STATE OF NEW JERSEY
DEPARTMENT OF EDUCATION

2020 New Jersey Student Learning Standards – Science

Introduction

Note: Brackets [ ] indicate deletions. **Bolding** indicates revisions and/or additions.

Science

Scientific and technological advances have proliferated and now permeate most aspects of life in the 21st century. It is increasingly important that all members of our society develop an understanding of scientific and engineering concepts and processes. Learning how to construct scientific explanations and how to design evidence-based solutions provides students with tools to think critically about personal and societal issues and needs. Students can then contribute meaningfully to decision-making processes, such as discussions about [humans' impact on the natural environment] **climate change**, new approaches to health care, and innovative solutions to local and global problems.[1]

Mission

All students will possess an understanding of scientific concepts and processes required for personal decision-making, participation in civic life, and preparation for careers in STEM fields (for those that chose).

Vision

Prepare students to become scientifically literate individuals who can effectively:

- Apply scientific thinking, skills, and understanding to real-world phenomena and problems;
- Engage in systems thinking and modeling to explain phenomena and to give a context for the ideas to be learned;
- Conduct investigations, solve problems, and engage in discussions;
- Discuss open-ended questions that focus on the strength of the evidence used to generate claims;
- Read and evaluate multiple sources, including science-related magazine and journal articles and web-based resources to gain knowledge about current and past science problems and solutions and develop well-reasoned claims; and
- Communicate ideas through journal articles, reports, posters, and media presentations that explain and argue.

Spirit and Intent

The New Jersey Student Learning Standards for Science (NJSLS-S) describe the expectations for what students should know and be able to do as well as promote three-dimensional science instruction across the three science domains (i.e., physical sciences, life science, earth and space sciences). From the earliest grades, the expectation is that students will engage in learning experiences that enable them to investigate phenomena, design solutions to problems, make sense of evidence to construct arguments, and critique and discuss those arguments (in appropriate ways relative to their grade level).

[1] Replaced "humans' impact on the natural environment" with "climate change."

The foundation of the NJSLS-S reflects three dimensions — science and engineering practices, disciplinary core ideas, and crosscutting concepts. The performance expectations are derived from the interplay of these three dimensions. It is essential that these three components are integrated [in] **into** all learning experiences.[2] Within each standard document, the three dimensions are intentionally presented as integrated components to foster sensemaking and designing solutions to problems. Because the NJSLS-S is built on the notions of coherence and contextuality, each of the science and engineering practices and crosscutting concepts appear multiple times across topics and at every grade level. Additionally, the three dimensions should be an integral part of every curriculum unit and should not be taught in isolation.

Three Dimensions of NJSLS-S

The performance expectations reflect the three dimensions and describe what students should know and be able to **do**.[3] In layman's terms, they are "the standards." They are written as statements that can be used to guide assessment and allow for flexibility in the way that students are able to demonstrate proficiency.

The example below is provided to illustrate the interconnected nature of the NJSLS-S components.

Disciplinary Core Ideas and Performance Expectations

Disciplinary Core Idea	Performance Expectation
Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.	Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.

Science and Engineering Practices

Developing and Using Models	Develop and use a model to describe phenomena.

Crosscutting Concepts

Scale, Proportion, and Quantity	Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.

Becoming familiar with the science practices and crosscutting concepts is a critically important first step in designing learning experiences reflective of the three dimensions. A description of each of the science and engineering practices and the cross-cutting concepts can be found in the next sections.

Further, for students to develop proficiency of the NJSLS-S, they will need to engage in learning experiences that are *meaningful, cumulative,* and *progressive*. Learning experiences designed to be *meaningful*, go beyond reading about science concepts and provide opportunities for students to be active learners and make sense of ideas. *Cumulative* learning experiences provide opportunities for students to use and build on ideas that they have learned in previous units. *Progressive* learning experiences provide multiple occasions for students to engage in ways that enable them to improve their construction of explanations and solutions over time by iteratively assessing them, elaborating on them, and holding them up to critique and evidence.

[2] "Replaced In" with "into."

[3] Added "do."

Scientific and Engineering Practices

Asking Questions and Defining Problems

A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world works and which can be empirically tested.

Engineering questions clarify problems to determine criteria for successful solutions and identify constraints to solve problems about the designed world.

Both scientists and engineers also ask questions to clarify the ideas of others.

Planning and Carrying Out Investigations

Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters.

Engineering investigations identify the effectiveness, efficiency, and durability of designs under different conditions.

Analyzing and Interpreting Data

Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis.

Engineering investigations include analysis of data collected in the tests of designs. This allows comparison of different solutions and determines how well each meets specific design criteria—that is, which design best solves the problem within given constraints. Like scientists, engineers require a range of tools to identify patterns within data and interpret the results. Advances in science make analysis of proposed solutions more efficient and effective.

Developing and Using Models

A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations.

Modeling tools are used to develop questions, predictions and explanations; analyze and identify flaws in systems; and communicate ideas. Models are used to build and revise scientific explanations and proposed engineered systems.

Measurements and observations are used to revise models and designs.

Constructing Explanations and Designing Solutions

The products of science are explanations and the products of engineering are solutions.

The goal of science is the construction of theories that provide explanatory accounts of the world. A theory becomes accepted when it has multiple lines of empirical evidence and greater explanatory power of phenomena than previous theories.

The goal of engineering design is to find a systematic solution to problems that is based on scientific knowledge and models of the material world. Each proposed solution results from a process of balancing competing criteria of desired functions, technical feasibility, cost, safety, aesthetics, and compliance with legal requirements. The optimal choice depends on how well the proposed solutions meet criteria and constraints.

Engaging in Argument from Evidence

Argumentation is the process by which explanations and solutions are reached.

In science and engineering, reasoning and argument based on evidence are essential to identifying the best explanation for a natural phenomenon or the best solution to a design problem. Scientists and engineers use argumentation to listen to, compare, and evaluate competing ideas and methods based on merits.

Scientists and engineers engage in argumentation when investigating a phenomenon, testing a design solution, resolving questions about measurements, building data models, and using evidence to identify strengths and weaknesses of claims.

Using Mathematics and Computational Thinking

In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; statistically analyzing data; and recognizing, expressing, and applying quantitative relationships.

Mathematical and computational approaches enable scientists and engineers to predict the behavior of systems and test the validity of such predictions. Statistical methods are frequently used to identify significant patterns and establish correlational relationships.

Obtaining, Evaluating, and Communicating Information

Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate.

Critiquing and communicating ideas individually and in groups is a critical professional activity.

Communicating information and ideas can be done in multiple ways: using tables, diagrams, graphs, models, and equations as well as orally, in writing, and through extended discussions. Scientists and engineers employ multiple sources to acquire information that is used to evaluate the merit and validity of claims, methods, and design.

Disciplinary Core Ideas

Disciplinary Core Ideas in Physical Science

PS1: Matter and Its Interactions

- PS1.A: Structure and Properties of Matter
- PS1.B: Chemical Reactions
- PS1.C: Nuclear Processes

PS2: M K-2-ETS1-2otion and Stability: Forces and Interactions

- PS2.A: Forces and Motion
- PS2.B: Types of Interactions
- PS2.C: Stability and Instability in Physical Systems

PS3: Energy

- PS3.A: Definitions of Energy
- PS3.B: Conservation of Energy and Energy Transfer
- PS3.C: Relationship Between Energy and Forces
- PS3.D: Energy in Chemical Processes and Everyday Life

PS4: Waves and Their Applications in Technologies for Information Transfer

- PS4.A: Wave Properties
- PS4.B: Electromagnetic Radiation
- PS4.C: Information Technologies and Instrumentation

Disciplinary Core Ideas in Life Science

LS1: From Molecules to Organisms: Structures and Processes

- LS1.A: Structure and Function
- LS1.B: Growth and Development of Organisms
- LS1.C: Organization for Matter and Energy Flow in Organisms
- LS1.D: Information Processing

LS2: Ecosystems: Interactions, Energy, and Dynamics

- LS2.A: Interdependent Relationships in Ecosystems
- LS2.B: Cycles of Matter and Energy Transfer in Ecosystems
- LS2.C: Ecosystem Dynamics, Functioning, and Resilience
- LS2.D: Social Interactions and Group Behavior

LS3: Heredity: Inheritance and Variation of Traits

- LS3.A: Inheritance of Traits
- LS3.B: Variation of Traits

LS4: Biological Evolution: Unity and Diversity

- LS4.A: Evidence of Common Ancestry and Diversity
- LS4.B: Natural Selection
- LS4.C: Adaptation
- LS4.D: Biodiversity and Humans

Disciplinary Core Ideas in Earth and Space Science

ESS1: Earth's Place in the Universe

- ESS1.A: The Universe and Its Stars
- ESS1.B: Earth and the Solar System
- ESS1.C: The History of Planet Earth

ESS2: Earth's Systems

- ESS2.A: Earth Materials and Systems
- ESS2.B: Plate Tectonics and Large-Scale System Interactions
- ESS2.C: The Roles of Water in Earth's Surface Processes
- ESS2.D: Weather and Climate
- ESS2.E: Biogeology

ESS3: Earth and Human Activity

- ESS3.A: Natural Resources
- ESS3.B: Natural Hazards
- ESS3.C: Human Impacts on Earth Systems
- ESS3.D: Global Climate Change

Disciplinary Core Ideas in Engineering, Technology, and the Application of Science

ETS1: Engineering Design

- ETS1.A: Defining and Delimiting an Engineering Problem
- ETS1.B: Developing Possible Solutions
- ETS1.C: Optimizing the Design Solution

ETS2: Links Among Engineering, Technology, Science, and Society

- ETS2.A: Interdependence of Science, Engineering, and Technology
- ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World

Crosscutting Concepts

Patterns

Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

Cause and Effect: Mechanism and Explanation

Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

Scale, Proportion, and Quantity

In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

Systems and System Models

Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.

Energy and Matter

Flows, Cycles, and Conservation Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.

Structure and Function

The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.

Stability and Change

For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

Standards in Action: Climate Change

Earth's climate is now changing faster than at any point in the history of modern civilization, primarily as a result of human activities. Global climate change has already resulted in a wide range of impacts across New Jersey and many sectors of its economy. The addition of academic standards that focus on climate change is important so that all students will have a basic understanding of the climate system, including the natural and human-caused factors that affect it. The underpinnings of climate change span across physical, life, as well as Earth and space sciences. The goal is for students to understand climate science as a way to inform decisions that improve quality of life for themselves, their community, and globally and to know how engineering solutions can allow us to mitigate impacts, adapt practices, and build resilient systems.

The topic of climate change can easily be integrated [in science classes without losing the big picture ideas] **into science classes**.[4] At each grade level in which systems thinking, managing uncertainty, and building arguments based on multiple lines of data are included, there are opportunities for students to develop essential knowledge and skills that will help them understand the impacts of climate change on humans, animals, and the environment. For example, in the earlier grades, students can use data from firsthand investigations of the school-yard habitat to justify recommendations for design improvements to the school-yard habitat for plants, animals, and humans. In the middle grades, students use resources from [NJ] **New Jersey** Department of Environmental Protection, the **National Oceanic and Atmospheric Administration** (NOAA), and **National Aeronautics and Space Administration** (NASA), to inform their actions as they engage in designing, testing, and modifying an engineered solution to mitigate the impact of climate change on their community.[5] In high school, students can construct models they develop of a proposed solution to mitigate the negative health effects of unusually high summer temperatures resulting from heat islands in cities across the globe and share in the appropriate setting.

[4] Replaced "in science classes without losing the big picture ideas" with "into science classes."

[5] Preceded each acronym with its full name (e.g., added "National Ocean and Atmospheric Administration before NOAA).

Structure of the NJSLS-S Documents

The performance expectations are the organizing structure for the NJSLS-S documents found below. In grades kindergarten through five, performance expectations are described by individual grades. In grades 6 through 12, the performance expectations are described as middle school (MS), grades 6 through 8, and high school (HS), grades 9 through 12.

As illustrated in Figure 1 (below), every document has four sections:

1. Title (e.g., Earth and Human Activity)
2. Performance expectation
3. Foundation box**es**[6] (science and engineering practice(s), disciplinary core idea(s), and crosscutting concept (s) that relate specifically to the performance expectation)
4. Connection box (connections to other disciplinary concepts at grade level, at grade levels above and below, and specific English language arts and mathematics standards that are relevant)

More information regarding the foundation and connection boxes can be found in the next section.

1. Title (e.g., Earth and Human Activity)
2. Performance Expectation(s) and code (e.g., 3-ESS3-1. Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.) [Clarification Statement: Examples of design solutions to weather-related hazards could include barriers to prevent flooding, wind resistant roofs, and lightning rods. [Assessment Boundary: none available for this performance expectation.]

3. Science and Engineering Practices	**3. Disciplinary Core Ideas**	**3. Crosscutting Concepts**

1. Connections to: • related disciplinary concepts at the same grade level • related disciplinary concepts for grades above and below that grade level • related New Jersey Student Learning Standards for Mathematics and English Language Arts

Figure 1: Structure of a NJSLS-S document

Note about the Clarification Statement and Assessment Boundary (in red): frequently, a Clarification Statement and an Assessment Boundary are listed after the performance expectation. The Clarification Statement provides real-world examples that reflect the performance expectations. The Assessment Boundary is intended to inform statewide assessment item writers and educators about what is "out of bounds" on statewide science assessments at the end of grades 5, 8, and 11.

[6] Replaced "box" with "boxes."

Coding of Performance Expectation

Every performance expectation is labeled with a specific alpha numeric code. The code summarizes important information. See Figure 2 below. The first number within the code reflects the grade or grade band. The letters are an abbreviation of the component idea from which the performance expectations are derived. PS1 is shorthand for Matter and its Interactions (see Disciplinary Core Ideas table on page 4). Finally, the number at the end of each code indicates the order in which the performance expectation appears in the NJSLS-S.

2	**PS1**	**2**
2nd grade	Physical Science Matter and its Interactions	Performance expectation

Figure 2: Coding of performance expectations

Foundation Boxes

The foundation boxes provide information about the specific science and engineering practice(s), disciplinary core idea(s), and crosscutting concept(s) that were used to write the performance expectation.

Science and Engineering Practices (SEP)

The blue box on the left (see Figure 1) includes the science and engineering practices used to construct the performance expectation(s). These statements further explain the science and engineering practices important to emphasize in each grade band. Most sets of performance expectations emphasize only a few of the practice categories; however, all practices are emphasized within a grade band. Teachers should be encouraged to utilize several practices in any instruction, and need not be limited by the performance expectation, which is only intended to guide assessment.

Disciplinary Core Ideas (DCI)

The orange box in the middle includes statements about the most essential ideas in the major science disciplines that all students should understand during 13 years of school. Including these detailed statements are very helpful in "unpacking" the disciplinary core ideas and sub-ideas.

Crosscutting Concepts (CCC)

The green box includes statements which apply to one or more of the performance expectations. Most sets of performance expectations limit the number of crosscutting concepts [so as] to focus on those that are readily apparent when considering the disciplinary core ideas.[7] However, all are emphasized within a grade band. Again, the list is not exhaustive nor is it intended to limit instruction.

Aspects of the Nature of Science relevant to the performance expectation(s) are also listed in this box, as are the Interdependence of Science and Engineering, and the influence of Engineering, Technology, and

[7] Deleted "so as."

Science on society and the natural world. Although these are not crosscutting concepts in the same sense as the others, they are best taught and assessed in the context of specific science ideas and are therefore also listed in this box.

Connection Boxes

Three connection boxes, below the foundation boxes, are designed to support a coherent curriculum by showing how the performance expectations in each standard connect to other performance expectations in science, as well as to New Jersey Student Learning Standards in English language arts and mathematics. The three boxes include:

Connections to other disciplinary core ideas in this grade level

This box contains the names of disciplinary core ideas that have related disciplinary core ideas at the same grade level. For example, both Physical Science and Life Science performance expectations contain core ideas related to photosynthesis and could be taught in relation to one another.

Articulation of disciplinary core ideas across grade levels

This box contains the names of disciplinary core ideas that either:

1) provide a foundation for student understanding of the core ideas in this performance expectation (usually at prior grade levels); or
2) build on the foundation provided by the core ideas in this performance expectations (usually at subsequent grade levels).

New Jersey Student Learning Standards Connections

This box contains the coding and names of prerequisite or connected NJSLS in mathematics and English language arts that align to the performance expectations. For example, performance expectations that require student use of exponential notation will align to the corresponding NJSLS mathematics standards. An effort has been made to ensure that the mathematical skills that students need for science were taught in a previous year where possible. Italicized performance expectation names indicate that the NJSLS standard is not prerequisite knowledge but could be connected to that performance expectation.

New Jersey Administrative Code Summary and Statutes

{begin new text}

Curriculum Development: Integration of 21st Century Skills and Themes and Interdisciplinary Connections

District boards of education shall be responsible for the review and continuous improvement of curriculum and instruction based upon changes in knowledge, technology, assessment results, and modifications to the NJSLS, according to N.J.A.C. 6A:8-2.

1. **District boards of education shall include interdisciplinary connections throughout the K–12 curriculum.**
2. **District boards of education shall integrate into the curriculum 21st century themes and skills (N.J.A.C. 6A:8-3.1(c)2).**

Twenty-first century themes and skills integrated into all content standards areas (N.J.A.C. 6A:8-1.1(a)3).

"Twenty-first century themes and skills" means themes such as global awareness; financial, economic, business, and entrepreneurial literacy; civic literacy; health literacy; learning and innovation skills, including creativity and innovation, critical thinking and problem solving, and communication and collaboration; information, media, and technology skills; and life and career skills, including flexibility and adaptability, initiative and self-direction, social and cross-cultural skills, productivity and accountability, and leadership and responsibility.

{end next text}

Dissection Law

N.J.S.A. 18A:35-4.25 and N.J.S.A. 18A:35-4.24 authorizes parents or guardians to assert the right of their children to refuse to dissect, vivisect, incubate, capture or otherwise harm or destroy animals or any parts thereof as part of a course of instruction.

Amistad Law: N.J.S.A. 18A 52:16A-88

Every board of education shall incorporate the information regarding the contributions of African-Americans to our country in an appropriate place in the curriculum of elementary and secondary school students.

Holocaust Law: N.J.S.A. 18A:35-28

Every board of education shall include instruction on the Holocaust and genocides in an appropriate place in the curriculum of all elementary and secondary school pupils. The instruction shall further emphasize the personal responsibility that each citizen bears to fight racism and hatred whenever and wherever it happens.

LGBT and Disabilities Law: N.J.S.A. 18A:35-4.35

A board of education shall include instruction on the political, economic, and social contributions of persons with disabilities and lesbian, gay, bisexual, and transgender people, in an appropriate place in the curriculum of middle school and high school students as part of the district's implementation of the New Jersey Student Learning Standards (N.J.S.A.18A:35-4.36).

A board of education shall have policies and procedures in place pertaining to the selection of instructional materials to implement the requirements of N.J.S.A. 18A:35-4.35. {begin deleted text} [When adopting instructional materials for use in the schools of the district, a board of education shall adopt inclusive instructional materials that portray the cultural and economic diversity of society including the political, economic, and social contributions of persons with disabilities and lesbian, gay, bisexual, and transgender people, where appropriate]{end deleted text}

References

ACT. (2011). Science for college and careers: A resource for developers of the next generation science standards. Unpublished Manuscript, commissionioned by Achieve.

American Association for the Advancemnt of Science (AAAS). (2011). *Vision and change in undergraduate biology education: a call to action.* Washington, DC: AAAS.

Association of American Medical Colleges (AAMC) and Howard Hughes Medical Institute (HHMI). (2009). *Scientific foundations for future physicians.* Washington, DC: AAMC.

College Board. (2009). *College Board standards for success: Science.* New York, NY: College Board.

College Board. (2010). College readiness in science. New York, NY: Unpublished Manuscript, commissioned by Achieve.

College Board. (2015). *Advances in AP: What's Changing.* New York, NY: College Board.

Conley, D. (2005). *College knowledge: What it really takes for students to succeed beyond high school.* San Francisco, CA: Jossey-Bass.

National Academies of Sciences, Engineering, and Medicine. (2019). *Science and Engineering for Grades 6-12: Investigation and Design at the Center* . Washington, DC: National Academies Press.

New Jersey State Board of Education. (2019). *New Jersey Administrative Code 6A:8-3.1 (c), Standards and Assessment.* Trenton, NJ: New Jersey Department of Education.

NRC. (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas.* Washington, DC: The National Academies Press.

