MS.LS-SFIP Structure, Function, and Information Processing

How to read the standards »

Go to the NGSS Survey

Students who demonstrate understanding can:

a. **Investigate and present evidence that the structure of cells in both unicellular and multicellular organisms is related to how cells function.** ***[Assessment Boundary: Students conduct, not design, investigations.]***

b. **Investigate and generate evidence that unicellular and multicellular organisms survive by obtaining food and water, disposing of waste, and having an environment in which to live.**

c. **Construct an explanation for the function of specific parts of cells including: nucleus, chloroplasts, and mitochondria and the structure of the cell membrane and cell wall for maintaining a stable internal environment.**

d. **Construct models and representations of body systems to demonstrate how multiple interacting subsystems and structures work together to accomplish specific functions.** **[Clarification Statement: Representations are specific to the interactions of the systems and focus on the following systems: excretory, digestive, respiratory, and nervous systems.]** ***[Assessment Boundary: The focus is on the interaction of subsystems within the system, not the mechanism of each body system itself.]***

e. **Provide explanations of how sense receptors respond to stimuli by sending messages to the brain to be processed for immediate behavior or stored as information.**

f. **Communicate an explanation for how the storage of long-term memories requires changes in the structure and function of millions of interconnected nerve cells in the brain.**

The performance expectations above were 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 and progresses to developing, using and revising models to explain, explore, and predict more abstract phenomena and design systems.
- Use and/or construct models to predict, explain, and/or collect data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs. (d)

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.
- Collect data and generate evidence to answer scientific questions or test design solutions under a range of conditions. (a),(b)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.
- Apply scientific reasoning to show why data are adequate for the explanation or conclusion. (c),(e)
- Construct explanations from models or representations. (c)

Obtaining, Evaluating, and Communicating Information
Obtaining, evaluating, and communicating information in 6–8 builds on 3–5 and progresses to evaluating the merit and validity of ideas and methods.
- Gather, read, and explain information from appropriate sources and evaluate the credibility of the publication, authors, possible bias of the source, and methods used. (f)

Disciplinary Core Ideas

LS1.A: Structure and Function
- All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular). (a)
- Unicellular organisms (microorganisms), like multicellular organisms, need food, water, a way to dispose of waste, and an environment in which they can live. (b)
- Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. (c)
- In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. (d)

LS1.D: Information Processing
- Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. (e)
- The signals are then processed in the brain, resulting in immediate behaviors or memories. Changes in the structure and functioning of many millions of interconnected nerve cells allow combined inputs to be stored as memories for long periods of time. (f)

Crosscutting Concepts

Systems and System Models
Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. Models are limited in that they only represent certain aspects of the system under study. (b),(d),(e)

Structure and Function
Complex 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 and designed structures/systems can be analyzed to determine how they function. Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. (a),(c),(f)

Connections to other DCIs in this grade-level: **MS.PS-CR**

Articulation of DCIs across grade-levels: **3.SFS, HS.LS-SFIP,**

Common Core State Standards Connections: [Note: these connections will be made more explicit and complete in future draft releases]

ELA

RST.6.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

RI.6.7	Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.
RI.6.8	Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not.
RI.7.8	Trace and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient to support the claims.
RI.8.8	Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced.
Mathematics	
MP.2	Reason abstractly and quantitatively.
MP.6	Attend to precision.
7.SP.1,2	Use random sampling to draw inferences about a population.

MS.LS-GDRO Growth, Development, and Reproduction of Organisms

How to read the standards »

Go to the NGSS Survey

Students who demonstrate understanding can:

a. **Use evidence to support an explanation of how environmental and genetic factors affect the growth of organisms. [Clarification Statement: The emphasis is on the impact of factors in terms of cause and effect, not the mechanism (e.g., abundant food leads to more significant growth, offspring of large breeds of dogs are larger than the offspring of small dogs).]**

b. **Investigate and present evidence that plants continue to grow throughout their life through the production of new plant matter via photosynthesis. [*Assessment Boundary: Reproduction is not treated in any detail here, for more specifics of grade level see DCI LS3.A.*]**

c. **Use models to construct an explanation of how the genetic contribution from each parent through sexual reproduction results in variation in offspring and how asexual reproduction results in offspring with identical genetic information. [*Assessment Boundary:The emphasis is on the impact of gene transmission in reproduction, not the mechanism of the gene interactions.*]**

