In Unit 1, students began to analyze the fossil record for patterns of biodiversity and events of mass extinction. In this unit, students build on that knowledge and skill set, as they continue to analyze the fossil record and use it to form a more cohesive picture of Earth’s history, which they will come to know as the geologic time scale. From here, students find that the fossil record is not the only piece of evidence that helps tell the story of life on Earth. There is also anatomical and embryological evidence to explain common ancestry, as well as mechanisms like natural selection and human intervention to explain change over time. In exploring these concepts, Unit 3 thus becomes the unit with the most life science content of the 8th grade integrated curriculum.

The integrated model requires students to access and use a wide range of ideas from prior grades. This content knowledge spans six different Disciplinary Core Ideas: ESS1.C: The History of Planet Earth, LS3.A: Inheritance of Traits, LS3.B: Variation of Traits, LS4.A: Evidence of Common Ancestry and Diversity, LS4.B: Natural Selection, and LS4.C: Adaptation.

As students explore these core ideas, they build on their skills in the following science and engineering practices: Developing and Using Models; Analyzing and Interpreting Data; Using Mathematics and Computational Thinking; Constructing Explanations; Engaging in Argument From Evidence; and Obtaining, Evaluating, and Communicating Information. In addition to science and engineering practices, students also continue to build on their knowledge of the following crosscutting concepts: Patterns; Cause and Effect; Scale, Proportion, and Quantity; Structure and Function; and Stability and Change.

\*This summary is based on information found in the NGSS Framework.

**K-8 Progression of Disciplinary Core Ideas, Science And Engineering Practices, and Crosscutting Concepts for Unit 3**

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| **Disciplinary Core Ideas** | **K-2** | **3-5** | **6-8** |
| **ESS1.C**  **The History of Planet Earth** | Some events happen very quickly; others occur very slowly, over a time period much longer than one can observe. | Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed. | The geologic time scale interpreted from rock strata provides a way to organize Earth’s history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. |
| **LS3.A**  **Inheritance of Traits** | Young animals are very much, but not exactly, like, their parents. Plants also are very much, but not exactly, like their parents. | Many characteristics of organisms are inherited from their parents. Other characteristics result from individuals’ interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment. | 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. 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** | Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways. | Different organisms vary in how they look and function because they have different inherited information. The environment also affects the traits that an organism develops. | 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. 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. |
| **LS4.A**  **Evidence of Common Ancestry and Diversity** | N/A | Some living organisms resemble organisms that once lived on Earth. Fossils provide evidence about the types of organisms and environments that existed long ago. | The fossil record documents the existence, diversity, extinction, and change of many life forms and their environments through Earth’s history. The fossil record and comparisons of anatomical similarities between organisms enables the inference of lines of evolutionary descent. |
| **LS4.B**  **Natural Selection** | N/A | Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing. | Natural selection leads to the predominance of certain traits in a population, and the suppression of others.  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. |
| **LS4.C**  **Adaptation** | N/A | For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all. | Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. 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. |