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2020 New Jersey Student Learning Standards: Science – K to 5

Kindergarten

K-PS2: Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

- **K-PS2-1** Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.
  [Clarification Statement: Examples of pushes or pulls could include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other.] [Assessment Boundary: Assessment is limited to different relative strengths or different directions, but not both at the same time. Assessment does not include non-contact pushes or pulls such as those produced by magnets.]
- **K-PS2-2**. Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.
  [Clarification Statement: Examples of problems requiring a solution could include having a marble or other object move a certain distance, follow a particular path, and knock down other objects. Examples of solutions could include tools such as a ramp to increase the speed of the object and a structure that would cause an object such as a marble or ball to turn.] [Assessment Boundary: Assessment does not include friction as a mechanism for change in speed.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. ▪ With guidance, plan and conduct an investigation in collaboration with peers. (K-PS2-1) **Analyzing and Interpreting Data** Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. ▪ Analyze data from tests of an object or tool to determine if it	**PS2.A: Forces and Motion** ▪ Pushes and pulls can have different strengths and directions. (K-PS2-1), (K-PS2-2) ▪ Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (K-PS2-1), (K-PS2-2) **PS2.B: Types of Interactions** ▪ When objects touch or collide, they push on one another and can change motion. (K-PS2-1) **PS3.C: Relationship Between Energy and Forces** ▪ A bigger push or pull makes things speed up or slow down more quickly. *(secondary to K-PS2-1)* **ETS1.A: Defining Engineering Problems**	**Cause and Effect** ▪ Simple tests can be designed to gather evidence to support or refute student ideas about causes. (K-PS2-1), (K-PS2-2) ***Connections to Nature of Science*** **Scientific Investigations Use a Variety of Methods** ▪ Scientists use different ways to study the world. (K-PS2-1)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
works as intended. (K-PS2-2)	▪ A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. *(secondary to K-PS2-2)*	

Connections to other DCIs in Kindergarten:

- **K.ETS1.A** (K-PS2-2)
- **K.ETS1.B** (K-PS2-2)

Articulation of DCIs across grade levels:

- **2.ETS1.B** (K-PS2-2)
- **3.PS2.A** (K-PS2-1), (K-PS2-2)
- **3.PS2.B** (K-PS2-1)
- **4.PS3.A** (K-PS2-1)
- **4.ETS1.A** (K-PS2-2)

Connections to NJSLS – English Language Arts

- **RI.K.1** With prompting and support, ask and answer questions about key details in a text. (K-PS2-2)
- **W.K.7** Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them). (K-PS2-1)
- **SL.K.3** Ask and answer questions in order to seek help, get information, or clarify something that is not understood. (K-PS2-2)

Connections to NJSLS – Mathematics

- **MP.2** Reason abstractly and quantitatively. (K-PS2-1)
- **K.MD.A.1** Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object. (K-PS2-1)
- **K.MD.A.2** Directly compare two objects with a measurable attribute in common, to see which object has "more of/less of" the attribute, and describe the difference. (K-PS2-1)

K-PS3: Energy

Students who demonstrate understanding can:

- **K-PS3-1** Make observations to determine the effect of sunlight on Earth's surface.
[Clarification Statement: Examples of Earth's surface could include sand, soil, rocks, and water]
[Assessment Boundary: Assessment of temperature is limited to relative measures such as warmer/cooler.]
- **K-PS3-2** Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.
[Clarification Statement: Examples of structures could include umbrellas, canopies, and tents that minimize the warming effect of the sun.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. ▪ Make observations (firsthand or from media) to collect data that can be used to make comparisons. (K-PS3-1) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. ▪ Use tools and materials provided to design and build a device that solves a specific problem or a solution to a specific problem. (K-PS3-2)	**PS3.B: Conservation of Energy and Energy Transfer** ▪ Sunlight warms Earth's surface. (K-PS3-1), (K-PS3-2)	**Cause and Effect** ▪ Events have causes that generate observable patterns. (K-PS3-1), (K-PS3-2) ***Connections to Nature of Science*** **Scientific Investigations Use a Variety of Methods** ▪ Scientists use different ways to study the world. (K-PS3-1)

Connections to other DCIs in kindergarten:

- **K.ETS1.A** (K-PS3-2)
- **K.ETS1.B** (K-PS3-2)

Articulation of DCIs across grade levels:

- **1.PS4.B** (K-PS3-1), (K-PS3-2)
- **2.ETS1.B** (K-PS3-2)
- **3.ESS2.D** (K-PS3-1)
- **4.ETS1.A** (K-PS3-2)
- **K.ETS1.A** (1-PS4-4)

Connections to NJSLS – English Language Arts

- **W.K.7** Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them). (K-PS3-1), (K-PS3-2)

Connections to NJSLS – Mathematics

- **K.MD.A.2** Directly compare two objects with a measurable attribute in common, to see which object has "more of/less of" the attribute, and describe the difference. (K-PS3-1), (K-PS3-2)

K-LS1: From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can:

- **K-LS1-1** Use observations to describe patterns of what plants and animals (including humans) need to survive. [Clarification Statement: Examples of patterns could include that animals need to take in food but plants do not; the different kinds of food needed by different types of animals; the requirement of plants to have light; and, that all living things need water.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. ▪ Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions. (K-LS1-1)	**LS1.C: Organization for Matter and Energy Flow in Organisms** ▪ All animals need food in order to live and grow. They obtain their food from plants or from other animals. Plants need water and light to live and grow. (K-LS1-1)	**Patterns** ▪ Patterns in the natural and human designed world can be observed and used as evidence. (K-LS1-1) ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** ▪ Scientists look for patterns and order when making observations about the world. (K-LS1-1)

Connections to other DCIs in Kindergarten:

N/A

Articulation of DCIs across grade levels:

- **1.LS1.A** (K-LS1-1)
- **2.LS2.A** (K-LS1-1)
- **3.LS2.C** (K-LS1-1)
- **3.LS4.B** (K-LS1-1)
- **5.LS1.C** (K-LS1-1)
- **5.LS2.A** (K-LS1-1)

Connections to NJSLS – English Language Arts

- **W.K.7** Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them). (K-LS-1)

Connections to NJSLS – Mathematics

- **K.MD.A.2** Directly compare two objects with a measurable attribute in common, to see which object has "more of/less of" the attribute, and describe the difference. (K-LS-1)

K-ESS2: Earth Systems

Students who demonstrate understanding can:

- **K-ESS2-1** Use and share observations of local weather conditions to describe patterns over time. [Clarification Statement: Examples of qualitative observations could include descriptions of the weather (such as sunny, cloudy, rainy, and warm); examples of quantitative observations could include numbers of sunny, windy, and rainy days in a month. Examples of patterns could include that it is usually cooler in the morning than in the afternoon and the number of sunny days versus cloudy days in different months.] [Assessment Boundary: Assessment of quantitative observations limited to whole numbers and relative measures such as warmer/cooler.]
- **K-ESS2-2** Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs. [Clarification Statement: Examples of plants and animals changing their environment could include a squirrel digs in the ground to hide its food and tree roots can break concrete.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. ▪ Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions. (K-ESS2-1) **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. (K-ESS2-2)	**ESS2.D: Weather and Climate** ▪ Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time. (K-ESS2-1) **ESS2.E: Biogeology** ▪ Plants and animals can change their environment. (K-ESS2-2) **ESS3.C: Human Impacts on Earth Systems** ▪ Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things. *(secondary to K-ESS2-2)*	**Patterns** ▪ Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. (K-ESS2-1) **Systems and System Models** ▪ Systems in the natural and designed world have parts that work together. (K-ESS2-2) ***Connections to Nature of Science*** **Science Knowledge is Based on Empirical Evidence** ▪ Scientists look for patterns and order when making observations about the world. (K-ESS2-1)

Connections to other DCIs in Kindergarten:

N/A

Articulation of DCIs across grade levels:

- **2.ESS2.A** (K-ESS2-1)
- **3.ESS2.D** (K-ESS2-1)
- **4.ESS2.A** (K-ESS2-1)
- **4.ESS2.E** (K-ESS2-2)
- **5.ESS2.A** (K-ESS2-2)

Connections to NJSLS – English Language Arts

- **W.K.7** Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them). (K-LS-1)
- **RL.K.1** With prompting and support, ask and answer questions about key details in a text (e.g., who, what, where, when, why, how). (K-ESS2-2)
- **W.K.1** Use a combination of drawing, dictating, and writing to compose opinion pieces in which they tell a reader the topic or the name of the book they are writing about and state an opinion or preference about the topic or book. (K-ESS2-2)
- **W.K.2** Use a combination of drawing, dictating, and writing to compose informative/explanatory texts in which they name what they are writing about and supply some information about the topic. (K-ESS2-2)
- **W.K.7** Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them). (K-ESS2-1)

Connections to NJSLS – Mathematics

- **MP.2** Reason abstractly and quantitatively. (K-ESS2-1)
- **MP.4** Model with mathematics. (K-ESS2-1)
- **K.CC.A** Know number names and the count sequence. (K-ESS2-1)
- **K.MD.A.1** Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object. (K-ESS2-1)
- **K.MD.B.3** Classify objects into given categories; count the number of objects in each category and sort the categories by count. (K-ESS2-1)

K-ESS3: Earth and Human Activity

Students who demonstrate understanding can:

- **K-ESS3-1** Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.
  [Clarification Statement: Examples of relationships could include that deer eat buds and leaves, therefore, they usually live in forested areas; and, grasses need sunlight, so they often grow in meadows. Plants, animals, and their surroundings make up a system.]
- **K-ESS3-2** Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather.
  [Clarification Statement: Emphasis is on local forms of severe weather.]
- **K-ESS3-3** Communicate solutions that will reduce the impact of climate change and humans on the land, water, air, and/or other living things in the local environment.
  [Clarification Statement: Examples of human impact on the land could include cutting trees to produce paper and using resources to produce bottles. Examples of solutions could include reusing paper and recycling cans and bottles.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in grades K–2 builds on prior experiences and progresses to simple descriptive questions that can be tested. ▪ Ask questions based on observations to find more information about the designed world. (K-ESS3-2) **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, storyboard) that represent concrete events or design solutions. ▪ Use a model to represent relationships in the natural world. (K-ESS3-1) **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses	**ESS3.A: Natural Resources** ▪ Living things need water, air, and resources from the land, and they live in places that have the things they need. Humans use natural resources for everything they do. (K-ESS3-1) **ESS3.B: Natural Hazards** ▪ Some kinds of severe weather are more likely than others in a given region. Weather scientists forecast severe weather so that the communities can prepare for and respond to these events. (K-ESS3-2) **ESS3.C: Human Impacts on Earth Systems** ▪ Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things. (K-ESS3-3) **ETS1.A: Defining and Delimiting an Engineering Problem** ▪ Asking questions, making observations, and gathering information are helpful in thinking	**Cause and Effect** ▪ Events have causes that generate observable patterns. (K-ESS3-2), (K-ESS3-3) **Systems and System Models** ▪ Systems in the natural and designed world have parts that work together. (K-ESS3-1) ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** ▪ People encounter questions about the natural world every day. (K-ESS3-2) **Influence of Engineering, Technology, and Science on Society and the Natural World** ▪ People depend on various technologies in their lives; human life would be very different without technology. (K-ESS3-2)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
observations and texts to communicate new information. ▪ Read grade-appropriate texts and/or use media to obtain scientific information to describe patterns in the natural world. (K-ESS3-2) ▪ Communicate solutions with others in oral and/or written forms using models and/or drawings that provide detail about scientific ideas. (K-ESS3-3)	about problems. *(secondary to K-ESS3-2)* **ETS1.B: Developing Possible Solutions** ▪ Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. *(secondary to K-ESS3-3)*	

Connections to other DCIs in Kindergarten:

- **K.ETS1.A** (K-ESS3-2), (K-ESS3-3)

Articulation of DCIs across grade levels:

- **1.LS1.A** (K-ESS3-1)
- **2.ESS1.C** (K-ESS3-2)
- **2.ETS1.B** (K-ESS3-3)
- **3.ESS3.B** (K-ESS3-2)
- **4.ESS3.A** (K-ESS3-3)
- **4.ESS3.B** (K-ESS3-2)
- **5.LS2.A** (K-ESS3-1)
- **5.ESS2.A** (K-ESS3-1)
- **5.ESS3.C** (K-ESS3-3)

Connections to NJSLS – English Language Arts

- **W.K.7** Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them). (K-LS-1)
- **RI.K.1** With prompting and support, ask and answer questions about key details in a text. (K-ESS3-2)
- **W.K.2** Use a combination of drawing, dictating, and writing to compose informative/explanatory texts in which they name what they are writing about and supply some information about the topic. (K-ESS3-3)
- **SL.K.3** Ask and answer questions in order to seek help, get information, or clarify something that is not understood. (K-ESS3-2)
- **SL.K.5** Add drawings or other visual displays to descriptions as desired to provide additional detail. (K-ESS3-1)

Mathematics –*Connections to NJSLS – Mathematics*

- **MP.2** Reason abstractly and quantitatively. (K-ESS2-1)
- **MP.4** Model with mathematics. (K-ESS2-1)
- **K.CC** Know number names and the count sequence. (K-ESS2-1)

K-2-ETS1: Engineering Design

Students who demonstrate understanding can:

- **K-2-ETS1-1** Ask questions, make observations, and gather information about a situation people want to change (e.g., climate change) to define a simple problem that can be solved through the development of a new or improved object or tool.
- **K-2-ETS1-2** Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
- **K-2-ETS1-3** Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in K–2 builds on prior experiences and progresses to simple descriptive questions. ▪ Ask questions based on observations to find more information about the natural and/or designed world(s). (K-2-ETS1-1) ▪ Define a simple problem that can be solved through the development of a new or improved object or tool. (K-2-ETS1-1) **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 a simple model based on evidence to represent a proposed object or tool. (K-2-ETS1-2) **Analyzing and Interpreting Data** Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.	**ETS1.A: Defining and Delimiting Engineering Problems** ▪ A situation that people want to change or create can be approached as a problem to be solved through engineering. (K-2-ETS1-1) ▪ Ask questions, make observations, and gather information about a situation people want to change (e.g., climate change) to define a simple problem that can be solved through the development of a new or improved object or tool. (K-2-ETS1-1) ▪ Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1) **ETS1.B: Developing Possible Solutions** ▪ Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions, such as climate change, to other people. (K-2-ETS1-2) **ETS1.C: Optimizing the Design Solution** ▪ Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (K-2-ETS1-3)	**Structure and Function** ▪ The shape and stability of structures of natural and designed objects are related to their function(s). (K-2-ETS1-2)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
▪ Analyze data from tests of an object or tool to determine if it works as intended. (K-2-ETS1-3)		

Connections to other DCIs in first grade:

- **K-2-ETS1.A** (1-PS4-4)

Articulation of DCIs across grade levels:

- **K-2-ETS1.A** (K-PS2-2), (K-ESS3-2)
- **K-2-ETS1.B** (K-ESS3-3), (1-PS4-4), (2-LS2-2), (K-ESS3-3)
- **K-2-ETS1.C** (2-ESS2-1)

Connections to NJSLS - English Language Arts

- **RI.2.1** Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text. (K-2-ETS1-1)
- **W.2.6** With guidance and support from adults, use a variety of digital tools to produce and publish writing, including in collaboration with peers. (K-2-ETS1-1), (K-2-ETS1-3)
- **W.2.8** Recall information from experiences or gather information from provided sources to answer a question. (K-2-ETS1-1), (K-2-ETS1-3)
- **SL.2.5** Create audio recordings of stories or poems; add drawings or other visual displays to stories or recounts of experiences when appropriate to clarify ideas, thoughts, and feelings. (K-2-ETS1-2)

Connections to NJSLS - Mathematics

- **MP.5** Use appropriate tools strategically. (1-PS4-4)
- **MP.2** Reason abstractly and quantitatively. (K-2-ETS1-1), (K-2-ETS1-3)
- **MP.4** Model with mathematics. (K-2-ETS1-1), (K-2-ETS1-3)
- **MP.5** Use appropriate tools strategically. (K-2-ETS1-1), (K-2-ETS1-3)
- **2.MD.D.10** Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. (K-2-ETS1-1), (K-2-ETS1-3)

Grade 1

1-PS4 Waves and their Applications in Technologies for Information Transfer

Students who demonstrate understanding can:

- **1-PS4-1** Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.
  [Clarification Statement: Examples of vibrating materials that make sound could include tuning forks and plucking a stretched string. Examples of how sound can make matter vibrate could include holding a piece of paper near a speaker making sound and holding an object near a vibrating tuning fork.]
- **1-PS4-2** Make observations to construct an evidence-based account that objects can be seen only when illuminated.
  [Clarification Statement: Examples of observations could include those made in a completely dark room, a pinhole box, and a video of a cave explorer with a flashlight. Illumination could be from an external light source or by an object giving off its own light.]
- **1-PS4-3** Plan and conduct an investigation to determine the effect of placing objects made with different materials in the path of a beam of light.
  [Clarification Statement: Examples of materials could include those that are transparent (such as clear plastic), translucent (such as wax paper), opaque (such as cardboard), and reflective (such as a mirror). The idea that light travels from place to place is developed through experiences with light sources, mirrors, and shadows, but no attempt is made to discuss the speed of light.] [Assessment Boundary: Assessment does not include the speed of light.]
- **1-PS4-4** Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.
  [Clarification Statement: Examples of devices could include a light source to send signals, paper cup and string "telephones," and a pattern of drum beats.] [Assessment Boundary: Assessment does not include technological details for how communication devices work.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. ▪ Plan and conduct investigations collaboratively to produce data to serve as the basis for evidence to answer a question. (1-PS4-1), (1-PS4-3)	**PS4.A: Wave Properties** ▪ Sound can make matter vibrate, and vibrating matter can make sound. (1-PS4-1) **PS4.B: Electromagnetic Radiation** ▪ Objects can be seen if light is available to illuminate them or if they give off their own light. (1-PS4-2) ▪ Some materials allow light to pass through them, others allow only some light through and others block all the light and create a dark shadow on any surface beyond them, where the light cannot reach. Mirrors can be used to redirect a light beam. (1-PS4-3)	**Cause and Effect** ▪ Simple tests can be designed to gather evidence to support or refute student ideas about causes. (1-PS4-1), (1-PS4-2), (1-PS4-3) ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Engineering, Technology, and Science, on Society and the Natural World** ▪ People depend on various technologies in their lives; human life would be very different without technology. (1-PS4-4)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. ▪ Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. (1-PS4-2) ▪ Use tools and materials provided to design a device that solves a specific problem. (1-PS4-4)	**PS4.C: Information Technologies and Instrumentation** ▪ People also use a variety of devices to communicate (send and receive information) over long distances. (1-PS4-4)	***Connections to Nature of Science*** **Scientific Investigations Use a Variety of Methods** ▪ Science investigations begin with a question. (1-PS4-1) ▪ Scientists use different ways to study the world. (1-PS4-1)

Connections to other DCIs in first grade:

N/A

Articulation of DCIs across grade levels:

- **K.ETS1.A** (1-PS4-4)
- **2.PS1.A** (1-PS4-3)
- **2.ETS1.B** (1-PS4-4)
- **4.PS4.C** (1-PS4-4)
- **4.PS4.B** (1-PS4-2)
- **4.ETS1.A** (1-PS4-4)

Connections to NJSLS – English Language Arts

- **W.1.2** Write informative/explanatory texts in which they name a topic, supply some facts about the topic, and provide some sense of closure. (1-PS4-2)
- **W.1.7** Participate in shared research and writing projects (e.g., explore a number of "how-to" books on a given topic and use them to write a sequence of instructions). (1-PS4-1), (1-PS4-2), (1-PS4-3), (1-PS4-4)
- **W.1.8** With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question. (1-PS4-1), (1-PS4-2), (1-PS4-3)
- **SL.1.1** Participate in collaborative conversations with diverse partners about grade 1 topics and texts with peers and adults in small and larger groups. (1-PS4-1), (1-PS4-2), (1-PS4-3)

Connections to NJSLS – Mathematics

- **MP.5** Use appropriate tools strategically. (1-PS4-4)
- **1.MD.A.1** Order three objects by length; compare the lengths of two objects indirectly by using a third object. (1-PS4-4)
- **1.MD.A.2** Express the length of an object as a whole number of length units, by layering multiple copies of a shorter object (the length unit) end to end; understand that the length measurement of an object is the number of same-size length units that span it with no gaps or overlaps. (1-PS4-4)

1-LS1: From Molecules to Organisms: Structure and Processes

Students who demonstrate understanding can:

- **1-LS1-1** Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.
  [Clarification Statement: Examples of human problems that can be solved by mimicking plant or animal solutions could include designing clothing or equipment to protect bicyclists by mimicking turtle shells, acorn shells, and animal scales; stabilizing structures by mimicking animal tails and roots on plants; keeping out intruders by mimicking thorns on branches and animal quills; and, detecting intruders by mimicking eyes and ears.]
- **1-LS1-2** Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.
  [Clarification Statement: Examples of patterns of behaviors could include the signals that offspring make (such as crying, cheeping, and other vocalizations s) and the responses of the parents (such as feeding, comforting, and protecting the offspring).]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. ▪ Use materials to design a device that solves a specific problem or a solution to a specific problem. (1-LS1-1) **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 use media to obtain scientific information to determine patterns in the natural world. (1-LS1-2)	**LS1.A: Structure and Function** ▪ All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. (1-LS1-1) **LS1.B: Growth and Development of Organisms** ▪ Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive. (1-LS1-2) **LS1.D: Information Processing** ▪ Animals have body parts that capture and convey different kinds of information needed for growth and survival. Animals respond to these inputs with behaviors that help them survive. Plants also respond to some external inputs. (1-LS1-1)	**Patterns** ▪ Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. (1-LS1-2) **Structure and Function** ▪ The shape and stability of structures of natural and designed objects are related to their function(s). (1-LS1-1) ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Engineering, Technology, and Science on Society and the Natural World** ▪ Every human-made product is designed by applying some knowledge of the natural world and is built using materials derived from the natural world. (1-LS1-1) ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** ▪ Scientists look for patterns and order when making observations about the world. (1-LS1-2)

Connections to other DCIs in first grade:

N/A

Articulation of DCIs across grade levels:

- **K.ETS1.A** (1-LS1-1)
- **3.LS2.D** (1-LS1-2)
- **4.LS1.A** (1-LS1-1)
- **4.LS1.D** (1-LS1-1)
- **4.ETS1.A** (1-LS1-1)

Connections to NJSLS – English Language Arts

- **RL.1.1** Ask and answer questions about key details in a text. (1-LS1-2)
- **RL.1.2** Identify the main topic and retell key details of a text. (1-LS1-2)
- **RL.1.10** With prompting and support, read and comprehend stories and poetry at grade level text complexity or above. (1-LS1-2)
- **W.1.7** Participate in shared research and writing projects (e.g., explore a number of "how-to" books on a given topic and use them to write a sequence of instructions). (1-LS1-1)