d. **Plan and conduct investigations to gather evidence for the relationship among specialized plant structures, specific animal behaviors, and the successful reproduction of the plant. [Clarification Statement: Examples of evidence of successful reproduction of plants could include placement of stamen and bees gathering nectar, hard shells on pine nuts and squirrels burying nuts.]**

e. **Use empirical evidence to support an argument for how characteristic animal behaviors affect the probability of successful reproduction. [Clarification Statement: Examples of animal behaviors could include birds building nests to protect young, brown trout spawning in late fall when predators are less active.]**

f. **Provide explanations of how changes (mutations) to genes, which are located on chromosomes, affect specific inherited traits resulting in harmful, beneficial, or neutral effects.**

g. **Provide an explanation for the relationship among changes (mutations) to genes, changes to the formation of proteins, and the effect on the structure and function of the organism and thereby traits.**

h. **Communicate explanations of ways technologies enable humans to influence the inheritance of certain traits in plants and animals. [Clarification Statement: Examples of human influence could be breeds of cattle for various purposes, disease resistant crops, genetically modified organisms.]**

The performance expectations above were 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 and progresses to developing, using and revising models to explain, explore, and predict more abstract phenomena and design systems.
- Modify models—based on their limitations—to increase detail or clarity, or to explore what will happen if a component is changed. (c)

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.
- Plan and carry out investigations individually and collaboratively, identifying independent and dependent variables and controls. (b)
- Collect data and generate evidence to answer scientific questions or test design solutions under a range of conditions. (b)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.
- Apply scientific reasoning to show why the data are adequate for the explanation or conclusion. (a),(d),(f),(g)

Engaging in Argument from Evidence
Engaging in argument from evidence in 6–8 builds from K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world.

Disciplinary Core Ideas

LS1.B: Growth and Development of Organisms
- Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. (c)
- Animals engage in characteristic behaviors that increase the odds of reproduction. (e)
- Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features (such as attractively colored flowers) for reproduction. (d)
- Plant growth can continue throughout the plant's life through production of plant matter in photosynthesis. (b)
- Genetic factors as well as local conditions affect the size of the adult plant. The growth of an animal is controlled by genetic factors, food intake, and interactions with other organisms, and each species has a typical adult size range. (a)

LS3.A: Inheritance of Traits
- Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. (c),(f)
- Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual (e.g., human skin color results from the actions of proteins that control the production of the pigment melanin). (c)
- Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. (f),(g)
- Sexual reproduction provides for transmission of genetic information to offspring through egg and sperm cells. These cells, which contain only one chromosome of each parent's chromosome pair, unite to form a new individual (offspring). Thus offspring possess one instance of each parent's

Crosscutting Concepts

Cause and Effect
Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. Cause and effect relationships may be used to predict phenomena in natural or designed systems. Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (a),(b),(c),(d),(e),(f)

Structure and Function
Complex 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 and designed structures/systems can be analyzed to determine how they function. Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. (d),(g)

Connections to Engineering, Technology, and Applications of Science

Influence of Engineering, Technology, and Science on Society and the Natural World
All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. The uses of technologies are driven by people's needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Technology use varies from region to region and over time. (h)

• Use oral and written arguments supported by empirical evidence and reasoning to support or refute an argument for a phenomenon or a solution to a problem. (e) **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 6–8 builds on 3–5 and progresses to evaluating the merit and validity of ideas and methods. • Read critically using scientific knowledge and reasoning to evaluate data, hypotheses, conclusions, and competing information. (h)	chromosome pair (forming a new chromosome pair). Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited or (more rarely) from mutations. (c) **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. (c) • 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. (f) **LS4.B: Natural Selection** • In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed on to offspring. (h)	

Connections to other DCIs in this grade-level: **MS.PS-CR**

Articulation of DCIs across grade-levels: **4.LCT, HS.LS-IVT, HS.LS-NSE**

Common Core State Standards Connections:[Note: these connections will be made more explicit and complete in future draft releases]

ELA

W.6.1	Write arguments to support claims with clear reasons and relevant evidence.
W.7.1	Write arguments to support claims with clear reasons and relevant evidence.
RI.6.7	Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.
WHST.7	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

Mathematics

MP.2	Reason abstractly and quantitatively.
MP.3	Construct viable arguments and critique the reasoning of others.
5.OA	Analyze patterns and relationships.
6.EE	Represent and analyze quantitative relationships between dependent and independent variables.
7.SP.1,2	Use random sampling to draw inferences about a population.