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| **Science and Engineering Practices** | **K-2** | **3-5** | **6-8** |
| **Developing and Using Models** | Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.   * Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s). | Modeling in 3–5 builds on prior experiences and progresses to building and revising simple models and using models to represent events and design solutions.   * Develop and/or use models to describe and/or predict phenomena. | Modeling in 6–8 builds on prior experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.   * Develop and/or use a model to predict and/or describe phenomena. |
| **Analyzing and Interpreting Data\*** | Analyzing data in K-2 builds on prior experiences and progresses to collecting, recording, and sharing observations.   * Use and share pictures, drawings, and/or writings of observations. * Use observations (firsthand or from media) to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems. | Analyzing data in 3-5 builds on prior experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used.   * Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings. * Represent data in tables and/or various graphical displays (bar graphs, pictographs, and/or pie charts) to reveal patterns that indicate relationships. | Analyzing data in 6-8 builds on prior experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.   * Analyze and interpret data to determine similarities and differences in findings. * Analyze displays of data to identify linear and nonlinear relationships. |
| **Using Mathematics and Computational Thinking** | Mathematical and computational thinking in K-2 builds on prior experiences and progresses to recognizing that mathematics can be used to describe the natural and designed world(s).   * Describe, measure, and/or compare quantitative attributes of different objects and display the data using simple graphs. | Mathematical and computational thinking in 3-5 builds on prior experiences and progresses to extending quantitative measurements to a variety of physical properties and using computation and mathematics to analyze data and compare alternative design solutions.   * Describe, measure, estimate, and/or graph quantities such as area, volume, weight, and time to address scientific and engineering questions and problems. | Mathematical and computational thinking in 6-8 builds on prior experiences and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.   * Use mathematical representations to support scientific conclusions and design solutions. |
| **Constructing Explanations\*** | Constructing Explanations in K-2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena.   * Use information from observations (firsthand and from media) to construct an evidence-based account for natural phenomena. | Constructing Explanations in 3-5 builds on prior experiences and progresses to the use of evidence and ideas in constructing explanations that specify variables that describe and predict phenomena.   * Construct an explanation of observed relationships (e.g., the distribution of plants in the back yard). * Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem. | Constructing Explanations in 6-8 builds on prior experiences and progresses to include constructing explanations supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.   * Construct an explanation that includes qualitative or quantitative relationships between variables that predict(s) and/or describe(s) phenomena. * Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students’ own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. * Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real-world phenomena, examples, or events. |
| **Engaging in Argument From Evidence\*** | Engaging in argument from evidence in K-2 builds on prior experiences and progresses to comparing ideas and representations about the natural and designed world(s).   * Construct an argument with evidence to support a claim. | Engaging in argument from evidence in 3-5 builds on prior experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s).   * Construct and/or support an argument with evidence, data, and/or a model. * Use data to evaluate claims about cause and effect. | Engaging in argument from evidence in 6-8 builds on prior experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).   * Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. |
| **Obtaining, Evaluating, and Communicating Information** | Obtaining, evaluating, and communicating information in K-2 builds on prior experiences and uses observations and texts to communicate new information.   * Read grade-appropriate texts and/or use media to obtain scientific and/or technical information to determine patterns in and/or evidence about the natural and designed world(s). | Obtaining, evaluating, and communicating information in 3-5 builds on prior experiences and progresses to evaluating the merit and accuracy of ideas and methods.   * Read and comprehend grade-appropriate complex texts and/or other reliable media to summarize and obtain scientific and technical ideas and describe how they are supported by evidence. * Compare and/or combine across complex texts and/or other reliable media to support the engagement in other scientific and/or engineering practices | Obtaining, evaluating, and communicating information in 6-8 builds on prior experiences and progresses to evaluating the merit and validity of ideas and methods.   * Critically read scientific texts adapted for classroom use to determine the central ideas and/or obtain scientific and/or technical information to describe patterns in and/or evidence about the natural and designed world(s). |

\*These SEPs are summatively assessed using Task 2 or the Culminating Project.

