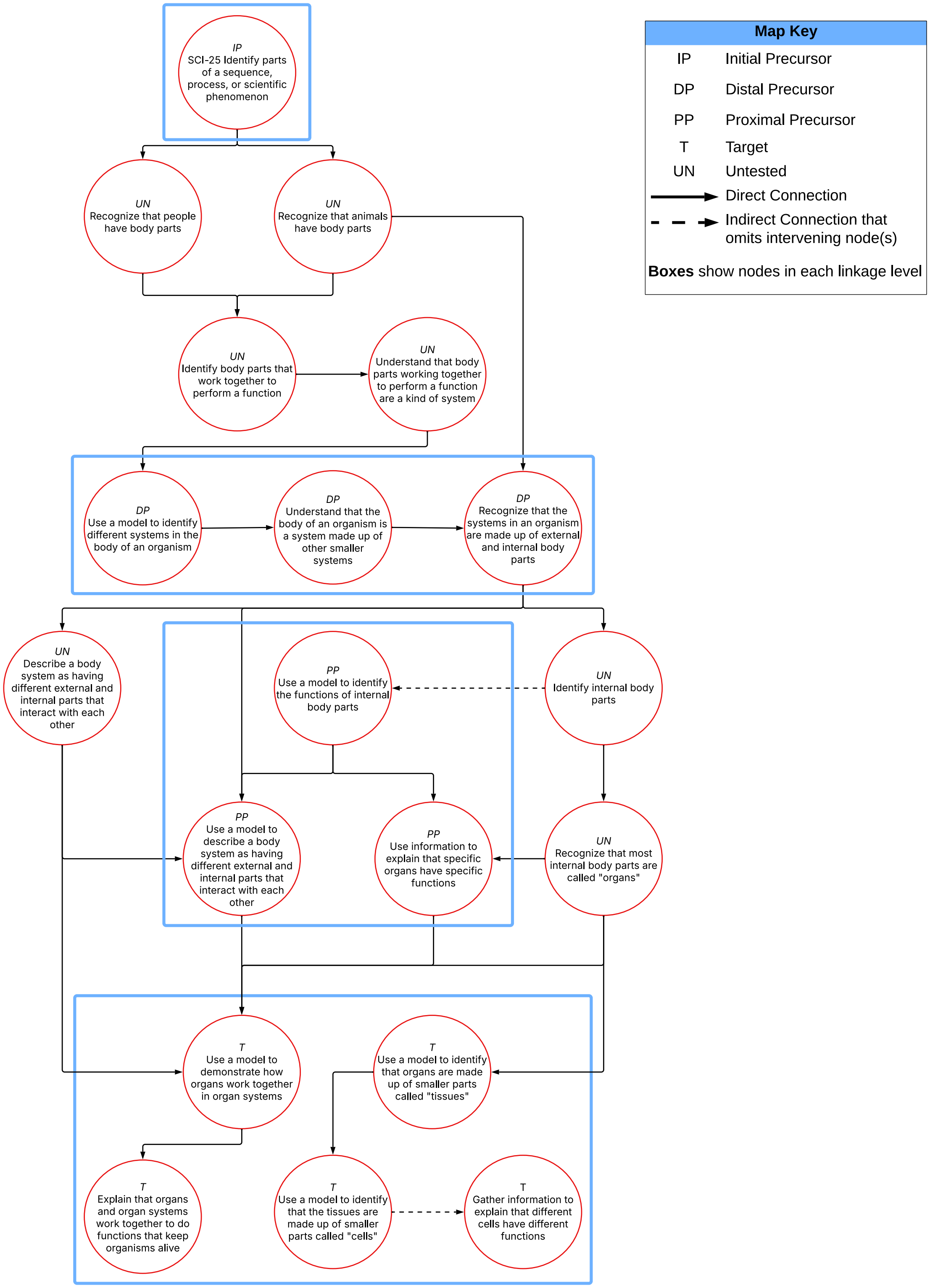
SCI.EE.12.LS.Org-1 Use a model to construct an explanation of how systems of specialized cells within organisms work together to perform essential functions of life.



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

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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).

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Essential Element Three Dimensions

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<table>
<tr>
<td>Science and Engineering Practices</td>
<td>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.

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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

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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.