Connections to NJSLS – Mathematics

- **1.NBT.B.3** Compare two two-digit numbers based on the meanings of the tens and one digits, recording the results of comparisons with the symbols >, =, and <. (1-LS1-2)
- **1.NBT.C.4** Add within 100, including adding a two-digit number and a one-digit number, and adding a two-digit number and a multiple of 10, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning uses. Understand that in adding two-digit numbers, one adds tens and tens, ones and ones; and sometimes it is necessary to compose a ten. (1-LS1-2)
- **1.NBT.C.5** Given a two-digit number, mentally find 10 more or 10 less than the number, without having to count; explain the reasoning used. (1-LS1-2)
- **1.NBT.C.6** Subtract multiples of 10 in the range 10–90 from multiples of 10 in the range 10–90 (positive or zero differences), using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used. (1-LS1-2)

1-LS3: Heredity: Inheritance and Variation of Traits

Students who demonstrate understanding can:

- **1-LS3-1** Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.
  [Clarification Statement: Examples of patterns could include features plants or animals share. Examples of observations could include leaves from the same kind of plant are the same shape but can differ in size; and, a particular breed of dog looks like its parents but is not exactly the same.] [Assessment Boundary: Assessment does not include inheritance or animals that undergo metamorphosis or hybrids.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. ▪ Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. (1-LS3-1	**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. (1-LS3-1) **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. (1-LS3-1)	**Patterns** ▪ Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. (1-LS3-1)

Connections to other DCIs in first grade:

N/A

Articulation of DCIs across grade levels:

- **3.LS3.A** (1-LS3-1)
- **3.LS3.B** (1-LS3-1)
- **5.PS2.B** (1-ESS1-1), (1-ESS1-2)

Connections to NJSLS – English Language Arts

- **RI.1.1** Ask and answer questions about key details in a text. (1-LS3-1)
- **W.1.7** Participate in shared research and writing projects (e.g., explore a number of "how-to" books on a given topic and use them to write a sequence of instructions). (1-LS3-1)
- **W.1.8** With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question. (1-LS3-1)

Connections to NJSLS – Mathematics

- **MP.2** Reason abstractly and quantitatively. (1-LS3-1)
- **MP.5** Use appropriate tools strategically. (1-LS3-1)
- **1.MD.A.1** Order three objects by length; compare the lengths of two objects indirectly by using a third object. (1-LS3-1)

1-ESS1: Earth's Place in the Universe

Students who demonstrate understanding can:

- **1-ESS1-1** Use observations of the sun, moon, and stars to describe patterns that can be predicted. [Clarification Statement: Examples of patterns could include that the sun and moon appear to rise in one part of the sky, move across the sky, and set; and stars other than our sun are visible at night but not during the day.] [Assessment Boundary: Assessment of star patterns is limited to stars being seen at night and not during the day.]
- **1-ESS1-2** Make observations at different times of year to relate the amount of daylight to the time of year. [Clarification Statement: Emphasis is on relative comparisons of the amount of daylight in the winter to the amount in the spring or fall.] [Assessment Boundary: Assessment is limited to relative amounts of daylight, not quantifying the hours or time of daylight.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. ▪ Make observations (firsthand or from media) to collect data that can be used to make comparisons. (1-ESS1-2) **Analyzing and Interpreting Data** Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. ▪ Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions. (1-ESS1-1)	**ESS1.A: The Universe and its Stars** ▪ Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted. (1-ESS1-1) **ESS1.B: Earth and the Solar System** ▪ Seasonal patterns of sunrise and sunset can be observed, described, and predicted. (1-ESS1-2)	**Patterns** ▪ Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. (1-ESS1-1), (1-ESS1-2) ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ▪ Science assumes natural events happen today as they happened in the past. (1-ESS1-1) ▪ Many events are repeated. (1-ESS1-1)

Connections to other DCIs in first grade:

N/A

Articulation of DCIs across grade levels:

- **3.PS2.A** (1-ESS1-1)
- **5.PS2.B** (1-ESS1-1), (1-ESS1-2)
- **5.ESS1.B** (1-ESS1-1), (1-ESS1-2)

Connections to NJSLS – English Language Arts

- **W.1.7** Participate in shared research and writing projects (e.g., explore a number of "how-to" books on a given topic and use them to write a sequence of instructions). (1-ESS1-1), (1-ESS1-2)
- **W.1.8** With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question. (1-ESS1-1), (1-ESS1-2)

Connections to NJSLS – Mathematics

- **MP.5** Use appropriate tools strategically. (1-PS4-4)
- **1.MD.A.1** Order three objects by length; compare the lengths of two objects indirectly by using a third object. (1-PS4-4)
- **1.MD.A.2** Express the length of an object as a whole number of length units, by layering multiple copies of a shorter object (the length unit) end to end; understand that the length measurement of an object is the number of same-size length units that span it with no gaps or overlaps. (1-PS4-4)

K-2-ETS1: Engineering Design

Students who demonstrate understanding can:

- **K-2-ETS1-1** Ask questions, make observations, and gather information about a situation people want to change (e.g., climate change) to define a simple problem that can be solved through the development of a new or improved object or tool.
- **K-2-ETS1-2** Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
- **K-2-ETS1-3** Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in K–2 builds on prior experiences and progresses to simple descriptive questions. ▪ Ask questions based on observations to find more information about the natural and/or designed world(s). (K-2-ETS1-1) ▪ Define a simple problem that can be solved through the development of a new or improved object or tool. (K-2-ETS1-1) **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 a simple model based on evidence to represent a proposed object or tool. (K-2-ETS1-2) **Analyzing and Interpreting Data** Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.	**ETS1.A: Defining and Delimiting Engineering Problems** ▪ A situation that people want to change or create can be approached as a problem to be solved through engineering. (K-2-ETS1-1) ▪ Ask questions, make observations, and gather information about a situation people want to change (e.g., climate change) to define a simple problem that can be solved through the development of a new or improved object or tool. (K-2-ETS1-1) ▪ Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1) **ETS1.B: Developing Possible Solutions** ▪ Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (K-2-ETS1-2) **ETS1.C: Optimizing the Design Solution** ▪ Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (K-2-ETS1-3)	**Structure and Function** ▪ The shape and stability of structures of natural and designed objects are related to their function(s). (K-2-ETS1-2)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
▪ Analyze data from tests of an object or tool to determine if it works as intended. (K-2-ETS1-3)		

Connections to other DCIs in first grade:

- **K-2-ETS1.A** (1-PS4-4)

Articulation of DCIs across grade levels:

- **K-2-ETS1.A** (K-PS2-2), (K-ESS3-2)
- **K-2-ETS1.B** (K-ESS3-3), (1-PS4-4), (2-LS2-2), (K-ESS3-3)
- **K-2-ETS1.C** (2-ESS2-1)

Connections to NJSLS - English Language Arts

- **RI.2.1** Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text. (K-2-ETS1-1)
- **W.2.6** With guidance and support from adults, use a variety of digital tools to produce and publish writing, including in collaboration with peers. (K-2-ETS1-1), (K-2-ETS1-3)
- **W.2.8** Recall information from experiences or gather information from provided sources to answer a question. (K-2-ETS1-1), (K-2-ETS1-3)
- **SL.2.5** Create audio recordings of stories or poems; add drawings or other visual displays to stories or recounts of experiences when appropriate to clarify ideas, thoughts, and feelings. (K-2-ETS1-2)

Connections to NJSLS - Mathematics

- **MP.5** Use appropriate tools strategically. (1-PS4-4)
- **MP.2** Reason abstractly and quantitatively. (K-2-ETS1-1), (K-2-ETS1-3)
- **MP.4** Model with mathematics. (K-2-ETS1-1), (K-2-ETS1-3)
- **MP.5** Use appropriate tools strategically. (K-2-ETS1-1), (K-2-ETS1-3)
- **2.MD.D.10** Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. (K-2-ETS1-1), (K-2-ETS1-3)

Grade 2

2-PS1: Matter and It's Interactions

Students who demonstrate understanding can:

- **2-PS1-1** Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.
  [Clarification Statement: Observations could include color, texture, hardness, and flexibility. Patterns could include the similar properties that different materials share.]
- **2-PS1-2** Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.
  [Clarification Statement: Examples of properties could include, strength, flexibility, hardness, texture, and absorbency.] [Assessment Boundary: Assessment of quantitative measurements is limited to length.]
- **2-PS1-3** Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.
  [Clarification Statement: Examples of pieces could include blocks, building bricks, or other assorted small objects.]
- **2-PS1-3** Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.
  [Clarification Statement: Examples of reversible changes could include materials such as water and butter at different temperatures. Examples of irreversible changes could include cooking an egg, freezing a plant leaf, and heating paper.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. ▪ Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. (2-PS1-1) **Analyzing and Interpreting Data** Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.	**PS1.A: Structure and Properties of Matter** ▪ Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. (2-PS1-1) ▪ Different properties are suited to different purposes. (2-PS1-2), (2-PS1-3) ▪ A great variety of objects can be built up from a small set of pieces. (2-PS1-3) **PS1.B: Chemical Reactions** ▪ Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. (2-PS1-4)	**Patterns** ▪ Patterns in the natural and human designed world can be observed. (2-PS1-1) **Cause and Effect** ▪ Events have causes that generate observable patterns. (2-PS1-4) ▪ Simple tests can be designed to gather evidence to support or refute student ideas about causes. (2-PS1-2) **Energy and Matter** ▪ Objects may break into smaller pieces and be put together into larger pieces or change shapes. (2-PS1-3) ***Connections to Engineering, Technology, and Applications of Science***

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
▪ Analyze data from tests of an object or tool to determine if it works as intended. (2-PS1-2) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. ▪ Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. (2-PS1-3) **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. (2-PS1-4)		**Influence of Engineering, Technology, and Science on Society and the Natural World** ▪ Every human-made product is designed by applying some knowledge of the natural world and is built using materials derived from the natural world. (2-PS1-2) ***Connections to Nature of Science*** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** ▪ Scientists search for cause and effect relationships to explain natural events. (2-PS1-4)

Connections to other DCIs in second grade:

N/A

Articulation of DCIs across grade levels:

- **4.ESS2.A** (2-PS1-3)
- **5.PS1.A** (2-PS1-1), (2-PS1-2), (2-PS1-3)
- **5.PS1.B** (2-PS1-4)
- **5.LS2.A** (2-PS1-3)

Connections to NJSLS - English Language Arts

- **RI.2.1** Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text. (K-2-ETS1-1)
- **RI.2.1** Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text. (2-PS1-4)

- **RI.2.3** Describe the connection between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text. (2-PS1-4)
- **RI.2.8** Describe how reasons support specific points the author makes in a text. (2-PS1-2), (2-PS1-4)
- **W.2.1** Write opinion pieces in which they introduce the topic or book they are writing about, state an opinion, supply reasons that support the opinion, use linking words (e.g., because, and, also) to connect opinion and reasons, and provide a concluding statement or section. (2-PS1-4)

Connections to NJSLS - Mathematics

- **MP.2** Reason abstractly and quantitatively. (2-PS1-2)
- **MP.4** Model with mathematics. (2-PS1-1), (2-PS1-2)
- **MP.5** Use appropriate tools strategically. (2-PS1-2)
- **2.MD.D.10** Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. (2-PS1-1),(2-PS1-2)

2-LS2: Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

- **2-LS2-1** Plan and conduct an investigation to determine if plants need sunlight and water to grow. [Assessment Boundary: Assessment is limited to testing one variable at a time.]
- **2-LS2-2** Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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 a simple model based on evidence to represent a proposed object or tool. (2-LS2-2) **Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. ▪ Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. (2-LS2-1)	**LS2.A: Interdependent Relationships in Ecosystems** ▪ Plants depend on water and light to grow. (2-LS2-1) ▪ Plants depend on animals for pollination or to move their seeds around. (2-LS2-2) **ETS1.B: Developing Possible Solutions** ▪ Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. *(secondary to 2-LS2-2)*	**Cause and Effect** ▪ Events have causes that generate observable patterns. (2-LS2-1) **Structure and Function** ▪ The shape and stability of structures of natural and designed objects are related to their function(s). (2-LS2-2)

Connections to other DCIs in second grade:

N/A

Articulation of DCIs across grade levels:

- **K.LS1.C** (2-LS2-1)
- **K-ESS3.A** (2-LS2-1)
- **K.ETS1.A** (2-LS2-2)
- **5.LS1.C** (2-LS2-1)
- **5.LS2.A** (2-LS2-2)

Connections to NJSLS - English Language Arts

- **W.2.7** Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). (2-LS2-1)
- **W.2.8** Recall information from experiences or gather information from provided sources to answer a question. (2-LS2-1)
- **SL.2.5** Create audio recordings of stories or poems; add drawings or other visual displays to stories or recounts of experiences when appropriate to clarify ideas, thoughts, and feelings. (2-LS2-2)

Connections to NJSLS - Mathematics

- **MP.2** Reason abstractly and quantitatively. (2-LS2-1)
- **MP.4** Model with mathematics. (2-LS2-1), (2-LS2-2)
- **MP.5** Use appropriate tools strategically. (2-LS2-1)
- **2.MD.D.10** Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. (2-LS2-2)

2-LS2: Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

- **2-LS4-1** Make observations of plants and animals to compare the diversity of life in different habitats. [Clarification Statement: Emphasis is on the diversity of living things in each of a variety of different habitats.] [Assessment Boundary: Assessment does not include specific animal and plant names in specific habitats.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. ▪ Make observations (firsthand or from media) to collect data that can be used to make comparisons. (2-LS4-1)	**LS4.D: Biodiversity and Humans** ▪ There are many different kinds of living things in any area, and they exist in different places on land and in water. (2-LS4-1)	**N/A** ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** ▪ Scientists look for patterns and order when making observations about the world. (2-LS4-1)

Connections to other DCIs in second grade:

N/A

Articulation of DCIs across grade levels:

- **K.LS1.C** (2-LS2-1)
- **3.LS4.C** (2-LS4-1)
- **3.LS4.D** (2-LS4-1)
- **5.LS2.A** (2-LS4-1)

Connections to NJSLS - English Language Arts

- **W.2.7** Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). (2-LS4-1)
- **W.2.8** Recall information from experiences or gather information from provided sources to answer a question. (2-LS4-1)

Connections to NJSLS - Mathematics

- **MP.2** Reason abstractly and quantitatively. (2-LS4-1)
- **MP.4** Model with mathematics. (2-LS4-1)
- **2.MD.D.10** Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. (2-LS4-1)

2-ESS1: Earth's Place in the Universe

Students who demonstrate understanding can:

- **2-ESS1-1** Use information from several sources to provide evidence that Earth events can occur quickly or slowly. [Clarification Statement: Examples of events and timescales could include volcanic explosions and earthquakes, which happen quickly and erosion of rocks, which occurs slowly.] [Assessment Boundary: Assessment does not include quantitative measurements of timescales.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. ▪ Make observations from several sources to construct an evidence-based account for natural phenomena. (2-ESS1-1)	**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. (2-ESS1-1)	**Stability and Change** ▪ Things may change slowly or rapidly. (2-ESS1-1)

Connections to other DCIs in second grade:

N/A

Articulation of DCIs across grade levels:

- **3.LS2.C** (2-ESS1-1)
- **4.ESS1.C** (2-ESS1-1)
- **4.ESS2.A** (2-ESS1-1)

Connections to NJSLS - English Language Arts

- **W.2.7** Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). (2-LS4-1)
- **RI.2.1** Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text. (2-ESS1-1)
- **RI.2.3** Describe the connection between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text. (2-ESS1-1)
- **W.2.6** With guidance and support from adults, use a variety of digital tools to produce and publish writing, including in collaboration with peers. (2-ESS1-1)
- **W.2.7** Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). (2-ESS1-1)

- **W.2.8** Recall information from experiences or gather information from provided sources to answer a question. (2-ESS1-1)
- **SL.2.2** Recount or describe key ideas or details from a text read aloud or information presented orally or through other media. (2-ESS1-1)

Connections to NJSLS - Mathematics

- **MP.2** Reason abstractly and quantitatively. (2-ESS1-1)
- **MP.4** Model with mathematics. (2-ESS1-1)
- **2.NBT.A** Understand place value. (2-ESS1-1)

2-ESS2: Earth's Systems

Students who demonstrate understanding can:

- **2-ESS2-1** Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.
  [Clarification Statement: Examples of solutions could include different designs of dikes and windbreaks to hold back wind and water, and different designs for using shrubs, grass, and trees to hold back the land.]
- **2-ESS2-2** Develop a model to represent the shapes and kinds of land and bodies of water in an area.
  [Assessment Boundary: Assessment does not include quantitative scaling in models.]
- **2-ESS2-3** Obtain information to identify where water is found on Earth and that it can be solid or liquid

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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 a model to represent patterns in the natural world. (2-ESS2-2) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. ▪ Compare multiple solutions to a problem. (2-ESS2-1) **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. ▪ Obtain information using various texts, text features (e.g., headings, tables of contents, glossaries, electronic menus, icons), and other	**ESS2.A: Earth Materials and Systems** ▪ Wind and water can change the shape of the land. (2-ESS2-1) **ESS2.B: Plate Tectonics and Large-Scale System Interactions** ▪ Maps show where things are located. One can map the shapes and kinds of land and water in any area. (2-ESS2-2) **ESS2.C: The Roles of Water in Earth's Surface Processes** ▪ Water is found in the ocean, rivers, lakes, and ponds. Water exists as solid ice and in liquid form. (2-ESS2-3) **ETS1.C: Optimizing the Design Solution** ▪ Because there is always more than one possible solution to a problem, it is useful to compare and test designs. *(secondary to 2-ESS2-1)*	**Patterns** ▪ Patterns in the natural world can be observed. (2-ESS2-2), (2-ESS2-3) **Stability and Change** ▪ Things may change slowly or rapidly. (2-ESS2-1) ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Engineering, Technology, and Science on Society and the Natural World** ▪ Developing and using technology has impacts on the natural world. (2-ESS2-1) ***Connections to Nature of Science*** **Science Addresses Questions About the Natural and Material World** ▪ Scientists study the natural and material world. (2-ESS2-1)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
media that will be useful in answering a scientific question. (2-ESS2-3)		

Connections to other DCIs in second grade:

- **2.PS1.A** (2-ESS2-3)

Articulation of DCIs across grade levels:

- **3.LS2.C** (2-ESS1-1)
- **4.ESS1.C** (2-ESS1-1)
- **4.ESS2.A** (2-ESS1-1)

Connections to NJSLS - English Language Arts

- **RI.2.3** Describe the connection between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text. (2-ESS2-1)
- **RI.2.9** Compare and contrast the most important points presented by two texts on the same topic. (2-ESS2-1)
- **W.2.6** With guidance and support from adults, use a variety of digital tools to produce and publish writing, including in collaboration with peers. (2-ESS2-3)
- **W.2.8** Recall information from experiences or gather information from provided sources to answer a question. (2-ESS2-3)
- **SL.2.5** Create audio recordings of stories or poems; add drawings or other visual displays to stories or recounts of experiences when appropriate to clarify ideas, thoughts, and feelings. (2-ESS2-2)

Connections to NJSLS - Mathematics

- **2.NBT.A.3** Read and write numbers to 1000 using base-ten numerals, number names, and expanded form. (2-ESS2-2)
- **2.MD.B.5** Use addition and subtraction within 100 to solve word problems involving lengths that are given in the same units, e.g., by using drawings (such as drawings of rulers) and equations with a symbol for the unknown number to represent the problem. (2-ESS2-1)

K-2-ETS1: Engineering Design

Students who demonstrate understanding can:

- **K-2-ETS1-1** Ask questions, make observations, and gather information about a situation people want to change (e.g., climate change) to define a simple problem that can be solved through the development of a new or improved object or tool.
- **K-2-ETS1-2** Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
- **K-2-ETS1-3** Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in K–2 builds on prior experiences and progresses to simple descriptive questions. ▪ Ask questions based on observations to find more information about the natural and/or designed world(s). (K-2-ETS1-1) ▪ Define a simple problem that can be solved through the development of a new or improved object or tool. (K-2-ETS1-1) **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 a simple model based on evidence to represent a proposed object or tool. (K-2-ETS1-2) **Analyzing and Interpreting Data** Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. ▪ Analyze data from tests of an object or tool to determine if it	**ETS1.A: Defining and Delimiting Engineering Problems** ▪ A situation that people want to change or create can be approached as a problem to be solved through engineering. (K-2-ETS1-1) ▪ Ask questions, make observations, and gather information about a situation people want to change (e.g., climate change) to define a simple problem that can be solved through the development of a new or improved object or tool. (K-2-ETS1-1) ▪ Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1) **ETS1.B: Developing Possible Solutions** ▪ Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (K-2-ETS1-2) **ETS1.C: Optimizing the Design Solution** ▪ Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (K-2-ETS1-3)	**Structure and Function** ▪ The shape and stability of structures of natural and designed objects are related to their function(s). (K-2-ETS1-2)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
works as intended. (K-2-ETS1-3)		

Connections to other DCIs in second grade:

N/A

Articulation of DCIs across grade levels:

- **K-2-ETS1.A**(K-PS2-2), (K-ESS3-2)
- **K-2-ETS1.B** (K-ESS3-3), (1-PS4-4), (2-LS2-2), (K-ESS3-3)
- **K-2-ETS1.C** (2-ESS2-1)

Connections to NJSLS - English Language Arts

- **RI.2.1** Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text. (K-2-ETS1-1)
- **W.2.6** With guidance and support from adults, use a variety of digital tools to produce and publish writing, including in collaboration with peers. (K-2-ETS1-1), (K-2-ETS1-3)
- **W.2.8** Recall information from experiences or gather information from provided sources to answer a question. (K-2-ETS1-1), (K-2-ETS1-3)
- **SL.2.5** Create audio recordings of stories or poems; add drawings or other visual displays to stories or recounts of experiences when appropriate to clarify ideas, thoughts, and feelings. (K-2-ETS1-2)