MS.LS-MEOE Matter and Energy in Organisms and Ecosystems

How to read the standards »

Go to the NGSS Survey

Students who demonstrate understanding can:

a. **Develop an explanation for the role of photosynthesis in the cycling of matter and flow of energy on Earth.** [*Assessment Boundary: Limited to the explanation related to water, carbon dioxide, and light energy being used to produce sugars and release oxygen NOT the chemical equation for photosynthesis.*]

b. **Investigate the cycling of matter among living and nonliving parts of ecosystems to explain the flow of energy and conservation of matter.** [Clarification Statement: Investigations are qualitative observations of the cycling of water, carbon, and oxygen in the environment.]

c. **Use models to explain the transfer of energy into, out of, and within ecosystems.** [*Assessment Boundary: Only light, chemical, and thermal energy need to be addressed with an emphasis that the total amount of energy does not change.*]

d. **Construct and communicate models of food webs that demonstrate the transfer of matter and energy among organisms within an ecosystem.** [Clarification Statement: Models of food webs should include producers, consumers and decomposers.]

e. **Use evidence to support an explanation that matter is conserved when molecules from food react with oxygen in the environment and cycle repeatedly between living and non-living components of ecosystem.**

f. **Use evidence to support arguments that changing any physical or biological component of an ecosystem may result in shifts in the populations of species in the ecosystem.**

The performance expectations above were 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 and progresses to developing, using and revising models to explain, explore, and predict more abstract phenomena and design systems.
- Use and/or construct models to predict, explain, and/or collect data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs. (c),(d)

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.
- Collect data and generate evidence to answer scientific questions or test design solutions under a range of conditions. (b)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.
- Base explanations on evidence and the assumption that natural laws operate today as they did in the past and will continue to do so in the future. (a)
- Construct explanations from models or representations. (e)

Engaging in Argument from Evidence
Engaging in argument from evidence in 6–8 builds from K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world.
- Use oral and written arguments supported by empirical evidence and reasoning to support or refute an argument for a phenomenon or a solution to a problem. (f)

Disciplinary Core Ideas

LS1.C: Organization for Matter and Energy Flow in Organisms
- Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (a)
- Animals obtain food from eating plants or eating other animals. (d)
- Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth or to release energy. (e)
- In most animals and plants, oxygen reacts with carbon-containing molecules (sugars) to provide energy and produce carbon-dioxide; anaerobic bacteria achieve their energy needs in other chemical processes that do not need oxygen. (c)

LS2.B: Cycle of Matter and Energy Transfer in Ecosystems
- Food webs are models that demonstrate how matter and energy is transferred between producers (generally plants and other organisms that engage in photosynthesis), consumers, and decomposers as the three groups interact—primarily for food—within an ecosystem. Transfers of matter into and out of the physical environment occur at every level—for example, when molecules from food react with oxygen captured from the environment, the carbon dioxide and water thus produced are transferred back to the environment, and ultimately so are waste products, such as fecal material. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (b),(c),(d)

LS2.C: Ecosystem Dynamics, Functioning, and Resilience
- Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (f)

Crosscutting Concepts

Systems and System Models
Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. Models are limited in that they only represent certain aspects of the system under study. (c)

Energy and Matter
Matter is conserved because atoms are conserved in physical and chemical processes. Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (a),(b),(e)

Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). The transfer of energy can be tracked as energy flows through a designed or natural system. (d)

Stability and Change
Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales, including the atomic scale. Small changes in one part of a system might cause large changes in another part. Stability might be disturbed either by sudden events or gradual changes that accumulate over time. Systems in dynamic equilibrium are stable due to a balance of feedback mechanisms. (f)

Connections to other DCIs in this grade-level: **MS.ESS-HE, MS.ESS-ESP, MS.PS-SPM, MS.PS-CR**

Articulation of DCIs across grade-levels: **3.SFS, 5.MEE, HS.LS-MEOE, HS.LS-IRE**

Common Core State Standards Connections:[Note: these connections will be made more explicit and complete in future draft releases]

ELA

SL.5.1	Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly.
SL.6.1	Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly.
W.6.8	Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources.
W.7.8	Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

Mathematics

MP.3	Construct viable arguments and critique the reasoning of others.
MP.4	Model with mathematics.
5.OA	Analyze patterns and relationships.
6.SP	Summarize and describe distributions.