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| **Crosscutting Concepts** | **K-2** | **3-5** | **6-8** |
| **Patterns\*** | Students recognize that patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.   * Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence. | Students identify similarities and differences in order to sort and classify natural objects and designed products. They identify patterns related to time, including simple rates of change and cycles, and to use these patterns to make predictions.   * Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena and designed products. * Patterns of change can be used to make predictions. * Patterns can be used as evidence to support an explanation. | Students recognize that macroscopic patterns are related to the nature of microscopic and atomic-level structure. They identify patterns in rates of change and other numerical relationships that provide information about natural and human designed systems. They use patterns to identify cause and effect relationships, and use graphs and charts to identify patterns in data.   * Graphs, charts and images can be used to identify patterns in data. * Patterns can be used to identify cause-and-effect relationships. |
| **Cause and Effect\*** | Students learn that events have causes that generate observable patterns. They design simple tests to gather evidence to support or refute their own ideas about causes.   * Events have causes that generate observable patterns. | Students routinely identify and test causal relationships and use these relationships to explain change. They understand events that occur together with regularity might or might not signify a cause and effect relationship.   * Cause and effect relationships are routinely identified, tested, and used to explain change. * Events that occur together with regularity might or might not be a cause and effect relationship. | Students classify relationships as causal or correlational, and recognize that correlation does not necessarily imply causation. They use cause and effect relationships to predict phenomena in natural or designed systems. They also understand that phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability   * Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. |
| **Scale, Proportion, and Quantity** | Students use relative scales (e.g., bigger and smaller; hotter and colder; faster and slower) to describe objects. They use standard units to measure length.   * Relative scales allow objects and events to be compared and described (e.g., bigger and smaller; hotter and colder; faster and slower). | Students recognize natural objects and observable phenomena exist from the very small to the immensely large. They use standard units to measure and describe physical quantities such as weight, time, temperature, and volume.   * Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods. | Students observe time, space, and energy phenomena at various scales using models to study systems that are too large or too small. They understand phenomena observed at one scale may not be observable at another scale, and the function of natural and designed systems may change with scale. They use proportional relationships (e.g., speed as the ratio of distance traveled to time taken) to gather information about the magnitude of properties and processes. They represent scientific relationships through the use of algebraic expressions and equations.   * Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. |
| **Structure and Function\*** | Students observe the shape and stability of structures of natural and designed objects are related to their function(s).   * The shape and stability of structures of natural and designed objects are related to their function(s). | Students learn different materials have different substructures, which can sometimes be observed and substructures have shapes and parts that serve functions.   * Substructures have shapes and parts that serve functions. | Students model complex and microscopic structures and systems and visualize how their function depends on the shapes, composition, and relationships among its parts. They analyze many complex natural and designed structures and systems to determine how they function. They design structures to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.   * 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. |
| **Stability and Change\*** | Students observe some things stay the same while other things change, and things may change slowly or rapidly   * Things may change slowly or rapidly. | Students measure change in terms of differences over time, and observe that change may occur at different rates. Students learn some systems appear stable, but over long periods of time they will eventually change.   * Change is measured in terms of differences over time and may occur at different rates. * Some systems appear stable, but over long periods of time will eventually change. | Students explain stability and change in natural or designed systems by examining changes over time, and considering forces at different scales, including the atomic scale. Students learn changes in one part of a system might cause large changes in another part, systems in dynamic equilibrium are stable due to a balance of feedback mechanisms, and stability might be disturbed by either sudden events or gradual changes that accumulate over time.   * Stability might be disturbed either by sudden events or gradual changes that accumulate over time. |

\*These CCCs are summatively assessed using Task 2 or the Culminating Project.

**Progression of Knowledge from Kindergarten - 8th Grade**

ESS1.C. The History of Planet Earth: In Kindergarten - second grade, students begin to engage in this DCI as it relates to the crosscutting concept of Stability and Change. In other words, students compare examples of sudden changes on Earth to gradual changes on Earth. In third – fifth grade, students move past this CCC to look more specifically at changes to rock formations and many students at this level will get an introduction to the fossil record as a form of evidence. Within this fourth grade performance expectation, students move towards using the crosscutting concept of Patterns to analyze changes they see. In this eighth grade unit, students continue their analysis of rock and their use of both crosscutting concepts mentioned above, but begin to form a greater picture of Earth’s 4.6 billion-year-old history. The previous years have set the stage for students to consider Scale, Proportion, and Quantity at a grander scale, thus formulating a concept of the geologic time scale. At all levels, students use evidence to construct explanations of phenomena related to the history of planet earth.

The following is the progression of the Performance Expectations for this DCI:

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| **2-ESS1-1** | Use information from several sources to provide evidence that Earth events can occur quickly or slowly. |
| **4-ESS1-1** | Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time. |
| **MS-ESS1-4** | Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth’s 4.6-billion-year-old history. |

LS3.A. Inheritance of Traits: In Kindergarten - second grade, students make observations based on examples they can see in order to conclude that plants and animals look like their parents. This physical observation-based understanding sets the foundation for them to engage with the science behind this phenomenon in third – fifth grade. At this level, students continue to look for Patterns in data, but start using content-specific vocabulary and concepts, such as traits, inheritance, and variation. Furthermore, they continue on to consider that it is not just genetics that can influence traits, but also environment. This sets the stage for this eighth grade unit as students dive into the mechanism at play—that certain genes result in specific proteins, which influences the trait. Variation thus results from both inheritance and mutation processes. In earlier grades, students focus on Analyzing and Interpreting Patterns in Data to Construct Explanations. In this eighth grade unit, students build on these skills and this crosscutting concept to Develop Models that describe the underlying mechanisms, utilizing the crosscutting concept of Structure and Function.