Connections to NJSLS - Mathematics

- **MP.5** Use appropriate tools strategically. (1-PS4-4)
- **MP.2** Reason abstractly and quantitatively. (K-2-ETS1-1), (K-2-ETS1-3)
- **MP.4** Model with mathematics. (K-2-ETS1-1), (K-2-ETS1-3)
- **MP.5** Use appropriate tools strategically. (K-2-ETS1-1), (K-2-ETS1-3)
- **2.MD.D.10** Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. (K-2-ETS1-1), (K-2-ETS1-3)

Grade 3

3-PS2: Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

- **3-PS2-1** Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.
  [Clarification Statement: Examples could include an unbalanced force on one side of a ball can make it start moving; and, balanced forces pushing on a box from both sides will not produce any motion at all. Qualitative and conceptual, but not quantitative addition of forces, are used at this level. [Assessment Boundary: Assessment is limited to one variable at a time: number, size, or direction of forces. Assessment does not include quantitative force size, only qualitative and relative. Assessment is limited to gravity being addressed as a force that pulls objects down.]
- **3-PS2-2** Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.
  [Clarification Statement: Examples of motion with a predictable pattern could include a child swinging in a swing, a ball rolling back and forth in a bowl, and two children on a see-saw.] [Assessment Boundary: Assessment does not include technical terms such as period and frequency.]
- **3-PS2-3** Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.
  [Clarification Statement: Examples of an electric force could include the force on hair from an electrically charged balloon and the electrical forces between a charged rod and pieces of paper; examples of a magnetic force could include the force between two permanent magnets, the force between an electromagnet and steel paperclips, and the force exerted by one magnet versus the force exerted by two magnets. Examples of cause and effect relationships could include how the distance between objects affects strength of the force and how the orientation of magnets affects the direction of the magnetic force.] [Assessment Boundary: Assessment is limited to forces produced by objects that can be manipulated by students, and electrical interactions are limited to static electricity.]
- **3-PS2-4** Define a simple design problem that can be solved by applying scientific ideas about magnets.
  [Clarification Statement: Examples of problems could include constructing a latch to keep a door shut and creating a device to keep two moving objects from touching each other.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in grades 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships. ▪ Ask questions that can be investigated based on patterns such as cause and effect relationships. (3-PS2-3)	**PS2.A: Forces and Motion** ▪ Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not	**Patterns** ▪ Patterns of change can be used to make predictions. (3-PS2-2) **Cause and Effect** ▪ Cause and effect relationships are routinely identified. (3-PS2-1) ▪ Cause and effect relationships are routinely identified, tested, and used to explain change. (3-PS2-3)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
▪ Define a simple problem that can be solved through the development of a new or improved object or tool. (3-PS2-4) **Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. ▪ Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (3-PS2-1) ▪ Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (3-PS2-2)	quantitative addition of forces, are used at this level.) (3-PS2-1) ▪ The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.) (3-PS2-2) **PS2.B: Types of Interactions** ▪ Objects in contact exert forces on each other. (3-PS2-1) ▪ Electric and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other. (3-PS2-3), (3-PS2-4)	***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** ▪ Scientific discoveries about the natural world can often lead to new and improved technologies, which are developed through the engineering design process. (3-PS2-4) ***Connections to Nature of Science*** **Science Knowledge is Based on Empirical Evidence** ▪ Science findings are based on recognizing patterns. (3-PS2-2) **Scientific Investigations Use a Variety of Methods** ▪ Science investigations use a variety of methods, tools, and techniques. (3-PS2-1)

Connections to other DCIs in third grade:

N/A

Articulation of DCIs across grade levels:

- **K-2-ETS1.A** (K-PS2-2), (K-ESS3-2)
- **K.PS2.A** (3-PS2-1)
- **K.PS2.B** (3-PS2-1)
- **K.PS3.C** (3-PS2-1)
- **K.ETS1.A** (3-PS2-4)
- **1.ESS1.A** (3-PS2-2)
- **4.PS4.A** (3-PS2-2)
- **4.ETS1.A** (3-PS2-4)
- **5.PS2.B** (3-PS2-1)
- **MS.PS2.A** (3-PS2-1), (3-PS2-2)
- **MS.PS2.B** (3-PS2-3), (3-PS2-4)
- **MS.ESS1.B** (3-PS2-1), (3-PS2-2)
- **MS.ESS2.C** (3-PS2-1)
- **K-2-ETS1.C** (2-ESS2-1)

Connections to NJSLS - English Language Arts

- **RI.3.1** Ask and answer questions, and make relevant connections to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. (3-PS2-1), (3-PS2-3)
- **RI.3.3** Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect. (3-PS2-3)
- **RI.3.8** Describe the logical connection between particular sentences and paragraphs in a text (e.g., comparison, cause/effect, first/second/third in a sequence) to support specific points the author makes in a text. (3-PS2-3)
- **W.3.7** Conduct short research projects that build knowledge about a topic. (3-PS2-1), (3-PS2-2)
- **W.3.8** Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories. (3-PS2-1), (3-PS2-2)
- **SL.3.3** Ask and answer questions about information from a speaker, offering appropriate elaboration and detail. (3-PS2-3)

Connections to NJSLS - Mathematics

- **MP.2** Reason abstractly and quantitatively. (3-PS2-1)
- **MP.5** Use appropriate tools strategically. (3-PS2-1)
- **3.MD.A.2** Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem. (3-PS2-1)

3-LS1: From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can:

- **3-LS1-1** Develop models to describe that organisms have unique and diverse life cycles, but all have in common birth, growth, reproduction, and death.
  [Clarification Statement: Changes organisms go through during their life form a pattern.] [Assessment Boundary: Assessment of plant life cycles is limited to those of flowering plants. Assessment does not include details of human reproduction.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in grades 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships. ▪ Ask questions that can be investigated based on patterns such as cause and effect relationships. (3-PS2-3) ▪ Define a simple problem that can be solved through the development of a new or improved object or tool. (3-PS2-4) **Developing and Using Models** Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. ▪ Develop models to describe phenomena. (3-LS1-1)	**LS1.B: Growth and Development of Organisms** ▪ Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles. (3-LS1-1)	**Patterns** ▪ Patterns of change can be used to make predictions. (3-LS1-1) ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** ▪ Science findings are based on recognizing patterns. (3-LS1-1)

Connections to other DCIs in third grade:

N/A

Articulation of DCIs across grade levels:

- **MS.LS1.B** (3-LS1-1)

Connections to NJSLS - English Language Arts

- **RI.3.7** Use information gained from illustrations (e.g., maps, photographs) and the words in a text to demonstrate understanding of the text (e.g., where, when, why, and how key events occur). (3-LS1-1)
- **SL.3.5** Create engaging audio recordings of stories or poems that demonstrate fluid reading at an understandable pace; add visual displays when appropriate to emphasize or enhance certain facts or details. (3-LS1-1)

Connections to NJSLS - Mathematics

- **MP.4** Model with mathematics. (3-LS1-1)
- **3.NBT** Number and Operations in Base Ten (3-LS1-1)
- **3.NF** Number and Operations—Fractions (3-LS1-1)

3-LS2: Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

- **3-LS2-1** Construct an argument that some animals form groups that help members survive.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K–2 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 an argument with evidence, data, and/or a model. (3-LS2-1)	**LS2.D: Social Interactions and Group Behavior** ▪ Being part of a group helps animals obtain food, defend themselves, and cope with changes. Groups may serve different functions and vary dramatically in size (3-LS2-1)	**Cause and Effect** ▪ Cause and effect relationships are routinely identified and used to explain change. (3-LS2-1)

Connections to other DCIs in third grade:

N/A

Articulation of DCIs across grade levels:

- **1.LS1.B** (3-LS2-1)
- **MS.LS2.A** (3-LS2-1)
- **MS.LS1.B** (3-LS1-1)

Connections to NJSLS - English Language Arts

- **RI.3.1** Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. (3-LS2-1)
- **RI.3.3** Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect. (3-LS2-1)

Connections to NJSLS - Mathematics

- **MP.4** Model with mathematics. (3-LS2-1)
- **3.NBT** Number and Operations in Base Ten (3-LS2-1)

3-LS3: Heredity: Inheritance and Variation of Traits

Students who demonstrate understanding can:

- **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.
  [Clarification Statement: Patterns are the similarities and differences in traits shared between offspring and their parents, or among siblings. Emphasis is on organisms other than humans.] [Assessment Boundary: Assessment does not include genetic mechanisms of inheritance and prediction of traits. Assessment is limited to non-human examples.]

3-LS3-2 Use evidence to support the explanation that traits can be influenced by the environment.
[Clarification Statement: Examples of the environment affecting a trait could include normally tall plants grown with insufficient water are stunted; and, a pet dog that is given too much food and little exercise may become overweight.].

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. Clarification: When possible and feasible, digital tools should be used. ▪ Analyze and interpret data to make sense of phenomena using logical reasoning. (3-LS3-1) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. ▪ Use evidence (e.g., observations, patterns) to support an explanation. (3-LS3-2)	**LS3.A: Inheritance of Traits** ▪ Many characteristics of organisms are inherited from their parents. (3-LS3-1) ▪ Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment. (3-LS3-2) **LS3.B: Variation of Traits** ▪ Different organisms vary in how they look and function because they have different inherited information. (3-LS3-1) ▪ The environment also affects the traits that an organism develops. (3-LS3-2)	**Patterns** ▪ Similarities and differences in patterns can be used to sort and classify natural phenomena. (3-LS3-1) **Cause and Effect** ▪ Cause and effect relationships are routinely identified and used to explain change. (3-LS3-2)

Connections to other DCIs in third grade:

N/A

Articulation of DCIs across grade levels:

- **1.LS3.A** (3-LS3-1)
- **1.LS3.B** (3-LS3-1)
- **MS.LS1.B** (3-LS3-2)
- **MS.LS3.A** (3-LS3-1)
- **MS.LS3.B** (3-LS3-1)

Connections to NJSLS - English Language Arts

- **RI.3.1** Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. (3-LS2-1)
- **RI.3.2** Determine the main idea of a text; recount the key details and explain how they support the main idea. (3-LS3-1), (3-LS3-2)
- **RI.3.3** Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect. (3-LS3-1), (3-LS3-2)
- **W.3.2** Write informative/explanatory texts to examine a topic and convey ideas and information clearly. (3-LS3-1), (3-LS3-2)
- **SL.3.4** Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace. (3-LS3-1), (3-LS3-2

Connections to NJSLS - Mathematics

- **MP.2** Reason abstractly and quantitatively. (3-LS3-1), (3-LS3-2)
- **MP.4** Model with mathematics. (3-LS3-1), (3-LS3-2)
- **3.MD.B.4** Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units—whole numbers, halves, or quarters. (3-LS3-1), (3-LS3-2)

3-LS4: Biological Evolution: Unity and Diversity

Students who demonstrate understanding can:

- **3-LS4-1** Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.
  [Clarification Statement: Examples of data could include type, size, and distributions of fossil organisms. Examples of fossils and environments could include marine fossils found on dry land, tropical plant fossils found in Arctic areas, and fossils of extinct organisms.] [Assessment Boundary: Assessment does not include identification of specific fossils or present plants and animals. Assessment is limited to major fossil types and relative ages.]
- **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.
  [Clarification Statement: Examples of cause and effect relationships could be plants that have larger thorns than other plants may be less likely to be eaten by predators; and, animals that have better camouflage coloration than other animals may be more likely to survive and therefore more likely to leave offspring.]
- **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.
  [Clarification Statement: Examples of evidence could include needs and characteristics of the organisms and habitats involved. The organisms and their habitat make up a system in which the parts depend on each other.]
- **3-LS4-4** Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.
  [Clarification Statement: Examples of environmental changes could include changes in land characteristics, water distribution, temperature, food, and other organisms.] [Assessment Boundary: Assessment is limited to a single environmental change. Assessment does not include the greenhouse effect or climate change.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in 3–5 builds on K–2 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. ▪ Analyze and interpret data to make sense of phenomena using logical reasoning. (3-LS4-1) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to	**LS2.C: Ecosystem Dynamics, Functioning, and Resilience** ▪ When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die. *(secondary to 3-LS4-4)* **LS4.A: Evidence of Common Ancestry and Diversity** ▪ Some kinds of plants and animals that once lived on Earth are no longer found anywhere. (3-LS4-1)	**Cause and Effect** ▪ Cause and effect relationships are routinely identified and used to explain change. (3-LS4-2), (3-LS4-3) **Scale, Proportion, and Quantity** ▪ Observable phenomena exist from very short to very long time periods. (3-LS4-1) **Systems and System Models** ▪ A system can be described in terms of its components and their interactions. (3-LS4-4)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. ▪ Use evidence (e.g., observations, patterns) to construct an explanation. (3-LS4-2) **Engaging in Argument from Evidence** Engaging in argument from evidence in 3–5 builds on K–2 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 an argument with evidence. (3-LS4-3) ▪ Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem. (3-LS4-4)	▪ Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments. (3-LS4-1) **LS4.B: Natural Selection** ▪ Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing. (3-LS4-2) **LS4.C: Adaptation** ▪ For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all. (3-LS4-3) **LS4.D: Biodiversity and Humans** ▪ Populations live in a variety of habitats and change in those habitats affects the organisms living there. (3-LS4-4)	***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** ▪ Knowledge of relevant scientific concepts and research findings is important in engineering. (3-LS4-4) ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ▪ Science assumes consistent patterns in natural systems. (3-LS4-1)

Connections to other DCIs in third grade:

- **3.LS4.C** (3-LS4-2)
- **3.ESS2.D** (3-LS4-3)
- **3.ESS3.B** (3-LS4-4)

Articulation of DCIs across grade levels:

- **K.ESS3.A** (3-LS4-3), (3-LS4-4)
- **K.ETS1.A** (3-LS4-4)
- **1.LS3.A** (3-LS4-2)
- **2.LS2.A** (3-LS4-3), (3-LS4-4)
- **2.LS4.D** (3-LS4-3), (3-LS4-4)
- **4.ESS1.C** (3-LS4-1)
- **4.ESS3.B** (3-LS4-4)
- **4.ETS1.A** (3-LS4-4)
- **MS.LS2.A** (3-LS4-1), (3-LS4-2), (3-LS4-3), (3-LS4-4)
- **MS.LS2.C** (3-LS4-4)
- **MS.LS3.B** (3-LS4-2)
- **MS.LS4.A** (3-LS4-1)
- **MS.LS4.B** (3-LS4-2), (3-LS4-3)
- **MS.LS4.C** (3-LS4-3), (3-LS4-4)
- **MS.ESS1.C** (3-LS4-1), (3-LS4-3), (3-LS4-4)
- **MS.ESS2.B** (3-LS4-1)
- **MS.ESS3.C** (3-LS4-4)

Connections to NJSLS - English Language Arts

- **RI.3.1** Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. (3-LS2-1)
- **RI.3.2** Determine the main idea of a text; recount the key details and explain how they support the main idea. (3-LS3-1), (3-LS3-2)
- **RI.3.3** Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect. (3-LS3-1), (3-LS3-2)
- **W.3.2** Write informative/explanatory texts to examine a topic and convey ideas and information clearly. (3-LS3-1), (3-LS3-2)
- **SL.3.4** Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace. (3-LS3-1), (3-LS3-2

Connections to NJSLS - Mathematics

- **MP.2** Reason abstractly and quantitatively. (3-LS3-1), (3-LS3-2)
- **MP.4** Model with mathematics. (3-LS3-1), (3-LS3-2)
- **3.MD.B.4** Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units—whole numbers, halves, or quarters. (3-LS3-1), (3-LS3-2)

3-ESS2: Earth's Systems

Students who demonstrate understanding can:

- **3-ESS2-1** Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.
  [Clarification Statement: Examples of data could include average temperature, precipitation, and wind direction.] [Assessment Boundary: Assessment of graphical displays is limited to pictographs and bar graphs. Assessment does not include climate change.]

- **3-ESS2-1** Obtain and combine information to describe climates in different regions of the world.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in 3–5 builds on K–2 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. ▪ Represent data in tables and various graphical displays (bar graphs and pictographs) to reveal patterns that indicate relationships. (3-ESS2-1) **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluating the merit and accuracy of ideas and methods. ▪ Obtain and combine information from books and other reliable media to explain phenomena. (3-ESS2-2)	**ESS2.D: Weather and Climate** ▪ Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next. (3-ESS2-1) ▪ Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years. (3-ESS2-2)	**Patterns** ▪ Patterns of change can be used to make predictions. (3-ESS2-1), (3-ESS2-2)

Connections to other DCIs in third grade:

- **3.LS4.C** (3-LS4-2)
- **3.ESS2.D** (3-LS4-3)
- **3.ESS3.B** (3-LS4-4)

Articulation of DCIs across grade levels:

- **K.ESS3.A** (3-LS4-3), (3-LS4-4)
- **K.ETS1.A** (3-LS4-4)
- **1.LS3.A** (3-LS4-2)
- **2.LS2.A** (3-LS4-3), (3-LS4-4)
- **2.LS4.D** (3-LS4-3), (3-LS4-4)
- **4.ESS1.C** (3-LS4-1)
- **4.ESS3.B** (3-LS4-4)
- **4.ETS1.A** (3-LS4-4)
- **MS.LS2.A** (3-LS4-1), (3-LS4-2), (3-LS4-3), (3-LS4-4)
- **MS.LS2.C** (3-LS4-4)
- **MS.LS3.B** (3-LS4-2)
- **MS.LS4.A** (3-LS4-1)
- **MS.LS4.B** (3-LS4-2), (3-LS4-3)
- **MS.LS4.C** (3-LS4-3), (3-LS4-4)
- **MS.ESS1.C** (3-LS4-1), (3-LS4-3), (3-LS4-4)
- **MS.ESS2.B** (3-LS4-1)
- **MS.ESS3.C** (3-LS4-4)

Connections to NJSLS - English Language Arts

- **RI.3.1** Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. (3-LS2-1)
- **RI.3.2** Determine the main idea of a text; recount the key details and explain how they support the main idea. (3-LS3-1), (3-LS3-2)
- **RI.3.3** Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect. (3-LS3-1), (3-LS3-2)
- **W.3.2** Write informative/explanatory texts to examine a topic and convey ideas and information clearly. (3-LS3-1), (3-LS3-2)
- **SL.3.4** Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace. (3-LS3-1), (3-LS3-2)

Connections to NJSLS - Mathematics

- **MP.2** Reason abstractly and quantitatively. (3-LS3-1), (3-LS3-2)
- **MP.4** Model with mathematics. (3-LS3-1), (3-LS3-2)
- **3.MD.B.4** Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units—whole numbers, halves, or quarters. (3-LS3-1), (3-LS3-2)

3-ESS3: Earth and Human Activity

Students who demonstrate understanding can:

- **3-ESS3-1** Make a claim about the merit of a design solution that reduces the impacts of climate change and/or a weather-related hazard.
  [Clarification Statement: Examples of design solutions to weather-related hazards could include barriers to prevent flooding, wind resistant roofs, and lightning rods.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). ▪ Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem. (3-ESS3-1)	**ESS3.B: Natural Hazards** ▪ A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts. (3-ESS3-1) *(Note: This Disciplinary Core Idea is also addressed by 4-ESS3-2.)*	**Cause and Effect** ▪ Cause and effect relationships are routinely identified, tested, and used to explain change. (3-ESS3-1) ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Engineering, Technology, and Science on Society and the Natural World** ▪ Engineers improve existing technologies or develop new ones to increase their benefits (e.g., better artificial limbs), decrease known risks (e.g., seatbelts in cars), and meet societal demands (e.g., cell phones). (3-ESS3-1) ***Connections to Nature of Science*** **Science is a Human Endeavor** ▪ Science affects everyday life. (3-ESS3-1)

Connections to other DCIs in third grade:

N/A

Articulation of DCIs across grade levels:

- **K.ESS3.B** (3-ESS3-1)
- **K.ETS1.A** (3-ESS3-1)
- **4.ESS3.B** (3-ESS3-1)
- **4.ETS1.A** (3-ESS3-1)
- **MS.ESS3.B** (3-ESS3-1)

Connections to NJSLS - English Language Arts

- **RI.3.1** Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. (3-LS2-1)
- **W.3.7** Conduct short research projects that build knowledge about a topic. (3-ESS3-1)

Connections to NJSLS - Mathematics

- **MP.2** Reason abstractly and quantitatively. (3-LS3-1), (3-LS3-2)
- **MP.4** Model with mathematics. (3-LS3-1), (3-LS3-2)

3-5-ETS1: Engineering Design

Students who demonstrate understanding can:

- **3-5-ETS1-1** Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- **3-5-ETS1-2** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- **3-5-ETS1-3** Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in 3–5 builds on K–2 experiences and progresses to specifying qualitative relationships. ▪ Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. (3-5-ETS1-1) **Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. ▪ Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (3-5-ETS1-3) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables	**ETS1.A: Defining and Delimiting Engineering Problems** ▪ Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1) **ETS1.B: Developing Possible Solutions** ▪ Research on a problem, such as climate change, should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2) ▪ At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2) ▪ Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3)	***Connections to Engineering, Technology, and Applications of Science*** **Influence of Engineering, Technology, and Science on Society and the Natural World** ▪ People's needs and wants change over time, as do their demands for new and improved technologies. (3-5-ETS1-1) ▪ Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands. (3-5-ETS1-2)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
that describe and predict phenomena and in designing multiple solutions to design problems. ▪ Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem. (3-5-ETS1-2)	**ETS1.C: Optimizing the Design Solution** ▪ Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)	

Connections to other DCIs in third grade:

N/A

Connections to other DCIs in fourth grade:

- **3-5-ETS1.A** (4-4-PS3-4)
- **3-5-ETS1.B** (4-ESS3-2)
- **3-5-ETS1.B** (4-PS4-3)

Connections to other DCIs in fifth grade:

N/A

Articulation of DCIs across grade levels:

- **K-2.ETS1.A** (3-5-ETS1-1), (3-5-ETS1-2), (3-5-ETS1-3)
- **K-2.ETS1.B** (3-5-ETS1-2)
- **K-2.ETS1.C** (3-5-ETS1-2), (3-5-ETS1-3)
- **MS.ETS1.A** (3-5-ETS1-1)
- **MS.ETS1.B** (3-5-ETS1-1), (3-5-ETS1-2), (3-5-ETS1-3)
- **MS.ETS1.C** (3-5-ETS1-2), (3-5-ETS1-3)