MS.LS-IRE Interdependent Relationships in Ecosystems

How to read the standards »

Go to the NGSS Survey

Students who demonstrate understanding can:

a. **Use a model to demonstrate the effect of resource availability on organisms and populations of organisms in an ecosystem.**

b. **Construct explanations to describe competitive, predatory, and mutually beneficial interactions as patterns across various ecosystems.**

c. **Ask researchable questions about the ways organisms obtain matter and energy across multiple and varied ecosystems. [*Assessment Boundary: Biochemical details of photosynthesis and cellular respiration are not to be treated in terms of mechanism.*]**

d. **Use models to explain the role of biodiversity in ecosystems.**

e. **Use evidence to construct arguments for how biodiversity can influence humans' resources as well as ecosystem services that humans rely on. [Clarification Statement: Examples of humans' resources include food, energy, medicines. Ecosystem services can include water purification and recycling.]**

f. **Pose questions about patterns in social interactions and grouping behaviors of animals that contribute to survival advantages.**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Asking Questions and Defining Problems
Asking questions and defining problems in grades 6–8 builds from grades K–5 experiences and progresses to formulating and refining empirically testable questions.

- Ask questions that arise from phenomena, models, or unexpected results. (c),(f)

Developing and Using Models
Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to explain, explore, and predict more abstract phenomena and design systems.

- Use and/or construct models to predict, explain, and/or collect data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs. (d)
- Modify models – based on their limitations – to increase detail or clarity, or to explore what will happen if a component is changed. (a)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.

- Apply scientific reasoning to show why data are adequate for the explanation or conclusion. (b)

Engaging in Argument from Evidence
Engaging in argument from evidence in 6–8 builds from K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world.

- Use oral and written arguments supported by empirical evidence and reasoning to support or refute an argument for a phenomenon or a solution to a problem. (e)

Disciplinary Core Ideas

LS2.A: Interdependent Relationships in Ecosystems

- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. Growth of organisms and population increases are limited by access to resources. In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (a),(c)
- Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (b)

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. (d)

LS2.D: Social Interactions and Group Behavior

- Groups may form because of genetic relatedness, physical proximity, or other recognition mechanisms (which may be species-specific). They engage in a variety of signaling behaviors to maintain the group's integrity or to warn of threats. Groups often dissolve if they no longer function to meet individuals' needs, if dominant members lose their place, or if other key members are removed from the group through death, predation, or exclusion by other members. (f)

LS4.D: Biodiversity and Humans

- Biodiversity is the wide range of existing life forms that have adapted to the variety of conditions on Earth from terrestrial to marine ecosystems. Biodiversity includes genetic variation within a species, in addition to species variation in different habitats and ecosystem types (e.g., forests, grasslands, wetlands). (d)
- Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. (e)

Crosscutting Concepts

Patterns
Macroscopic patterns are related to the nature of microscopic and atomic-level structure. Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems. Patterns can be used to identify cause and effect relationships. Graphs and charts can be used to identify patterns in data. (b),(f)

Cause and Effect
Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. Cause and effect relationships may be used to predict phenomena in natural or designed systems. Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (a), (e)

Systems and System Models
Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. Models are limited in that they only represent certain aspects of the system under study. (d)

Energy and Matter
Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). The transfer of energy can be tracked as energy flows through a designed or natural system. (c)

Connections to other DCIs in this grade-level: **MS.ESS-HE, MS.ESS-HI, MS.ETS-ETSS**

Articulation of DCIs across grade-levels: **3.EIO, 5.MEE, HS.LS-IRE, HS.LS-MEOE**

Common Core State Standards Connections: [Note: these connections will be made more explicit and complete in future draft releases]

ELA

W.6.3	Delineate a speaker's argument and specific claims, distinguishing claims that are supported by reasons and evidence from claims that are not.
SL.7.3	Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and the relevance and sufficiency of the evidence.
WHST.7	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

Mathematics

MP.3	Construct viable arguments and critique the reasoning of others.
5.OA	Analyze patterns and relationships.
7.SP.3	Draw informal comparative inferences about two populations.