The following is the progression of the Performance Expectations for this DCI:

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| **1-LS3-1** | Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents. |
| **3-LS3-1** | Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms. |
| **3-LS3-2** | Use evidence to support the explanation that traits can be influenced by the environment. |
| **MS-LS3-1** | 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. |

LS3.B. Variation of Traits: As you can see by the performance expectations listed below, this DCI is heavily linked to LS3.A Inheritance. Recall that in Kindergarten - second grade, students are making observations based on examples they can see in order to conclude that plants and animals look like their parents. This also includes a conclusion that plants and animals do not look exactly like their parents, thus laying the foundation for this concept of variation. In third – fifth grade, they continue to explore this idea of variation in more depth, analyzing data sets for evidence of variation that result from both genetics and environment. While in sixth grade, students discover that variation occurs because of the processes in sexual reproduction, this eighth grade unit focuses on variation that occurs because of mutation. Due to the nature of the performance expectations at the different levels, students start by Analyzing and Interpreting Patterns in Data in order to Construct Explanations, but move toward Developing Models using Structure and Function in this eighth grade unit.

The following is the progression of the Performance Expectations for this DCI:

|  |  |
| --- | --- |
| **1-LS3-1** | Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents. |
| **3-LS3-1** | Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms. |
| **3-LS3-2** | Use evidence to support the explanation that traits can be influenced by the environment |
| **MS-LS3-1** | 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. |

LS4.A. Evidence of Common Ancestry and Diversity: Students do not engage with this DCI until the third grade. In third – fifth grade, students begin to ask the question: How are plants, animals, and environments of the past similar or different from current plants, animals, and environments? This gives students a first exposure to the fossil record, which they will study more in depth in eighth grade. At the third grade level, students only make isolated connections between organisms and their environment, comparing data between the past and the present. As in Unit 1, students in this unit attempt to form a much more cohesive and complex picture of the history of life on Earth. In Unit 1, however, they use the fossil record mostly as a tool to show biodiversity and events of extinction over time. Here, they move past just the fossil record to explore relationships between species, looking at anatomical and embryological evidence. Thus, students move from a focus on Scale, Proportion, and Quantity in early grades to a focus on Patterns to organize the fossil record and compare anatomical and embryological features in eighth grade. Regardless of the grade level, however, students focus on Analyzing and Interpreting Data as they look at the fossil record and other pieces of evidence.

The following is the progression of the Performance Expectations for this DCI:

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| **3-LS4-1** | Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago. |
| **MS-LS4-1** | Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past. |
| **MS-LS4-2** | Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships. |
| **MS-LS4-3** | Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy. |

LS4.B: Natural Selection: This DCI is not introduced in kindergarten – second grade and first appears in the third grade. Before students are ready to understand the mechanism of natural selection, they must first understand the cause-and-effect reasoning behind it by looking at examples. At this level, students are using evidence to conclude that variations in organisms can provide advantages in surviving, finding mates, and reproducing. This sets the stage for students to learn the step-by-step mechanism of natural selection in this eighth grade unit. Students are able to apply these new concepts as they continue with the same science and engineering practice and crosscutting concept as they practiced in third grade: Constructing Explanations and Cause and Effect. At this eighth grade level, students are also beginning to incorporate mathematical representations to support their explanation of natural selection, thus adding the skill of Using Mathematics and Computational Thinking. Students should then be able to apply these knowledge and skills to processes of selective breeding and genetic engineering.

The following is the progression of the Performance Expectations for this DCI:

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| **3-LS4-2** | Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing. |
| **MS-LS4-4** | Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals’ probability of surviving and reproducing in a specific environment. |
| **MS-LS4-5** | Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. |

LS4.C.Adaptation: This DCI is also not introduced until the third grade, when students explore examples of how some organisms can survive well, some survive less well, and some cannot survive at all in a given environment. Not only are students looking at examples, they are also thinking about why this is the case, thus using Cause-and-Effect reasoning that will be built on in this eighth grade unit. In this unit, students look not just at examples, but also at actual mathematical representations showing increases and decreases of specific traits over time. Students use the crosscutting concept of Cause and Effect again to explain this phenomenon in terms of natural selection. Thus this DCI is heavily related to the previous LS4.B: Natural Selection.

The following is the progression of the Performance Expectations for this DCI:

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| **3-LS4-3** | Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. |
| **MS-LS4-6** | Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. |