Connections to NJSLS - English Language Arts

- **RI.5.1** Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. (3-5-ETS1-2)
- **RI.5.7** Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (3-5-ETS1-2)
- **RI.5.9** Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (3-5-ETS1-2)
- **W.5.7** Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (3-5-ETS1-1), (3-5-ETS1-3)

- **W.5.8** Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work and provide a list of sources. (3-5-ETS1-1), (3-5-ETS1-3)
- **W.5.9** Draw evidence from literary or informational texts to support analysis, reflection, and research. (3-5-ETS1-1), (3-5-ETS1-3)

Connections to NJSLS - Mathematics

- **MP.2** Reason abstractly and quantitatively. (3-5-ETS1-1), (3-5-ETS1-2), (3-5-ETS1-3)
- **MP.4** Model with mathematics. (3-5-ETS1-1), (3-5-ETS1-2), (3-5-ETS1-3)
- **MP.5** Use appropriate tools strategically. (3-5-ETS1-1), (3-5-ETS1-2), (3-5-ETS1-3)
- **3-5.OA** Operations and Algebraic Thinking (3-5-ETS1-1), (3-5-ETS1-2)

4-PS3: Energy

Students who demonstrate understanding can:

- **4-PS3-1** Use evidence to construct an explanation relating the speed of an object to the energy of that object. [Assessment Boundary: Assessment does not include quantitative measures of changes in the speed of an object or on any precise or quantitative definition of energy.]
- **4-PS3-2** Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. [Assessment Boundary: Assessment does not include quantitative measurements of energy.]
- **4-PS3-3** Ask questions and predict outcomes about the changes in energy that occur when objects collide. [Clarification Statement: Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact.] [Assessment Boundary: Assessment does not include quantitative measurements of energy.]
- **4-PS3-4** Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. [Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device.] [Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in grades 3–5 builds on K–2 experiences and progresses to specifying qualitative relationships. ▪ Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. (4-PS3-3) **Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. ▪ Make observations to produce data to serve as the basis for evidence	**PS3.A: Definitions of Energy** ▪ The faster a given object is moving, the more energy it possesses. (4-PS3-1) ▪ Energy can be moved from place to place by moving objects or through sound, light, or electric currents. (4-PS3-2), (4-PS3-3) **PS3.B: Conservation of Energy and Energy Transfer** ▪ Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. (4-PS3-2), (4-PS3-3)	**Energy and Matter** ▪ Energy can be transferred in various ways and between objects. (4-PS3-1), (4-PS3-2), (4-PS3-3), (4-PS3-4) ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering and Technology on Society and the Natural World** ▪ Engineers improve existing technologies or develop new ones. (4-PS3-4) ***Connections to Nature of Science*** **Science is a Human Endeavor** ▪ Most scientists and engineers work in teams. (4-PS3-4) ▪ Science affects everyday life. (4-PS3-4)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
for an explanation of a phenomenon or test a design solution. (4-PS3-2) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. ▪ Use evidence (e.g., measurements, observations, patterns) to construct an explanation. (4-PS3-1) ▪ Apply scientific ideas to solve design problems. (4-PS3-4)	▪ Light also transfers energy from place to place. (4-PS3-2) ▪ Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy. (4-PS3-2), (4-PS3-4) **PS3.C: Relationship Between Energy and Forces** ▪ When objects collide, the contact forces transfer energy so as to change the objects' motions. (4-PS3-3) **PS3.D: Energy in Chemical Processes and Everyday Life** ▪ The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use. (4-PS3-4) **ETS1.A: Defining Engineering Problems** ▪ Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. *(secondary to 4-PS3-4*	

Connections to other DCIs in fourth grade:

N/A

Articulation of DCIs across grade levels:

- **K.PS2.B** (4-PS3-3)
- **K.ETS1.A** (4-PS3-4)
- **2.ETS1.B** (4-PS3-4)
- **3.PS2.A** (4-PS3-3)
- **5.PS3.D** (4-PS3-4)
- **5.LS1.C** (4-PS3-4)
- **MS.PS2.A** (4-PS3-3)
- **MS.PS2.B** (4-PS3-2)
- **MS.PS3.A** (4-PS3-1), (4-PS3-2), (4-PS3-3), (4-PS3-4)
- **MS.PS3.B** (4-PS3-2), (4-PS3-3), (4-PS3-4)
- **MS.PS3.C** (4-PS3-3)
- **MS.PS4.B** (4-PS3-**2)**
- **MS.ETS1.B** (4-PS3-4)
- **MS.ETS1.C** (4-PS3-4)

Connections to NJSLS - English Language Arts

- **RI.4.1** Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text. (4-PS3-1)
- **RI.4.3** Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text. (4-PS3-1)
- **RI.4.9** Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably. (4-PS3-1)
- **W.4.2** Write informative/explanatory texts to examine a topic and convey ideas and information clearly. (4-PS3-1)
- **W.4.7** Conduct short research projects that build knowledge through investigation of different aspects of a topic. (4-PS3-2), (4-PS3-3), (4-PS3-4)
- **W.4.8** Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information and provide a list of sources. (4-PS3-1), (4-PS3-2), (4-PS3-3), (4-PS3-4)
- **W.4.9** Draw evidence from literary or informational texts to support analysis, reflection, and research. (4-PS3-1)

Connections to NJSLS - Mathematics

- **4.OA.A.3** Solve multistep word problems posed with whole numbers and having whole-number answers using the four operations, including problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding. (4-PS3-4)

4- PS4: Waves and their Applications in Technologies for Information Transfer

Students who demonstrate understanding can:

- **4-PS4-1** Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.
  [Clarification Statement: Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves.] [Assessment Boundary: Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.]
- **4-PS4-2** Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.
  [Assessment Boundary: Assessment does not include knowledge of specific colors reflected and seen, the cellular mechanisms of vision, or how the retina works.]
- **4-PS4-3** Generate and compare multiple solutions that use patterns to transfer information.
  [Clarification Statement: Examples of solutions could include drums sending coded information through sound waves, using a grid of 1's and 0's representing black and white to send information about a picture, and using Morse code to send text.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. ▪ Develop a model using an analogy, example, or abstract representation to describe a scientific principle. (4-PS4-1) ▪ Develop a model to describe phenomena. (4-PS4-2) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. ▪ Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. (4-PS4-3)	**PS3.A: Definitions of Energy** ▪ The faster a given object is moving, the more energy it possesses. (4-PS3-1) ▪ Energy can be moved from place to place by moving objects or through sound, light, or electric currents. (4-PS3-2), (4-PS3-3) **PS3.B: Conservation of Energy and Energy Transfer** ▪ Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. (4-PS3-2), (4-PS3-3) ▪ Light also transfers energy from place to place. (4-PS3-2) ▪ Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound,	**Patterns** ▪ Similarities and differences in patterns can be used to sort and classify natural phenomena. (4-PS4-1) ▪ Similarities and differences in patterns can be used to sort and classify designed products. (4-PS4-3) **Cause and Effect** ▪ Cause and effect relationships are routinely identified. (4-PS4-2) ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** ▪ Knowledge of relevant scientific concepts and research findings is important in engineering. (4-PS4-3) ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence**

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
	heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy. (4-PS3-2), (4-PS3-4) **PS3.C: Relationship Between Energy and Forces** ▪ When objects collide, the contact forces transfer energy so as to change the objects' motions. (4-PS3-3) **PS3.D: Energy in Chemical Processes and Everyday Life** ▪ The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use. (4-PS3-4) **ETS1.A: Defining Engineering Problems** ▪ Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. *(secondary to 4-PS3-4)*	▪ Science findings are based on recognizing patterns. (4-PS4-1)

Connections to other DCIs in fourth grade:

- **4.PS3.A** (4-PS4-1)
- **4.PS3.B** (4-PS4-1)

Articulation of DCIs across grade levels:

- **K.ETS1.A** (4-PS4-3)
- **1.PS4.B** (4-PS4-2)
- **1.PS4.C** (4-PS4-3)
- **2.ETS1.B** (4-PS4-3)
- **2.ETS1.C** (4-PS4-3)
- **3.PS2.A** (4-PS4-3)
- **MS.PS4.A** (4-PS4-1)
- **MS.PS4.B** (4-PS4-2)

- **MS.PS4.C** (4-PS4-3)
- **MS.LS1.D** (4-PS4-2)
- **MS.ETS1.B** (4-PS4-3)

Connections to NJSLS - English Language Arts

- **RI.4.1** Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text. (4-PS4-3)
- **RI.4.9** Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably. (4-PS4-3)
- **SL.4.5** Add audio recordings and visual displays to presentations when appropriate to enhance the development of main ideas or themes. (4-PS4-1), (4-PS4-2)

Connections to NJSLS - Mathematics

MP.4 Model with mathematics. (4-PS4-1), (4-PS4-2)

4.G.A.1 Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures. (4-PS4-1), (4-PS4-2)

4-LS1: From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can:

- **4-LS1-1** Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
  [Clarification Statement: Examples of structures could include thorns, stems, roots, colored petals, heart, stomach, lung, brain, and skin.] [Assessment Boundary: Assessment is limited to macroscopic structures within plant and animal systems.]
- **4-LS1-2** Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.
  [Clarification Statement: Emphasis is on systems of information transfer.] [Assessment Boundary: Assessment does not include the mechanisms by which the brain stores and recalls information or the mechanisms of how sensory receptors function.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. ▪ Use a model to test interactions concerning the functioning of a natural system. (4-LS1-2) **Engaging in Argument from Evidence** Engaging in argument from evidence in 3–5 builds on K–2 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 an argument with evidence, data, and/or a model. (4-LS1-1)	**LS1.A: Structure and Function** ▪ Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1) **LS1.D: Information Processing** ▪ Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions. (4-LS1-2)	**Systems and System Models** ▪ A system can be described in terms of its components and their interactions. (4-LS1-1), (4-LS1-2)

Connections to other DCIs in fourth grade:

N/A

Articulation of DCIs across grade levels:

- 1.LS1.A (4-LS1-1)
- 1.LS1.D (4-LS1-2)
- 3.LS3.B (4-LS1-1)
- MS.LS1.A (4-LS1-1), (4-LS1-2)
- MS.LS1.D (4-LS1-2)

Connections to NJSLS – English Language Arts

- **W.4.1** Write opinion pieces on topics or texts, supporting a point of view with reasons and information. (4-LS1-1)
- **SL.4.5** Add audio recordings and visual displays to presentations when appropriate to enhance the development of main ideas or themes. (4-LS1-2)

Connections to NJSLS – Mathematics

- **4.G.A.3** Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded across the line into matching parts. Identify line-symmetric figures and draw lines of symmetry. (4-LS1-1)

4-ESS1: Earth's Place in the Universe

Students who demonstrate understanding can:

- **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.
  [Clarification Statement: Examples of evidence from patterns could include rock layers with marine shell fossils above rock layers with plant fossils and no shells, indicating a change from land to water over time; and, a canyon with different rock layers in the walls and a river in the bottom, indicating that over time a river cut through the rock.] [Assessment Boundary: Assessment does not include specific knowledge of the mechanism of rock formation or memorization of specific rock formations and layers. Assessment is limited to relative time.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. ▪ Identify the evidence that supports particular points in an explanation. (4-ESS1-1)	**ESS1.C: The History of Planet Earth** ▪ 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. (4-ESS1-1)	**Patterns** ▪ Patterns can be used as evidence to support an explanation. (4-ESS1-1) ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ▪ Science assumes consistent patterns in natural systems. (4-ESS1-1)

Connections to other DCIs in fourth grade:

N/A

Articulation of DCIs across grade levels:

- **2.ESS1.C** (4-ESS1-1)
- **3.LS4.A** (4-ESS1-1)
- **MS.LS4.A** (4-ESS1-1)
- **MS.ESS1.C** (4-ESS1-1)
- **MS.ESS2.A** (4-ESS1-1)
- **MS.ESS2.B** (4-ESS1-1)

Connections to NJSLS – English Language Arts

- **W.4.7** Conduct short research projects that build knowledge through investigation of different aspects of a topic. (4-ESS1-1)
- **W.4.8** Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information and provide a list of sources. (4-ESS1-1)
- **W.4.9** Draw evidence from literary or informational texts to support analysis, reflection, and research. (4-ESS1-1)

Connections to NJSLS – Mathematics

- **MP.2** Reason abstractly and quantitatively. (4-ESS1-1)
- **MP.4** Model with mathematics. (4-ESS1-1)
- **4.MD.A.1** Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table. (4-ESS1-1)

4-ESS2: Earth's Systems

Students who demonstrate understanding can:

- **4-ESS2-1** Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.
  [Clarification Statement: Examples of variables to test could include angle of slope in the downhill movement of water, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow.] [Assessment Boundary: Assessment is limited to a single form of weathering or erosion.]
- **4-ESS2-1** Analyze and interpret data from maps to describe patterns of Earth's features.
  [Clarification Statement: Maps can include topographic maps of Earth's land and ocean floor, as well as maps of the locations of mountains, continental boundaries, volcanoes, and earthquakes.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. ▪ Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon. (4-ESS2-1) **Analyzing and Interpreting Data** Analyzing data in 3–5 builds on K–2 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. ▪ Analyze and interpret data to make sense of phenomena using logical reasoning. (4-ESS2-2)	**ESS2.A: Earth Materials and Systems** ▪ Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. (4-ESS2-1) **ESS2.B: Plate Tectonics and Large-Scale System Interactions** ▪ The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features areas of Earth. (4-ESS2-2) **ESS2.E: Biogeology** ▪ Living things affect the physical characteristics of their regions. (4-ESS2-1)	**Patterns** ▪ Patterns can be used as evidence to support an explanation. (4-ESS2-2) **Cause and Effect** ▪ Cause and effect relationships are routinely identified, tested, and used to explain change. (4-ESS2-1)

Connections to other DCIs in fourth grade:

N/A

Articulation of DCIs across grade levels:

- **2.ESS1.C** (4-ESS2-1)
- **2.ESS2.A** (4-ESS2-1)
- **2.ESS2.B** (4-ESS2-2)
- **2.ESS2.C** (4-ESS2-2)
- **5.ESS2.A** (4-ESS2-1)
- **5.ESS2.C** (4-ESS2-2)
- **MS.ESS1.C** (4-ESS2-2)
- **MS.ESS2.A** (4-ESS2-2)
- **MS.ESS2.B** (4-ESS2-2)

Connections to NJSLS – English Language Arts

- **RI.4.7** Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears. (4-ESS2-2)
- **W.4.7** Conduct short research projects that build knowledge through investigation of different aspects of a topic. (4-ESS2-1)
- **W.4.8** Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources. (4-ESS2-1)

Mathematics –*Connections to NJSLS – Mathematics*

- **MP.2** Reason abstractly and quantitatively. (4-ESS2-1)
- **MP.4** Model with mathematics. (4-ESS2-1)
- **MP.5** Use appropriate tools strategically. (4-ESS2-1)
- **4.MD.A.1** Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table. (4-ESS2-1)
- **4.MD.A.2** Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale. (4-ESS2-1), (4-ESS2-2)

4-ESS3: Earth and Human Activity

Students who demonstrate understanding can:

- **4-ESS3-1** Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.
  [Clarification Statement: Examples of renewable energy resources could include wind energy, water behind dams, and sunlight; non-renewable energy resources are fossil fuels and fissile materials. Examples of environmental effects could include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution from burning of fossil fuels.]
- **4-ESS3-2** Generate and compare multiple solutions to reduce the impacts of natural Earth processes and climate change have on humans.
  [Clarification Statement: Examples of solutions could include designing an earthquake resistant building and improving monitoring of volcanic activity.] [Assessment Boundary: Assessment is limited to earthquakes, floods, tsunamis, and volcanic eruptions.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. ▪ Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. (4-ESS3-2) **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluate the merit and accuracy of ideas and methods. ▪ Obtain and combine information from books and other reliable media to explain phenomena. (4-ESS3-1)	**ESS3.A: Natural Resources** ▪ Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not. (4-ESS3-1) **ESS3.B: Natural Hazards** ▪ A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. (4-ESS3-2) *(Note: This Disciplinary Core Idea can also be found in 3.WC.)* **ETS1.B: Designing Solutions to Engineering Problems** ▪ Testing a solution involves investigating how well it performs under a range of likely conditions. (secondary to 4-ESS3-2)	**Cause and Effect** ▪ Cause and effect relationships are routinely identified and used to explain change. (4-ESS3-1) ▪ Cause and effect relationships are routinely identified, tested, and used to explain change. (4-ESS3-2) **Connections to Engineering, Technology, and Applications of Science** **Interdependence of Science, Engineering, and Technology** ▪ Knowledge of relevant scientific concepts and research findings is important in engineering. (4-ESS3-1) **Influence of Science, Engineering and Technology on Society and the Natural World** ▪ Over time, people's needs and wants change, as do their demands for new and improved technologies. (4-ESS3-1) ▪ Engineers improve existing technologies or develop new ones to increase their benefits, to decrease known risks, and to meet societal demands. (4-ESS3-2)

Connections to other DCIs in fourth grade:

- **4.ETS1.C** (4-ESS3-2)

Articulation of DCIs across grade levels:

- **K.ETS1.A** (4-ESS3-2)
- **2.ETS1.B** (4-ESS3-2)
- **2.ETS1.C** (4-ESS3-2)
- **5.ESS3.C** (4-ESS3-1)
- **MS.PS3.D** (4-ESS3-1)
- **MS.ESS2.A** (4-ESS3-1), (4-ESS3-2)
- **MS.ESS3.A** (4-ESS3-1)
- **MS.ESS3.B** (4-ESS3-2)
- **MS.ESS3.C** (4-ESS3-1)
- **MS.ESS3.D** (4-ESS3-1)
- **MS.ETS1.B** (4-ESS3-2)

Connections to NJSLS – English Language Arts

- **RI.4.1** Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text. (4-ESS3-2)
- **RI.4.9** Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably. (4-ESS3-2)
- **W.4.7** Conduct short research projects that build knowledge through investigation of different aspects of a topic. (4-ESS3-1)
- **W.4.8** Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources. (4-ESS3-1)
- **W.4.9** Draw evidence from literary or informational texts to support analysis, reflection, and research. (4-ESS3-1)

Connections to NJSLS – Mathematics

- **MP.2** Reason abstractly and quantitatively. (4-ESS3-1), (4-ESS3-2)
- **MP.4** Model with mathematics. (4-ESS3-1), (4-ESS3-2)
- **4.OA.A.1** Interpret a multiplication equation as a comparison, e.g., interpret $35 = 5 \times 7$ as a statement that 35 is 5 times as many as 7 and 7 times as many as 5. Represent verbal statements of multiplicative comparisons as multiplication equations. (4-ESS3-1), (4-ESS3-2)

3-5-ETS1: Engineering Design

Students who demonstrate understanding can:

- **3-5-ETS1-1** Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- **3-5-ETS1-2** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- **3-5-ETS1-3** Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in 3–5 builds on K–2 experiences and progresses to specifying qualitative relationships. ▪ Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. (3-5-ETS1-1) **Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. ▪ Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (3-5-ETS1-3) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables	**ETS1.A: Defining and Delimiting Engineering Problems** ▪ Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1) **ETS1.B: Developing Possible Solutions** ▪ Research on a problem, such as climate change, should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2) ▪ At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2) ▪ Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3) **ETS1.C: Optimizing the Design Solution**	***Connections to Engineering, Technology, and Applications of Science*** **Influence of Engineering, Technology, and Science on Society and the Natural World** ▪ People's needs and wants change over time, as do their demands for new and improved technologies. (3-5-ETS1-1) ▪ Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands. (3-5-ETS1-2)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
that describe and predict phenomena and in designing multiple solutions to design problems. ▪ Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem. (3-5-ETS1-2)	▪ Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)	

Connections to other DCIs in fourth grade:

- **3-5-ETS1.B** (4-ESS3-2)
- **3-5-ETS1.C** (4-PS4-3)

Connections to other DCIs in fourth grade:

N/A

Articulation of DCIs across grade levels:

- **K-2.ETS1.A** (3-5-ETS1-1), (3-5-ETS1-2), (3-5-ETS1-3)
- **K-2.ETS1.B** (3-5-ETS1-2)
- **K-2.ETS1.C** (3-5-ETS1-2), (3-5-ETS1-3)
- **MS.ETS1.A** (3-5-ETS1-1)
- **MS.ETS1.B** (3-5-ETS1-1), (3-5-ETS1-2), (3-5-ETS1-3)
- **MS.ETS1.C** (3-5-ETS1-2), (3-5-ETS1-3)

Connections to NJSLS - English Language Arts

- **RI.5.1** Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. (3-5-ETS1-2)
- **RI.5.7** Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (3-5-ETS1-2)
- **RI.5.9** Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (3-5-ETS1-2)
- **W.5.7** Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (3-5-ETS1-1), (3-5-ETS1-3)
- **W.5.8** Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work and provide a list of sources. (3-5-ETS1-1), (3-5-ETS1-3)
- **W.5.9** Draw evidence from literary or informational texts to support analysis, reflection, and research. (3-5-ETS1-1), (3-5-ETS1-3)

Connections to NJSLS - Mathematics

- **MP.2** Reason abstractly and quantitatively. (3-5-ETS1-1), (3-5-ETS1-2), (3-5-ETS1-3)
- **MP.4** Model with mathematics. (3-5-ETS1-1), (3-5-ETS1-2), (3-5-ETS1-3)
- **MP.5** Use appropriate tools strategically. (3-5-ETS1-1), (3-5-ETS1-2), (3-5-ETS1-3)
- **3-5.OA** Operations and Algebraic Thinking (3-5-ETS1-1), (3-5-ETS1-2)

Grade 5

5-PS1: Matter and its Interactions

Students who demonstrate understanding can:

- **5-PS1-1** Develop a model to describe that matter is made of particles too small to be seen. [Clarification Statement: Examples of evidence supporting a model could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.] [Assessment Boundary: Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.]