MS.LS-NSA Natural Selection and Adaptations

How to read the standards »

Go to the NGSS Survey

Students who demonstrate understanding can:

a. **Analyze and interpret patterns of change in fossils to provide evidence of the history of life on Earth.**

b. **Construct explanations for the anatomical similarities and differences between fossils of once living organisms and organisms living today. [Clarification Statement: Students should use the record of evolutionary descent between ancient and modern-day organisms.]**

c. **Develop explanations for why most individual organisms, as well as some entire species of organisms, that lived in the past were never fossilized. [*Assessment Boundary: The process of fossilization is not treated in any detail within the life sciences but addressed in the Earth sciences.*]**

d. **Recognize and compare patterns in the embryological development across different species to identify relationships not evident in the fully formed anatomy. [*Assessment Boundary: Limited to general characteristics of embryological development among species.*]**

e. **Communicate explanations for how genetic variations of traits in a population increase some individual's probability of surviving and reproducing in a specific environment which tends to increase these traits in the population.**

f. **Use mathematical models to explain how natural selection over many generations results in changes within species in response to environmental conditions that increase or decrease certain traits in a population. [Clarification Statement: Population data for organisms over time showing trends in numbers of individuals with specific traits.] [*Assessment Boundary: Data should be provided to students.*]**

g. **Obtain and evaluate information about how two populations of the same species in different environments have evolved to become separate species.**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Analyzing and Interpreting Data
Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigation, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.
- Distinguish between causal and correlational relationships. (a)
- Use graphical displays to analyze data in order to identify linear and nonlinear relationships. (d)

Using Mathematics and Computational Thinking
Mathematical and computational thinking at the 6–8 level builds on K–5 and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.
- Use mathematical concepts such as ratios, averages, basic probability, and simple functions, including linear relationships to analyze data. (f)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.
- Base explanations on evidence and the assumption that natural laws operate today as they did in the past and will continue to do so in the future. (b)
- Generate and revise causal explanations from data (e.g., observations, sources of reliable information) and relate these explanations to current knowledge. (c)

Obtaining, Evaluating, and Communicating Information
Obtaining, evaluating, and communicating information in 6–8 builds on 3–5 and progresses to evaluate the merit and validity of ideas and methods.
- Generate and communicate ideas using scientific language and reasoning. (e)
- Gather, read, and explain information from appropriate sources and evaluate the credibility of the publication, authors, possible bias of the source, and methods used. (g)

Disciplinary Core Ideas

LS4.A: Evidence of Common Ancestry and Diversity
- Fossils are mineral replacements, preserved remains, or traces of organisms that lived in the past. Thousands of layers of sedimentary rock not only provide evidence of the history of the Earth itself but also of changes in organisms whose fossil remains have been found in those layers. (a)
- The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth. Because of the conditions necessary for their preservation, not all types of organisms that existed in the past have left fossils that can be retrieved. (c)
- Anatomical similarities and differences between various organisms living today, and between them and organisms in the fossil record, enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent. (b)
- Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy. (d)

LS4.B: Natural Selection
- Genetic variations among individuals in a population give some individual an advantage in surviving and reproducing in their environment. This is known as natural selection. It leads to the predominance of certain traits in a population, and the suppression of others. (e),(f)

LS4.C: Adaptation
- Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. (g)
- Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes. (f)

Crosscutting Concepts

Patterns
Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them. Macroscopic patterns are related to the nature of microscopic and atomic-level structure. Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems. Patterns can be used to identify cause and effect relationships. Graphs and charts can be used to identify patterns in data (a),(b),(d)

Cause and Effect
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. Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. Cause and effect relationships may be used to predict phenomena in natural or designed systems. Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (c),(e),(f)

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. Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales, including the atomic scale. Small changes in one part of a system might cause large changes in another part. Stability might be disturbed either by sudden events or gradual changes that accumulate over time. Systems in dynamic equilibrium are stable due to a balance of feedback mechanisms. (g)

- In separated populations with different conditions, the changes can be large enough that the populations, provided they remain separated (a process called reproductive isolation), evolve to be separate species. (g)

Connections to other DCIs in this grade-level: **MS.ESS-HE**

Articulation of DCIs across grade-levels: **3.EIO, 3.SFS, 4.PSE, 4.LCT, HS.LS-NSE, HS.LS-IRE, HS.PS-NP**

Common Core State Standards Connections: [Note: these connections will be made more explicit and complete in future draft releases]

ELA

SL.6.4	Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation.
SL.7.4	Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details and examples; use appropriate eye contact, adequate volume, and clear pronunciation.

Mathematics

MP.2	Reason abstractly and quantitatively.
MP.4	Model with mathematics.
MP.6	Attend to precision.
5.OA	Analyze patterns and relationships.
6.EE	Apply and extend previous understandings of arithmetic to algebraic expressions.
	Reason about and solve one-variable equations and inequalities
7.EE	Solve real-life and mathematical problems using numerical and algebraic expressions and equations.