- **5-PS1-2** Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved. [Clarification Statement: Examples of reactions or changes could include phase changes, dissolving, and mixing that form new substances.] [Assessment Boundary: Assessment does not include distinguishing mass and weight.]

- **5-PS1-3** Make observations and measurements to identify materials based on their properties. [Clarification Statement: Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility; density is not intended as an identifiable property.] [Assessment Boundary: Assessment does not include density or distinguishing mass and weight.]

- **5-PS1-4** Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. ▪ Develop a model to describe phenomena. (5-PS1-1) **Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. ▪ Conduct an investigation collaboratively to produce data to serve as the basis for evidence,	**PS1.A: Structure and Properties of Matter** ▪ Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) ▪ The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2) ▪ Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade	**Cause and Effect** ▪ Cause and effect relationships are routinely identified, tested, and used to explain change. (5-PS1-4) **Scale, Proportion, and Quantity** ▪ Natural objects exist from the very small to the immensely large. (5-PS1-1) ▪ Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. (5-PS1-2), (5-PS1-3) ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ▪ Science assumes consistent patterns in natural systems. (5-PS1-2)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
using fair tests in which variables are controlled and the number of trials considered. (5-PS1-4) ▪ Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon. (5-PS1-3) **Using Mathematics and Computational Thinking** Mathematical and computational thinking in 3–5 builds on K–2 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. ▪ Measure and graph quantities such as weight to address scientific and engineering questions and problems. (5-PS1-2)	level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.) (5-PS1-3) **PS1.B: Chemical Reactions** ▪ When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4) ▪ No matter what reaction or change in properties occurs, the total weight of the substances does not change. (Boundary: Mass and weight are not distinguished at this grade level.) (5-PS1-2)	

Connections to other DCIs in first grade:

N/A

Articulation of DCIs across grade levels:

- **3.PS2.A** (5-PS2-1)
- **3.PS2.B** (5-PS2-1)
- **MS.PS2.B** (5-PS2-1)
- **MS.ESS1.B (**5-PS2-1)
- **MS.ESS2.C** (5-PS2-1)

Connections to NJSLS – English Language Arts

- **RI.5.1** Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. (5-PS2-1)
- **RI.5.9** Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (5-PS2-1)
- **W.5.1** Write opinion pieces on topics or texts, supporting a point of view with reasons and information. (5-PS2-1)

Connections to NJSLS – Mathematics

N/A

5-PS2: Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

- **5-PS2-1** Support an argument that the gravitational force exerted by Earth on objects is directed down. [Clarification Statement: "Down" is a local description of the direction that points toward the center of the spherical Earth.] [Assessment Boundary: Assessment does not include mathematical representation of gravitational force.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). ▪ Support an argument with evidence, data, or a model. (5-PS2-1)	**PS2.B: Types of Interactions** ▪ The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center. (5-PS2-1)	**Cause and Effect** ▪ Cause and effect relationships are routinely identified and used to explain change. (5-PS2-1)

Connections to other DCIs in fifth grade:

N/A

Articulation of DCIs across grade levels:

- **3.PS2.A** (1-ESS1-1)
- **5.PS2.B** (1-ESS1-1), (1-ESS1-2)
- **5.ESS1.B** (1-ESS1-1), (1-ESS1-2)
- **MS.ESS2.C** (5-PS2-1)

Connections to NJSLS – English Language Arts

- **RI.5.1** Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. (5-PS2-1)
- **RI.5.9** Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (5-PS2-1)
- **W.5.1** Write opinion pieces on topics or texts, supporting a point of view with reasons and information. (5-PS2-1)

Connections to NJSLS – Mathematics

N/A

5-PS3: Energy

Students who demonstrate understanding can:

- **5-PS3-1.** Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.
[Clarification Statement: Examples of models could include diagrams, and flow charts.].

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. ▪ Use models to describe phenomena. (5-PS3-1)	**PS3.D: Energy in Chemical Processes and Everyday Life** ▪ The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1) **LS1.C: Organization for Matter and Energy Flow in Organisms** ▪ Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. (*secondary to 5-PS3-1*)	**Energy and Matter** ▪ Energy can be transferred in various ways and between objects. (5-PS3-1)

Connections to other DCIs in fifth grade:

N/A

Articulation of DCIs across grade levels:

- **K.LS1.C** (5-PS3-1)
- **2.LS2.A** (5-PS3-1)
- **4.PS3.A** (5-PS3-1)
- **4.PS3.B** (5-PS3-1)
- **4.PS3.D** (5-PS3-1)
- **MS.PS3.D** (5-PS3-1)
- **MS.PS4.B** (5-PS3-1)
- **MS.LS1.C** (5-PS3-1)
- **MS.LS2.B** (5-PS3-1)

Connections to NJSLS - English Language Arts

- **RI.5.7** Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (5-PS3-1)
- **SL.5.5** Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes. (5-PS3-1)

Connections to NJSLS - Mathematics

N/A

5-LS1: From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can:

- **5-LS1-1.** Support an argument that plants get the materials they need for growth chiefly from air and water. [Clarification Statement: Emphasis is on the idea that plant matter comes mostly from air and water, not from the soil.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). ▪ Support an argument with evidence, data, or a model. (5-LS1-1)	**LS1.C: Organization for Matter and Energy Flow in Organisms** ▪ Plants acquire their material for growth chiefly from air and water. (5-LS1-1)	**Energy and Matter** ▪ Matter is transported into, out of, and within systems. (5-LS1-1)

Connections to other DCIs in fifth grade:

- **5.PS1.A** (5-LS1-1)

Articulation of DCIs across grade levels:

- **K.LS1.C** (5-LS1-1)
- **2.LS2.A** (5-LS1-1)
- **MS.LS1.C** (5-LS1-1)

Connections to NJSLS – English Language Arts

- **RI.5.1** Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. (5-LS1-1)
- **RI.5.9** Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (5-LS1-1)
- **W.5.1** Write opinion pieces on topics or texts, supporting a point of view with reasons and information. (5-LS1-1)

Connections to NJSLS – Mathematics

- **MP.2** Reason abstractly and quantitatively. (5-LS1-1)
- **MP.4** Model with mathematics. (5-LS1-1)
- **MP.5** Use appropriate tools strategically. (5-LS1-1)
- **5.MD.A.1** Convert among different-sized standard measurement units within a given measurement system (e.g., convert 5 cm to 0.05 m), and use these conversions in solving multi-step, real world problems. (5-LS1-1)

5-LS2: Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

- **5-LS2-1.** Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
  [Clarification Statement: Emphasis is on the idea that matter that is not food (air, water, decomposed materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and the Earth.] [Assessment Boundary: Assessment does not include molecular explanations.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 3–5 builds on K–2 models and progresses to building and revising simple models and using models to represent events and design solutions. ▪ Develop a model to describe phenomena. (5-LS2-1)	**LS2.A: Interdependent Relationships in Ecosystems** ▪ The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1) **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** ▪ Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)	**Systems and System Models** ▪ A system can be described in terms of its components and their interactions. (5-LS2-1) ***Connections to Nature of Science*** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** ▪ Science explanations describe the mechanisms for natural events. (5-LS2-1)

Connections to other DCIs in fifth grade:

- **5.PS1.A** (5-LS2-1)
- **5.ESS2.A** (5-LS2-1)

Articulation of DCIs across grade levels:

- **2.PS1.A (5-LS2-1)**
- **2.LS4.D (5-LS2-1)**
- **4.ESS2.E (5-LS2-1)**
- **MS.PS3.D (5-LS2-1)**
- **MS.LS1.C (5-LS2-1)**
- **MS.LS2.A (5-LS2-1)**
- **MS.LS2.B (5-LS2-1)**

Connections to NJSLS – English Language Arts

- **RL.1.1** Ask and answer questions about key details in a text. (1-LS1-2)
- **RL.1.2** Identify the main topic and retell key details of a text. (1-LS1-2)
- **RL.1.10** With prompting and support, read and comprehend stories and poetry at grade level text complexity or above. (1-LS1-2)
- **W.1.7** Participate in shared research and writing projects (e.g., explore a number of "how-to" books on a given topic and use them to write a sequence of instructions). (1-LS1-1)

Connections to NJSLS – Mathematics

- **1.NBT.B.3** Compare two two-digit numbers based on the meanings of the tens and one digits, recording the results of comparisons with the symbols >, =, and <. (1-LS1-2)
- **1.NBT.C.4** Add within 100, including adding a two-digit number and a one-digit number, and adding a two-digit number and a multiple of 10, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning uses. Understand that in adding two-digit numbers, one adds tens and tens, ones and ones; and sometimes it is necessary to compose a ten. (1-LS1-2)
- **1.NBT.C.5** Given a two-digit number, mentally find 10 more or 10 less than the number, without having to count; explain the reasoning used. (1-LS1-2)
- **1.NBT.C.6** Subtract multiples of 10 in the range 10–90 from multiples of 10 in the range 10–90 (positive or zero differences), using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used. (1-LS1-2)

5- LS2: Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

- **5-LS2-1.** Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
  [Clarification Statement: Emphasis is on the idea that matter that is not food (air, water, decomposed materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and the Earth.] [Assessment Boundary: Assessment does not include molecular explanations.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 3–5 builds on K–2 models and progresses to building and revising simple models and using models to represent events and design solutions. ▪ Develop a model to describe phenomena. (5-LS2-1)	**LS2.A: Interdependent Relationships in Ecosystems** ▪ The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as “decomposers.” Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1) **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** ▪ Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)	**Systems and System Models** ▪ A system can be described in terms of its components and their interactions. (5-LS2-1) ***Connections to Nature of Science*** Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena ▪ Science explanations describe the mechanisms for natural events. (5-LS2-1)

Connections to other DCIs in fifth grade:

- **5.PS1.A** (5-LS2-1)
- **5.ESS2.A** (5-LS2-1)

Articulation of DCIs across grade levels:

- **2.PS1.A** (5-LS2-1)
- **2.LS4.D** (5-LS2-1)
- **4.ESS2.E** (5-LS2-1)
- **MS.PS3.D** (5-LS2-1)
- **MS.LS1.C** (5-LS2-1)
- **MS.LS2.A** (5-LS2-1)
- **MS.LS2.B** (5-LS2-1)

Connections to NJSLS – English Language Arts

- **RI.5.7** Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (5-LS2-1)
- **SL.5.5** Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes. (5-LS2-1)

Connections to NJSLS – Mathematics

- **MP.2** Reason abstractly and quantitatively. (5-LS2-1)
- **MP.4** Model with mathematics. (5-LS2-1)

5-ESS1: Earth's Place in the Universe

Students who demonstrate understanding can:

- **5-ESS1-1** Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth.
  [Assessment Boundary: Assessment is limited to relative distances, not sizes, of stars. Assessment does not include other factors that affect apparent brightness (such as stellar masses, age, stage).]
- **5-ESS1-2** Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.
  [Clarification Statement: Examples of patterns could include the position and motion of Earth with respect to the sun and selected stars that are visible only in particular months.] [Assessment Boundary: Assessment does not include causes of seasons.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in 3–5 builds on K–2 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. ▪ Represent data in graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships. (5-ESS1-2) **Engaging in Argument from Evidence** Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). ▪ Support an argument with evidence, data, or a model. (5-ESS1-1)	**ESS1.A: The Universe and its Stars** ▪ The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS1-1) **ESS1.B: Earth and the Solar System** ▪ The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2)	**Patterns** ▪ Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena. (5-ESS1-2) **Scale, Proportion, and Quantity** ▪ Natural objects exist from the very small to the immensely large. (5-ESS1-1)

Connections to other DCIs in fifth grade:

N/A

Articulation of DCIs across grade levels:

- **1.ESS1.A** (5-ESS1-2)
- **1.ESS1.B** (5-ESS1-2)
- **3.PS2.A** (5-ESS1-2)
- **MS.ESS1.A** (5-ESS1-1), (5-ESS1-2)
- **MS.ESS1.B** (5-ESS1-1),(5-ESS1-2)
- **5.PS2.B** (1-ESS1-1), (1-ESS1-2)
- **5.ESS1.B** (1-ESS1-1), (1-ESS1-2)

Connections to NJSLS – English Language Arts

- **RI.5.1** Quote accurately from a text and make relevant connections when explaining what the text says explicitly and when drawing inferences from the text. (5-ESS1-1)
- **RI.5.7** Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (5-ESS1-1)
- **RI.5.8** Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point(s). (5-ESS1-1)
- **RI.5.9** Integrate and reflect on (e.g. practical knowledge, historical/cultural context, and background knowledge) information from several texts on the same topic in order to write or speak about the subject knowledgeably. (5-ESS1-1)
- **W.5.1** Write opinion pieces on topics or texts, supporting a point of view with reasons and information. (5-ESS1-1)
  A. Introduce a topic or text clearly, state an opinion, and create an organizational structure in which ideas are logically grouped to support the writer's purpose.
  B. Provide logically ordered reasons that are supported by facts and details from text(s), quote directly from text when appropriate.
  C. Link opinion and reasons using words, phrases, and clauses (e.g., consequently, specifically).
  D. Provide a conclusion related to the opinion presented.
- **SL.5.5** Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes. (5-ESS1-2)

Connections to NJSLS – Mathematics

- **MP.2** Reason abstractly and quantitatively. *(5-ESS1-1),*(5-ESS1-2)
- **MP.4** Model with mathematics. *(5-ESS1-1),*(5-ESS1-2)
- **5.NBT.A.2** Explain patterns in the number of zeros of the product when multiplying a number by powers of 10, and explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10. *(5-ESS1-1)*
- **5.G.A.2** Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation. (5-ESS1-2)

5-ESS2: Earth's Systems

Students who demonstrate understanding can:

- **5-ESS2-1** Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
  [Clarification Statement: Examples could include the influence of the ocean on ecosystems, landform shape, and climate; the influence of the atmosphere on landforms and ecosystems through weather and climate; and the influence of mountain ranges on winds and clouds in the atmosphere. The geosphere, hydrosphere, atmosphere, and biosphere are each a system.] [Assessment Boundary: Assessment is limited to the interactions of two systems at a time.]
- **5-ESS2-1** Describe and graph the amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.
  [Assessment Boundary: Assessment is limited to oceans, lakes, rivers, glaciers, ground water, and polar ice caps, and does not include the atmosphere.].
- **K-2-ETS1-3** Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 3 - 5 builds on K - 2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. ▪ Develop a model using an example to describe a scientific principle. (5-ESS2-1) **Using Mathematics and Computational Thinking** ▪ Mathematical and computational thinking in 3 - 5 builds on K - 2 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 and graph quantities such as area and volume to address scientific questions. (5-ESS2-2)	**ESS2.A: Earth Materials and Systems** ▪ Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1) **ESS2.C: The Roles of Water in Earth's Surface Processes** ▪ Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. (5-ESS2-2)	**Scale, Proportion, and Quantity** ▪ Standard units are used to measure and describe physical quantities such as weight and volume. (5-ESS2-2) **Systems and System Models** ▪ A system can be described in terms of its components and their interactions. (5-ESS2-1)

Connections to other DCIs in fifth grade:

N/A

Articulation of DCIs across grade levels:

- **2.ESS2.A** (5-ESS2-1)
- **2.ESS2.C** (5-ESS2-2)
- **3.ESS2.D** (5-ESS2-1)
- **4.ESS2.A** (5-ESS2-1)
- **MS.ESS2.A** (5-ESS2-1)
- **MS.ESS2.C** (5-ESS2-1), (5-ESS2-2)
- **MS.ESS2.D** (5-ESS2-1)
- **MS.ESS3.A** (5-ESS2-2)

Connections to NJSLS - English Language Arts

- **RI.5.7** Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (5-ESS2-1),(5-ESS2-2)
- **W.5.8** Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. (5-ESS2-2)

Connections to NJSLS - Mathematics

- **MP.2** Reason abstractly and quantitatively. (5-ESS2-1), (5-ESS2-2)
- **MP.4** Model with mathematics. (5-ESS2-1), (5-ESS2-2)
- **5.G.A.2** Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation. (5-ESS2-1)

5-ESS3: Earth and Human Activity

Students who demonstrate understanding can:

- **5-ESS3-1** Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources, environment, and address climate change issues.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluating the merit and accuracy of ideas and methods. ▪ Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem. (5-ESS3-1)	**ESS3.C: Human Impacts on Earth Systems** ▪ Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. (5-ESS3-1)	**Systems and System Models** ▪ A system can be described in terms of its components and their interactions. (5-ESS3-1) ***Connections to Nature of Science*** **Science Addresses Questions About the Natural and Material World.** ▪ Science findings are limited to questions that can be answered with empirical evidence. (5-ESS3-1)

Connections to other DCIs in first grade:

N/A

Articulation of DCIs across grade levels:

- **MS.ESS3.A** (5-ESS3-1)
- **MS.ESS3.C** (5-ESS3-1)
- **MS.ESS3.D** (5-ESS3-1)

Connections to NJSLS – English Language Arts

- **RI.5.1** Quote accurately from a text and make relevant connections when explaining what the text says explicitly and when drawing inferences from the text. (5-ESS3-1)
- **RI.5.7** Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (5-ESS3-1)
- **RI.5.9** Integrate and reflect on (e.g. practical knowledge, historical/cultural context, and background knowledge) information from several texts on the same topic in order to write or speak about the subject knowledgeably. (5-ESS3-1)
- **W.5.8** Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. (5-ESS3-1)
- **W.5.9** Draw evidence from literary or informational texts to support analysis, reflection, and research. (5-ESS3-1)
- **SL.1.1** Participate in collaborative conversations with diverse partners about grade 1 topics and texts with peers and adults in small and larger groups. (1-PS4-1), (1-PS4-2), (1-PS4-3)

Connections to NJSLS – Mathematics

- **MP.2** Reason abstractly and quantitatively. (5-ESS3-1)
- **MP.4** Model with mathematics. (5-ESS3-1)
- **1.MD.A.2** Express the length of an object as a whole number of length units, by layering multiple copies of a shorter object (the length unit) end to end; understand that the length measurement of an object is the number of same-size length units that span it with no gaps or overlaps. (1-PS4-4)

3-5-ETS1: Engineering Design

Students who demonstrate understanding can:

- **3-5-ETS1-1** Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- **3-5-ETS1-2** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- **3-5-ETS1-3** Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships. ▪ Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. (3-5-ETS1-1) **Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. ▪ Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (3-5-ETS1-3) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions	**ETS1.A: Defining and Delimiting Engineering Problems** ▪ Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1) **ETS1.B: Developing Possible Solutions** ▪ Research on a problem, such as climate change, should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2) ▪ At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2) ▪ Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3) **ETS1.C: Optimizing the Design Solution** ▪ Different solutions need to be tested in order to determine which	**Influence of Engineering, Technology, and Science on Society and the Natural World** ▪ People's needs and wants change over time, as do their demands for new and improved technologies. (3-5-ETS1-1) ▪ Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands. (3-5-ETS1-2)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
to design problems. ▪ Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem. (3-5-ETS1-2)	of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)	

Connections to other DCIs in fifth grade:

Connections to Defining and Delimiting Engineering Problems include:

- **3-5-ETS1.A** (4-PS3-4)
- **3-5-ETS1.B** (4-PS3-4)
- **3-5-ETS1.C** (4-PS3-4)

Articulation of DCIs across grade levels:

- **K-2.ETS1.A** (3-5-ETS1-1), (3-5-ETS1-2), (3-5-ETS1-3)
- **K-2.ETS1.B** (3-5-ETS1-2)
- **K-2.ETS1.C** (3-5-ETS1-2), (3-5-ETS1-3)
- **MS.ETS1.A** (3-5-ETS1-1)
- **MS.ETS1.B** (3-5-ETS1-1), (3-5-ETS1-2), (3-5-ETS1-3)
- **MS.ETS1.C** (3-5-ETS1-2),(3-5-ETS1-3))

Connections to NJSLS – English Language Arts

- **RI.5.1** Quote accurately from a text and make relevant connections when explaining what the text says explicitly and when drawing inferences from the text. (3-5-ETS1-2)
- **RI.5.7** Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (3-5-ETS1-2)
- **RI.5.9** Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (3-5-ETS1-2)
- **W.5.7** Conduct short research projects that use several sources to build knowledge through investigation of different perspectives of a topic. (3-5-ETS1-1),(3-5-ETS1-3)
- **W.5.8** Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. (3-5-ETS1-1),(3-5-ETS1-3)
- **W.5.9** Draw evidence from literary or informational texts to support analysis, reflection, and research. (3-5-ETS1-1),(3-5-ETS1-3)

Connections to NJSLS – Mathematics

- **MP.2** Reason abstractly and quantitatively. (3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)
- **MP.4** Model with mathematics. (3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)
- **MP.5** Use appropriate tools strategically. (3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)
- **3-5.OA** Operations and Algebraic Thinking (3-5-ETS1-1),(3-5-ETS1-2)

STATE OF NEW JERSEY
DEPARTMENT OF EDUCATION

2020 New Jersey Student Learning Standards: Science – Grades 6 through 8

MS-PS1: Matter and its Interactions

Students who demonstrate understanding can:

- **MS-PS1-1** Develop models to describe the atomic composition of simple molecules and extended structures. [Clarification Statement: Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or diamonds. Examples of molecular-level models could include drawings, 3D ball and stick structures, or computer representations showing different molecules with different types of atoms.] [Assessment Boundary: Assessment does not include valence electrons and bonding energy, discussing the ionic nature of subunits of complex structures, or a complete depiction of all individual atoms in a complex molecule or extended structure.]
- **MS-PS1-2** Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
[Clarification Statement: Examples of reactions could include burning sugar or steel wool, fat reacting with sodium hydroxide, and mixing zinc with hydrogen chloride.] [Assessment Boundary: Assessment is limited to analysis of the following properties: density, melting point, boiling point, solubility, flammability, and odor.]
- **MS-PS1-3** Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.
[Clarification Statement: Emphasis is on natural resources that undergo a chemical process to form the synthetic material. Examples of new materials could include new medicine, foods, and alternative fuels.] [Assessment Boundary: Assessment is limited to qualitative information.]
- **MS-PS1-4** Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.
[Clarification Statement: Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawings and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.]
- **MS-PS1-5** Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.
[Clarification Statement: Emphasis is on law of conservation of matter and on physical models or drawings, including digital forms, that represent atoms.] [Assessment Boundary: Assessment does not include the use of atomic masses, balancing symbolic equations, or intermolecular forces.]
- **MS-PS1-6** Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.
[Clarification Statement: Emphasis is on the design, controlling the transfer of energy to the environment, and modification of a device using factors such as type and concentration of a substance. Examples of designs could involve chemical reactions such as dissolving ammonium

chloride or calcium chloride.] [Assessment Boundary: Assessment is limited to the criteria of amount, time, and temperature of substance in testing the device.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems. ▪ Develop a model to predict and/or describe phenomena. (MS-PS1-1), (MS-PS1-4) ▪ Develop a model to describe unobservable mechanisms. (MS-PS1-5) **Analyzing and Interpreting Data** Analyzing data in 6–8 builds on K–5 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. (MS-PS1-2) **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. ▪ Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints. (MS-PS1-6)	**PS1.A: Structure and Properties of Matter** ▪ Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS-PS1-1) ▪ Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-2), (MS-PS1-3) ▪ Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4) ▪ In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. (MS-PS1-4) ▪ Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (MS-PS1-1) ▪ The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (MS-PS1-4) **PS1.B: Chemical Reactions** ▪ Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of	**Patterns** ▪ Macroscopic patterns are related to the nature of microscopic and atomic-level structure. (MS-PS1-2) **Cause and Effect** ▪ Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS1-4) **Scale, Proportion, and Quantity** ▪ Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-PS1-1) **Energy and Matter** ▪ Matter is conserved because atoms are conserved in physical and chemical processes. (MS-PS1-5) ▪ The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS1-6) **Structure and 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. (MS-PS1-3) ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** ▪ Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems. (MS-PS1-3)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 6–8 builds on K–5 and progresses to evaluating the merit and validity of ideas and methods. ▪ Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. (MS-PS1-3)	the reactants. (MS-PS1-2), (MS-PS1-3), (MS-PS1-5) ▪ The total number of each type of atom is conserved, and thus the mass does not change. (MS-PS1-5) ▪ Some chemical reactions release energy, others store energy. (MS-PS1-6) **PS3.A: Definitions of Energy** ▪ The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. (*secondary to MS-PS1-4*) ▪ The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecule (whichever is the appropriate building block for the system's material). The details of that relationship depend on the type of atom or molecule and the interactions among the atoms in the material. Temperature is not a direct measure of a system's total thermal energy. The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system, and the state of the material. (secondary to MS-PS1-4) **ETS1.B: Developing Possible Solutions** ▪ A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (secondary to MS-PS1-6)	**Influence of Science, Engineering and Technology on Society and the Natural World** ▪ The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus, technology use varies from region to region and over time. (MS-PS1-3) ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** ▪ Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS1-2) **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** ▪ Laws are regularities or mathematical descriptions of natural phenomena. (MS-PS1-5)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
	ETS1.C: Optimizing the Design Solution ▪ Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of the characteristics may be incorporated into the new design. (*secondary to MS-PS1-6*) ▪ The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (*secondary to MS-PS1-6*)	

Connections to other DCIs in grades 6–8:

- **MS.PS3.D** (MS-PS1-2), (MS-PS1-6)
- **MS.LS1.C** (MS-PS1-2), (MS-PS1-5)
- **MS.LS2.A** (MS-PS1-3)
- **MS.LS2.B** (MS-PS1-5)
- **MS.LS4.D** (MS-PS1-3)
- **MS.ESS2.A** (MS-PS1-2), (MS-PS1-5)
- **MS.ESS2.C** (MS-PS1-1), (MS-PS1-4)
- **MS.ESS3.A** (MS-PS1-3)
- **MS.ESS3.C** (MS-PS1-3)

Articulation of DCIs across grade levels:

- **5.PS1.A** (MS-PS1-1)
- **5.PS1.B** (MS-PS1-2), (MS-PS1-5)
- **HS.PS1** (MS-PS1-1), (MS-PS1-3), (MS-PS1-4), (MS-PS1-6)
- **HS.PS1.B** (MS-PS1-2), (MS-PS1-4), (MS-PS1-5), (MS-PS1-6)
- **HS.PS3.A** (MS-PS1-4), (MS-PS1-6)
- **HS.PS3.B** (MS-PS1-6)
- **HS.PS3.D** (MS-PS1-6)
- **HS.LS2.A** (MS-PS1-3)
- **HS.LS4.D** (MS-PS1-3)
- **HS.ESS1.A** (MS-PS1-1)
- **HS.ESS3.A** (MS-PS1-3)

Connections to NJSLS – English Language Arts

- **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions (MS-PS1-2), (MS-PS1-3)
- **RST.6-8.3** Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS1-6)
- **RST.6-8.7** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-PS1-1), (MS-PS1-2), (MS-PS1-4), (MS-PS1-5)
- **WHST.6-8.7** 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. (MS-PS1-6)
- **WHST.6-8.8** 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. (MS-PS1-3)

Connections to NJSLS – Mathematics

- **MP.2** Reason abstractly and quantitatively. (MS-PS1-1), (MS-PS1-2), (MS-PS1-5)
- **MP.4** Model with mathematics. (MS-PS1-1), (MS-PS1-5)
- **6.RP.A.3** Use ratio and rate reasoning to solve real-world and mathematical problems. (MS-PS1-1), (MS-PS1-2), (MS-PS1-5)
- **6.NS.C.5** Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. (MS-PS1-4)
- **8.EE.A.3** Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. (MS-PS1-1)
- **6.SP.B.4** Display numerical data in plots on a number line, including dot plots, histograms, and box plots. (MS-PS1-2)
- **6.SP.B.5** Summarize numerical data sets in relation to their context (MS-PS1-2)

MS-PS2: Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

- **MS-PS2-1** Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.
  [Clarification Statement: Examples of practical problems could include the impact of collisions between two cars, between a car and stationary objects, and between a meteor and a space vehicle.] [Assessment Boundary: Assessment is limited to vertical or horizontal interactions in one dimension.]
- **MS-PS2-2** Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
  [Clarification Statement: Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton's Second Law), frame of reference, and specification of units.] [Assessment Boundary: Assessment is limited to forces and changes in motion in one-dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.]
- **MS-PS2-3** Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.
  [Clarification Statement: Examples of devices that use electric and magnetic forces could include electromagnets, electric motors, or generators. Examples of data could include the effect of the number of turns of wire on the strength of an electromagnet, or the effect of increasing the number or strength of magnets on the speed of an electric motor.] [Assessment Boundary: Assessment about questions that require quantitative answers is limited to proportional reasoning and algebraic thinking.]
- **MS-PS2-4** Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.
  [Clarification Statement: Examples of evidence for arguments could include data generated from simulations or digital tools; and charts displaying mass, strength of interaction, distance from the Sun, and orbital periods of objects within the solar system.] [Assessment Boundary: Assessment does not include Newton's Law of Gravitation or Kepler's Laws.]
- **MS-PS2-5** Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.
  [Clarification Statement: Examples of this phenomenon could include the interactions of magnets, electrically-charged strips of tape, and electrically-charged pith balls. Examples of investigations could include first-hand experiences or simulations.] [Assessment Boundary: Assessment is limited to electric and magnetic fields and limited to qualitative evidence for the existence of fields.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in grades 6–8 builds from grades K–5 experiences and	**PS2.A: Forces and Motion** ▪ For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the	**Cause and Effect** ▪ Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS2-3), (MS-PS2-5)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
progresses to specifying relationships between variables and clarifying arguments and models. ▪ Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles. (MS-PS2-3) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 6–8 builds from grades K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. ▪ Apply scientific ideas or principles to design an object, tool, process or system. (MS-PS2-1) **Engaging in Argument from Evidence** Engaging in argument from evidence in 6–8 builds from grades 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. ▪ Construct and present oral and written arguments 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. (MS-PS2-4)	second object exerts on the first, but in the opposite direction (Newton's third law). (MS-PS2-1) ▪ The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. (MS-PS2-2) ▪ All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared. (MS-PS2-2) **PS2.B: Types of Interactions** ▪ Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. (MS-PS2-3) ▪ Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun. (MS-PS2-4) ▪ Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object,	**Systems and System Models** ▪ Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems. (MS-PS2-1), (MS-PS2-4), **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. (MS-PS2-2) ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** ▪ Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS2-2), (MS-PS2-4)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
	or a ball, respectively). (MS-PS2-5)	

Connections to other DCIs in grades 6–8:

- **MS.PS3.A** (MS-PS2-2)
- **MS.PS3.B** (MS-PS2-2)
- **MS.PS3.C** (MS-PS2-1)
- **MS.ESS1.A** (MS-PS2-4)
- **MS.ESS1.B** (MS-PS2-4)
- **MS.ESS2.C** (MS-PS2-2), (MS-PS2-4)

Articulation of DCIs across grade levels:

- **3.PS2.A** (MS-PS2-1), (MS-PS2-2)
- **3.PS2.B** (MS-PS2-3), (MS-PS2-5)
- **5.PS2.B** (MS-PS2-4)
- **HS.PS2.A** (MS-PS2-1), (MS-PS2-2)
- **HS.PS2.B** (MS-PS2-3), (MS-PS2-4), (MS-PS2-5)
- **HS.PS3.A** (MS-PS2-5)
- **HS.PS3.B** (MS-PS2-2), (MS-PS2-5)
- **HS.PS3.C** (MS-PS2-5)
- **HS.ESS1.B** (MS-PS2-2), (MS-PS2-4)

Connections to NJSLS – English Language Arts

- **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions (MS-PS2-1), (MS-PS2-3)
- **RST.6-8.3** Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS2-1), (MS-PS2-2), (MS-PS2-5)
- **WHST.6-8.1** Write arguments focused on discipline-specific content. (MS-PS2-4)
- **WHST.6-8.7** 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. (MS-PS2-1), (MS-PS2-2), (MS-PS2-5)

Connections to NJSLS – Mathematics

- **MP.4** Model with mathematics. (MS-LS2-5)
- **6.RP.A.3** Use ratio and rate reasoning to solve real-world and mathematical problems. (MS-LS2-5)
- **6.EE.C.9** Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables and relate these to the equation. (MS-LS2-3)
- **6.SP.B.5** Summarize numerical data sets in relation to their context. (MS-LS2-2)

MS-PS3: Energy

Students who demonstrate understanding can:

- **MS-PS3-1** Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.
  [Clarification Statement: Emphasis is on descriptive relationships between kinetic energy and mass separately from kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different sizes of rocks downhill, and getting hit by a wiffle ball versus a tennis ball.]
- **MS-PS3-2** Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.
  [Clarification Statement: Emphasis is on relative amounts of potential energy, not on calculations of potential energy. Examples of objects within systems interacting at varying distances could include: the Earth and either a roller coaster cart at varying positions on a hill or objects at varying heights on shelves, changing the direction/orientation of a magnet, and a balloon with static electrical charge being brought closer to a classmate's hair. Examples of models could include representations, diagrams, pictures, and written descriptions of systems.] [Assessment Boundary: Assessment is limited to two objects and electric, magnetic, and gravitational interactions.]
- **MS-PS3-3** Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.
  [Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.]
- **MS-PS3-4** Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.
  [Clarification Statement: Examples of experiments could include comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass as they cool or heat in the environment, or the same material with different masses when a specific amount of energy is added.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.]
- **MS-PS3-5** Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object. [Clarification Statement: Examples of empirical evidence used in arguments could include an inventory or other representation of the energy before and after the transfer in the form of temperature changes or motion of object.] [Assessment Boundary: Assessment does not include calculations of energy.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems. ▪ Develop a model to describe unobservable mechanisms. (MS-PS3-2) **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 an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. (MS-PS3-4) **Analyzing and Interpreting Data** Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. ▪ Construct and interpret graphical displays of data to identify linear and nonlinear relationships. (MS-PS3-1)	**PS3.A: Definitions of Energy** ▪ Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. (MS-PS3-1) ▪ A system of objects may also contain stored (potential) energy, depending on their relative positions. (MS-PS3-2) ▪ Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS3-3), (MS-PS3-4) **PS3.B: Conservation of Energy and Energy Transfer** ▪ When the motion energy of an object changes, there is inevitably some other change in energy at the same time. (MS-PS3-5) ▪ The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment. (MS-PS3-4) ▪ Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS-PS3-3) **PS3.C: Relationship Between Energy and Forces** ▪ When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (MS-PS3-2) **ETS1.A: Defining and Delimiting an Engineering Problem** ▪ The more precisely a design task's criteria and constraints can be defined, the more likely it is that	**Scale, Proportion, and Quantity** ▪ Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. (MS-PS3-1), (MS-PS3-4) **Systems and System Models** ▪ Models can be used to represent systems and their interactions – such as inputs, processes, and outputs – and energy and matter flows within systems. (MS-PS3-2) **Energy and Matter** ▪ Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). (MS-PS3-5) ▪ The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS3-3) ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** ▪ Science knowledge is based upon logical and conceptual connections between evidence and explanations (MS-PS3-4), (MS-PS3-5)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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 ideas, principles, and theories. ▪ Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system. (MS-PS3-3) **Engaging in Argument from Evidence** Engaging in argument from evidence in 6–8 builds on 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 worlds. ▪ Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon. (MS-PS3-5)	the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. *(secondary to MS-PS3-3)* **ETS1.B: Developing Possible Solutions** ▪ A solution needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. *(secondary to MS-PS3-3)*	

Connections to other DCIs in grades 6–8:

- **MS.PS1.A** (MS-PS3-4)
- **MS.PS1.B** (MS-PS3-3)
- **MS.PS2.A** (MS-PS3-1), (MS-PS3-4), (MS-PS3-5)
- **MS.ESS2.A** (MS-PS3-3)
- **MS.ESS2.C** (MS-PS3-3), (MS-PS3-4)
- **MS.ESS2.D** (MS-PS3-3), (MS-PS3-4)
- **MS.ESS3.D** (MS-PS3-4)

Articulation of DCIs across grade levels:

- **4.PS3.B** (MS-PS3-1), (MS-PS3-3)
- **4.PS3.C** (MS-PS3-4), (MS-PS3-5)
- **HS.PS1.B** (MS-PS3-4)
- **HS.PS2.B** (MS-PS3-2)
- **HS.PS3.A** (MS-PS3-1), (MS-PS3-4), (MS-PS3-5)
- **HS.PS3.B** (MS-PS3-1), (MS-PS3-2), (MS-PS3-3), (MS-PS3-4), (MS-PS3-5)
- **HS.PS3.C** (MS-PS3-2)

Connections to NJSLS – English Language Arts

- **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions (MS-PS3-1), (MS-PS3-5)
- **RST.6-8.3** Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS3-3), (MS-PS3-4)
- **RST.6-8.7** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-PS3-1)
- **WHST.6-8.1** Write arguments focused on discipline content. (MS-PS3-5)
- **WHST.6-8.7** 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. (MS-PS3-3), (MS-PS3-4)
- **SL.8.5** Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-PS3-2)

Connections to NJSLS – Mathematics

- **MP.2** Reason abstractly and quantitatively. (MS-PS3-1), (MS-PS3-4), (MS-PS3-5)
- **6.RP.A.1** Understand the concept of ratio and use ratio language to describe a ratio relationship between two quantities. (MS-PS3-1), (MS-PS3-5)
- **6.RP.A.2** Understand the concept of a unit rate a/b associated with a ratio $a:b$ with $b \neq 0$, and use rate language in the context of a ratio relationship. (MS-PS3-1)
- **7.RP.A.2** Recognize and represent proportional relationships between quantities. (MS-PS3-1), (MS-PS3-5)
- **8.EE.A.1** Know and apply the properties of integer exponents to generate equivalent numerical expressions. (MS-PS3-1)
- **8.EE.A.2** Use square root and cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that $\sqrt{2}$ is irrational. (MS-PS3-1)
- **8.F.A.3** Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. (MS-PS3-1), (MS-PS3-5)
- **6.SP.B.5** Summarize numerical data sets in relation to their context. (MS-PS3-4)

MS-PS4: Waves and Their Applications in Technologies for Information Transfer

Students who demonstrate understanding can:

- **MS-PS4-1** Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.
  [Clarification Statement: Emphasis is on describing waves with both qualitative and quantitative thinking.] [Assessment Boundary: Assessment does not include electromagnetic waves and is limited to standard repeating waves.]
- **MS-PS4-1** Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.
  [Clarification Statement: Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions.] [Assessment Boundary: Assessment is limited to qualitative applications pertaining to light and mechanical waves.]
- **MS-PS4-3** Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals. [Clarification Statement: Emphasis is on a basic understanding that waves can be used for communication purposes. Examples could include using fiber optic cable to transmit light pulses, radio wave pulses in wifi devices, and conversion of stored binary patterns to make sound or text on a computer screen.] [Assessment Boundary: Assessment does not include binary counting. Assessment does not include the specific mechanism of any given device.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 6–8 builds on K–5 and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. ▪ Develop and use a model to describe phenomena. (MS-PS4-2) **Using Mathematics and Computational Thinking** Mathematical and computational thinking at the 6–8 builds on K–5 and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments. ▪ Use mathematical representations to describe and/or support scientific	**PS4.A: Wave Properties** ▪ A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1) ▪ A sound wave needs a medium through which it is transmitted. (MS-PS4-2) **PS4.B: Electromagnetic Radiation** ▪ When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light. (MS-PS4-2) ▪ The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends. (MS-PS4-2) ▪ A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending	**Patterns** ▪ Graphs and charts can be used to identify patterns in data. (MS-PS4-1) **Structure and 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. (MS-PS4-2) ▪ Structures can be designed to serve particular functions. (MS-PS4-3) ***Connections to Engineering,*** Technology***, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** ▪ Technologies extend the measurement, exploration, modeling, and computational

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
	of light at a surface between media. (MS-PS4-2) ▪ However, because light can travel through space, it cannot be a matter wave, like sound or water waves. (MS-PS4-2) **PS4.C: Information Technologies and Instrumentation** ▪ Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. (MS-PS4-3)	capacity of scientific investigations. (MS-PS4-3)

Connections to other DCIs in grades 6–8:

- **MS.LS1.D** (MS-PS4-2)

Articulation of DCIs across grade levels:

- **4.PS3.A** (MS-PS4-1)
- **4.PS3.B** (MS-PS4-1)
- **4.PS4.A** (MS-PS4-1)
- **4.PS4.B** (MS-PS4-2)
- **4.PS4.C** (MS-PS4-3)
- **HS.PS4.A** (MS-PS4-1), (MS-PS4-2), (MS-PS4-3)
- **HS.PS4.B** (MS-PS4-1), (MS-PS4-2)
- **HS.PS4.C** (MS-PS4-3)
- **HS.ESS1.A** (MS-PS4-2)
- **HS.ESS2.A** (MS-PS4-2)
- **HS.ESS2.C** (MS-PS4-2)
- **HS.ESS2.D** (MS-PS4-2)

Connections to NJSLS - English Language Arts

- **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts. (MS-PS4-3)
- **RST.6-8.2** Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. (MS-PS4-3)
- **RST.6-8.9** Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-PS4-3)
- **WHST.6-8.9** Draw evidence from informational texts to support analysis, reflection, and research. (MS-PS4-3)
- **SL.8.5** Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-PS4-1), (MS-PS4-2)

Connections to NJSLS – Mathematics

- **MP.2** Reason abstractly and quantitatively. (MS-PS3-1), (MS-PS3-4), (MS-PS3-5)
- **6.RP.A.1** Understand the concept of ratio and use ratio language to describe a ratio relationship between two quantities. (MS-PS3-1), (MS-PS3-5)
- **6.RP.A.2** Understand the concept of a unit rate a/b associated with a ratio $a:b$ with $b \neq 0$, and use rate language in the context of a ratio relationship. (MS-PS3-1)
- **7.RP.A.2** Recognize and represent proportional relationships between quantities. (MS-PS3-1), (MS-PS3-5)
- **8.EE.A.1** Know and apply the properties of integer exponents to generate equivalent numerical expressions. (MS-PS3-1)
- **8.EE.A.2** Use square root and cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that $\sqrt{2}$ is irrational. (MS-PS3-1)
- **8.F.A.3** Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. (MS-PS3-1), (MS-PS3-5)
- **6.SP.B.5** Summarize numerical data sets in relation to their context. (MS-PS3-4)

MS-LS1: From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can:

- **MS-LS1-1** Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.
[Clarification Statement: Emphasis is on developing evidence that living things are made of cells, distinguishing between living and non-living things, and understanding that living things may be made of one cell or many and varied cells.]

- **MS-LS1-2** Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.
[Clarification Statement: Emphasis is on the cell functioning as a whole system and the primary role of identified parts of the cell, specifically the nucleus, chloroplasts, mitochondria, cell membrane, and cell wall.] [Assessment Boundary: Assessment of organelle structure/function relationships is limited to the cell wall and cell membrane. Assessment of the function of the other organelles is limited to their relationship to the whole cell. Assessment does not include the biochemical function of cells or cell parts.]

- **MS-LS1-3** Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.
[Clarification Statement: Emphasis is on the conceptual understanding that cells form tissues and tissues form organs specialized for particular body functions. Examples could include the interaction of subsystems within a system and the normal functioning of those systems.] [Assessment Boundary: Assessment does not include the mechanism of one body system independent of others. Assessment is limited to the circulatory, excretory, digestive, respiratory, muscular, and nervous systems.]

- **MS-LS1-4** Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.
[Clarification Statement: Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, herding of animals to protect young from predators, and vocalization of animals and colorful plumage to attract mates for breeding. Examples of animal behaviors that affect the probability of plant reproduction could include transferring pollen or seeds, and creating conditions for seed germination and growth. Examples of plant structures could include bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.]

- **MS-LS1-5** Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
[Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.]
[Assessment Boundary: Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.]

- **MS-LS1-6** Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.
  [Clarification Statement: Emphasis is on tracing movement of matter and flow of energy.]
  [Assessment Boundary: Assessment does not include the biochemical mechanisms of photosynthesis.]
- **MS-LS1-7** Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.
  [Clarification Statement: Emphasis is on describing that molecules are broken apart and put back together and that in this process, energy is released.] [Assessment Boundary: Assessment does not include details of the chemical reactions for photosynthesis or respiration.]
- **MS-LS1-8** Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.
  [Assessment Boundary: Assessment does not include mechanisms for the transmission of this information.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. ▪ Develop and use a model to describe phenomena. (MS-LS1-2) ▪ Develop a model to describe unobservable mechanisms. (MS-LS1-7) **Planning and Carrying Out Investigations** Planning and carrying out investigations in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions. ▪ Conduct an investigation to produce data to serve as the basis for evidence that meet the goals of an investigation. (MS-LS1-1)	**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). (MS-LS1-1) ▪ Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. (MS-LS1-2) ▪ 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. (MS-LS1-3) **LS1.B: Growth and Development of Organisms** ▪ Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4) ▪ Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized	**Cause and Effect** ▪ Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS1-8) ▪ Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-LS1-4), (MS-LS1-5) **Scale, Proportion, and Quantity** ▪ Phenomena that can be observed at one scale may not be observable at another scale. (MS-LS1-1) **Systems and System Models** ▪ Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. (MS-LS1-3) **Energy and Matter** ▪ Matter is conserved because atoms are conserved in physical and chemical processes. (MS-LS1-7) ▪ Within a natural system, the transfer of energy drives the motion and/or cycling of matter. (MS-LS1-6)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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. ▪ 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. (MS-LS1-5), (MS-LS1-6) **Engaging in Argument from Evidence** Engaging in argument from evidence in 6–8 builds on 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(s). ▪ Use an oral and written argument supported by evidence to support or refute an explanation or a model for a phenomenon. (MS-LS1-3) ▪ Use 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. (MS-LS1-4) **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 6–8 builds on K–5 experiences and	features for reproduction. (MS-LS1-4) ▪ Genetic factors as well as local conditions affect the growth of the adult plant. (MS-LS1-5) **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. (MS-LS1-6) ▪ 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. (MS-LS1-7) **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. The signals are then processed in the brain, resulting in immediate behaviors or memories. (MS-LS1-8) **PS3.D: Energy in Chemical Processes and Everyday Life** ▪ The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen. *(secondary to MS-LS1-6)* ▪ Cellular respiration in plants and animals involve chemical reactions	**Structure and Function** ▪ Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function. (MS-LS1-2) **Connections to Engineering, Technology, and Applications of Science** **Interdependence of Science, Engineering, and Technology** ▪ Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems. (MS-LS1-1) ***Connections to Nature of Science*** **Science is a Human Endeavor** ▪ Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas. (MS-LS1-3) **Scientific Knowledge is Based on Empirical Evidence** ▪ Science knowledge is based upon logical connections between evidence and explanations. (MS-LS1-6)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
progresses to evaluating the merit and validity of ideas and methods. ▪ Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. (MS-LS1-8)	with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials. *(secondary to MS-LS1-7)*	

Connections to other DCIs in grades 6–8:

- **MS.PS1.B** (MS-LS1-6), (MS-LS1-7)
- **MS.LS2.A** (MS-LS1-4), (MS-LS1-5)
- **MS.LS3.A** (MS-LS1-2)
- **MS.ESS2.A** (MS-LS1-6)

Articulation of DCIs across grade levels:

- **3.LS1.B** (MS-LS1-4), (MS-LS1-5)
- **3.LS3.A** (MS-LS1-5)
- **4.LS1.A** (MS-LS1-2)
- **4.LS1.D** (MS-LS1-8)
- **5.PS3.D** (MS-LS1-6), (MS-LS1-7)
- **5.LS1.C** (MS-LS1-6), (MS-LS1-7)
- **5.LS2.A** (MS-LS1-6)
- **5.LS2.B** (MS-LS1-6), (MS-LS1-7)
- **HS.PS1.B** (MS-LS1-6), (MS-LS1-7)
- **HS.LS1.A** (MS-LS1-1), (MS-LS1-2), (MS-LS1-3), (MS-LS1-8)
- **HS.LS2.A** (MS-LS1-4), (MS-LS1-5)
- **HS.LS2.B** (MS-LS1-6), (MS-LS1-7)
- **HS.LS2.D** (MS-LS1-4)
- **HS.ESS2.D** (MS-LS1-6)
- **HS.ESS3.A** (MS-PS1-3)

Connections to NJSLS – English Language Arts

- **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts. (MS-LS1-3), (MS-LS1-4), (MS-LS1-5), (MS-LS1-6)
- **RST.6-8.2** Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. (MS-LS1-5), (MS-LS1-6)
- **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. (MS-LS1-3), (MS-LS1-4)
- **WHST.6-8.1** Write arguments focused on discipline content. (MS-LS1-3), (MS-LS1-4)
- **WHST.6-8.2** Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-LS1-5), (MS-LS1-6)
- **WHST.6-8.7** 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. (MS-LS1-1)
- **WHST.6-8.8** 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. (MS-LS1-8)
- **WHST.6-8.9** Draw evidence from informational texts to support analysis, reflection, and research. (MS-LS1-5), (MS-LS1-6)
- **SL.8.5** Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-LS1-2, (MS-LS1-7)

Connections to NJSLS – Mathematics

- **6.EE.C.9** Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. (MS-LS1-1), (MS-LS1-2), (MS-LS1-3), (MS-LS1-6)
- **6.SP.A.2** Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape. (MS-LS1-4), (MS-LS1-5)
- **6.SP.B.4** Summarize numerical data sets in relation to their context. (MS-LS1-4), (MS-LS1-5)

MS-LS2: Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

- **MS-LS2-1** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
  [Clarification Statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.]
- **MS-LS2-2** Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.
  [Clarification Statement: Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial.]
- **MS-LS2-3** Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
  [Clarification Statement: Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.] [Assessment Boundary: Assessment does not include the use of chemical reactions to describe the processes.]
- **MS-LS2-4** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
  [Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]
- **MS-LS2-5** Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
  [Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. ▪ Develop a model to describe phenomena. (MS-LS2-3) **Analyzing and Interpreting Data** Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to	**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. (MS-LS2-1) ▪ 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	**Patterns** ▪ Patterns can be used to identify cause and effect relationships. (MS-LS2-2) **Cause and Effect** ▪ Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-LS2-1) **Energy and Matter** ▪ The transfer of energy can be tracked as energy flows through a natural system. (MS-LS2-3)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. ▪ Analyze and interpret data to provide evidence for phenomena. (MS-LS2-1) **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 ideas, principles, and theories. ▪ Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. (MS-LS2-2) **Engaging in Argument from Evidence** Engaging in argument from evidence in 6–8 builds on 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(s). ▪ Construct 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. (MS-LS2-4) ▪ Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-LS2-5)	growth and reproduction. (MS-LS2-1) ▪ Growth of organisms and population increases are limited by access to resources. (MS-LS2-1) ▪ 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. (MS-LS2-2) **LS2.B: Cycle of Matter and Energy Transfer in Ecosystems** ▪ Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. 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. (MS-LS2-3) **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	**Stability and Change** ▪ Small changes in one part of a system might cause large changes in another part. (MS-LS2-4), (MS-LS2-5) ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** ▪ The use of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus, technology use varies from region to region and over time. (MS-LS2-5) ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ▪ Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-LS2-3) **Science Addresses Questions About the Natural and Material World** ▪ Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-LS2-5) ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence**

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
	ecosystem can lead to shifts in all its populations. (MS-LS2-4) ▪ 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. (MS-LS2-5) **LS4.D: Biodiversity and Humans** ▪ 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. (*secondary to MS-LS2-5*) **ETS1.B: Developing Possible Solutions** ▪ There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. *(secondary to MS-LS2-5)*	▪ Science disciplines share common rules of obtaining and evaluating empirical evidence. (MS-LS2-4)

Connections to other DCIs in grades 6–8:

- **MS.PS1.B** (MS-LS2-3)
- **MS.LS1.B** (MS-LS2-2)
- **MS.LS4.C** (MS-LS2-4)
- **MS.LS4.D** (MS-LS2-4)
- **MS.ESS2.A** (MS-LS2-3),(MS-LS2-4)
- **MS.ESS3.A** (MS-LS2-1),(MS-LS2-4)
- **MS.ESS3.C** (MS-LS2-1),(MS-LS2-4), (MS-LS2-5)

Articulation of DCIs across grade levels:

- **1.LS1.B** (MS-LS2-2)
- **3.LS2.C** (MS-LS2-1), (MS-LS2-4)
- **3.LS4.D** (MS-LS2-1), (MS-LS2-4)
- **5.LS2.A** (MS-LS2-1), (MS-LS2-3)
- **5.LS2.B** (MS-LS2-3)
- **HS.PS3.B** (MS-LS2-3)
- **HS.LS1.C** (MS-LS2-3)
- **HS.LS2.A** (MS-LS2-1), (MS-LS2-2), (MS-LS2-5)
- **HS.LS2.B** (MS-LS2-2), (MS-LS2-3)
- **HS.LS2.C** (MS-LS2-4), (MS-LS2-5)
- **HS.LS2.D** (MS-LS2-2)
- **HS.LS4.C** (MS-LS2-1), (MS-LS2-4)
- **HS.LS4.D** (MS-LS2-1), (MS-LS2-4), (MS-LS2-5)

- **HS.ESS2.A** (MS-LS2-3)
- **HS.ESS2.E** (MS-LS2-4)
- **HS.ESS3.A** (MS-LS2-1), (MS-LS2-5)
- **HS.ESS3.B** (MS-LS2-4)
- **HS.ESS3.C** (MS-LS2-4), (MS-LS2-5)
- **HS.ESS3.D** (MS-LS2-5)
- **HS.PS3.A** (MS-PS2-5)

Connections to NJSLS – English Language Arts

- **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts. (MS-LS2-1), (MS-LS2-2), (MS-LS2-4)
- **RST.6-8.7** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-LS2-1)
- **RST.6-8.8** Distinguish among facts, reasoned judgment based on research findings, and speculation in a text. (MS-LS2-5)
- **RI.8.8** 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. (MS-LS-4), (MS-LS2-5)
- **WHST.6-8.1** Write arguments focused on discipline-specific content. (MS-LS2-4)
- **WHST.6-8.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (MS-LS2-2)
- **WHST.6-8.9** Draw evidence from literary or informational texts to support analysis, reflection, and research. (MS-LS2-2), (MS-LS2-4)
- **SL.8.1** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly. (MS-LS2-2)
- **SL.8.4** Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. (MS-LS2-2)
- **SL.8.5** Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-LS2-3)

Connections to NJSLS – Mathematics

- **MP.4** Model with mathematics. (MS-LS2-5)
- **6.RP.A.3** Use ratio and rate reasoning to solve real-world and mathematical problems. (MS-LS2-5)
- **6.EE.C.9** Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables and relate these to the equation. (MS-LS2-3)
- **6.SP.B.5** Summarize numerical data sets in relation to their context. (MS-LS2-2)

MS-LS3: Heredity: Inheritance and Variation of Traits

Students who demonstrate understanding can:

- **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.
  [Clarification Statement: Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins.] [Assessment Boundary: Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.]

- **MS-LS3-1** Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.
  [Clarification Statement: Emphasis is on using models such as Punnett squares, diagrams, and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. ▪ Develop and use a model to describe phenomena. (MS-LS3-1), (MS-LS3-2)	**LS1.B: Growth and Development of Organisms** ▪ Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. *(secondary to MS-LS3-2)* **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. 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. (MS-LS3-1) ▪ Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. (MS-LS3-2)	**Cause and Effect** ▪ Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS3-2) **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 structures/systems can be analyzed to determine how they function. (MS-LS3-1)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
	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. (MS-LS3-2) ▪ 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. (MS-LS3-1)	

Connections to other DCIs in grades 6–8:

- **MS.LS1.A** (MS-LS3-1)
- **MS.LS4.A** (MS-LS3-1)

Articulation of DCIs across grade levels:

- **3.LS3.A** (MS-LS3-1), (MS-LS3-2)
- **3.LS3.B** (MS-LS3-1), (MS-LS3-2)
- **HS.LS1.A** (MS-LS3-1)
- **HS.LS1.B** (MS-LS3-1), (MS-LS3-2)
- **HS.LS3.A** (MS-LS3-1), (MS-LS3-2)
- **HS.LS3-B** (MS-LS3-1), (MS-LS3-2)
- **HS.PS1.B** (MS-PS3-4)
- **HS.PS2.B** (MS-PS3-2)
- **HS.PS3.A** (MS-PS3-1), (MS-PS3-4), (MS-PS3-5)
- **HS.PS3.B** (MS-PS3-1), (MS-PS3-2), (MS-PS3-3), (MS-PS3-4), (MS-PS3-5)
- **HS.PS3.C** (MS-PS3-2)

Connections to NJSLS – English Language Arts

- **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts. (MS-LS3-1), (MS-LS3-2)
- **RST.6-8.4** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics. (MS-LS3-1), (MS-LS3-2)
- **RST.6-8.7** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-LS3-1), (MS-LS3-2)
- **SL.8.5** Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-LS3-1), (MS-LS3-2)

Connections to NJSLS – Mathematics

- **MP.4** Model with mathematics. (MS-LS3-2)
- **6.SP.B.5** Summarize numerical data sets in relation to their context. (MS-LS3-2)

MS-LS-LS4: Biological Evolution: Unity and Diversity

Students who demonstrate understanding can:

- **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.
  [Clarification Statement: Emphasis is on finding patterns of changes in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in the rock layers.] [Assessment Boundary: Assessment does not include the names of individual species or geological eras in the fossil record.]
- **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.
  [Clarification Statement: Emphasis is on explanations of the evolutionary relationships among organisms in terms of similarity or differences of the gross appearance of anatomical structures.]
- **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.
  [Clarification Statement: Emphasis is on inferring general patterns of relatedness among embryos of different organisms by comparing the macroscopic appearance of diagrams or pictures.] [Assessment Boundary: Assessment of comparisons is limited to gross appearance of anatomical structures in embryological development.]
- **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.
  [Clarification Statement: Emphasis is on using simple probability statements and proportional reasoning to construct explanations.]
- **MS-LS4-5** Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.
  [Clarification Statement: Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, gene therapy); and, on the impacts these technologies have on society as well as the technologies leading to these scientific discoveries.]
- **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.
  [Clarification Statement: Emphasis is on using mathematical models, probability statements, and proportional reasoning to support explanations of trends in changes to populations over time.] [Assessment Boundary: Assessment does not include Hardy Weinberg calculations.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. ▪ Analyze displays of data to identify linear and nonlinear relationships. (MS-LS4-3) ▪ Analyze and interpret data to determine similarities and differences in findings. (MS-LS4-1) **Using Mathematics and Computational Thinking** Mathematical and computational thinking in 6–8 builds on K–5 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. (MS-LS4-6) **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 ideas, principles, and theories. ▪ Apply scientific ideas to construct an explanation for real-world phenomena, examples, or events. (MS-LS4-2) ▪ Construct an explanation that includes qualitative or quantitative relationships between variables	**LS4.A: Evidence of Common Ancestry and Diversity** ▪ 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. (MS-LS4-1) ▪ 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. (MS-LS4-2) ▪ Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy. (MS-LS4-3) **LS4.B: Natural Selection** ▪ Natural selection leads to the predominance of certain traits in a population, and the suppression of others. (MS-LS4-4) ▪ 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. (MS-LS4-5) **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. Traits	**Patterns** ▪ Patterns can be used to identify cause and effect relationships. (MS-LS4-2) ▪ Graphs, charts, and images can be used to identify patterns in data. (MS-LS4-1), (MS-LS4-3) **Cause and Effect** ▪ Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-LS4-4), (MS-LS4-5), (MS-LS4-6) ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** ▪ Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems. (MS-LS4-5) ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-LS4-1) **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ▪ Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-LS4-1), (MS-LS4-2)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
that describe phenomena. (MS-LS4-4) **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 6–8 builds on K–5 experiences and progresses to evaluating the merit and validity of ideas and methods. ▪ Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. (MS-LS4-5)	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. (MS-LS4-6)	**Science Addresses Questions About the Natural and Material World** ▪ Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-LS4-5)

Connections to other DCIs in grades 6–8:

- **MS.LS2.A** (MS-LS4-4), (MS-LS4-6)
- **MS.LS2.C** (MS-LS4-6)
- **MS.LS3.A** (MS-LS4-2), (MS-LS4-4)
- **MS.LS3.B** (MS-LS4-2), (MS-LS4-4), (MS-LS4-6)
- **MS.ESS1.C** (MS-LS4-1), (MS-LS4-2), (MS-LS4-6)
- **MS.ESS2.B** (MS-LS4-1)

Articulation of DCIs across grade levels:

- **4.PS3.A** (MS-PS4-1)
- **3.LS3.B** (MS-LS4-4)
- **3.LS4.A** (MS-LS4-1), (MS-LS4-2)
- **3. LS4.B** (MS-LS4-4)
- **3.LS4.C** (MS-LS4-6)
- **HS.LS2.A** (MS-LS4-4), (MS-LS4-6)
- **HS.LS2.C** (MS-LS4-6)
- **HS.LS3.B** (MS-LS4-4), (MS-LS4-5), (MS-LS4-6)
- **HS.LS4.A** (MS-LS4-1), (MS-LS4-2), (MS-LS4-3)
- **HS.LS4.B** (MS-LS4-4), (MS-LS4-6)
- **HS.LS4.C** (MS-LS4-4), (MS-LS4-5), (MS-LS4-6)
- **HS.ESS1.C** (MS-LS4-1),(MS-LS4-2)
- **HS.ESS2.D** (MS-PS4-2)

Connections to NJSLS - English Language Arts

- **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions (MS-LS4-1), (MS-LS4-2), (MS-LS4-3), (MS-LS4-4), (MS-LS4-5)
- **RST.6-8.7** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-LS4-1), (MS-LS4-3)
- **RST.6-8.9** Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-LS4-3), (MS-LS4-4)
- **WHST.6-8.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (MS-LS4-2), (MS-LS4-4)
- **WHST.6-8.8** 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. (MS-LS4-5)
- **WHST.6-8.9** Draw evidence from informational texts to support analysis, reflection, and research. (MS-LS4-2), (MS-LS4-4)
- **SL.8.1** Engage effectively in a range of collaborative discussions (one-on-one, in groups, teacher led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly. (MS-LS4-2), (MS-LS4-4)
- **SL.8.4** Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. (MS-LS4-2), (MS-LS4-4)

Connections to NJSLS – Mathematics

- **MP.4** Model with mathematics. (MS-LS4-6)
- **6.RP.A.1** Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-LS4-4), (MS-LS4-6)
- **6.SP.B.5** Summarize numerical data sets in relation to their context. (MS-LS4-4), (MS-LS4-6)
- **6.EE.B.6** Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-LS4-1), (MS-LS4-2)
- **7.RP.A.2** Recognize and represent proportional relationships between quantities. (MS-LS4-4), (MS-LS4-6)

MS-ESS1: Earth's Place in the Universe

Students who demonstrate understanding can:

- **MS-ESS1-1** Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.
  [Clarification Statement: Examples of models can be physical, graphical, or conceptual.]
- **MS-ESS1-2** Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.
  [Clarification Statement: Emphasis for the model is on gravity as the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. Examples of models can be physical (such as the analogy of distance along a football field or computer visualizations of elliptical orbits) or conceptual (such as mathematical proportions relative to the size of familiar objects such as students' school or state).] [Assessment Boundary: Assessment does not include Kepler's Laws of orbital motion or the apparent retrograde motion of the planets as viewed from Earth.]
- **MS-ESS1-3** Analyze and interpret data to determine scale properties of objects in the solar system.
  [Clarification Statement: Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects. Examples of scale properties include the sizes of an object's layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data include statistical information, drawings and photographs, and models.] [Assessment Boundary: Assessment does not include recalling facts about properties of the planets and other solar system bodies.]
- **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.
  [Clarification Statement: Emphasis is on how analyses of rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history. Examples of Earth's major events could range from being very recent (such as the last Ice Age or the earliest fossils of homo sapiens) to very old (such as the formation of Earth or the earliest evidence of life). Examples can include the formation of mountain chains and ocean basins, the evolution or extinction of particular living organisms, or significant volcanic eruptions.] [Assessment Boundary: Assessment does not include recalling the names of specific periods or epochs and events within them.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. ▪ Develop and use a model to describe phenomena. (MS-ESS2-1), (MS-ESS2-6)	**ESS1.A: The Universe and Its Stars** ▪ Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. (MS-ESS1-1) ▪ Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (MS-ESS1-2)	**Patterns** ▪ Patterns in rates of change and other numerical relationships can provide information about natural systems. (MS-ESS2-3) **Cause and Effect** ▪ Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS2-5)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
▪ Develop a model to describe unobservable mechanisms. (MS-ESS2-4) **Planning and Carrying Out Investigations** Planning and carrying out investigations in in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions. ▪ Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. (MS-ESS2-5) **Analyzing and Interpreting Data** Analyzing data in in 6–8 builds on K–5 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 provide evidence for phenomena. (MS-ESS2-3) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 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 ideas, principles, and theories. ▪ 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 nature operate today as they did in	**ESS1.C: The History of Planet Earth** ▪ Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches. (HS.ESS1.C GBE) *(secondary to MS-ESS2-3)* **ESS2.A: Earth's Materials and Systems** ▪ All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. (MS-ESS2-1) ▪ The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. (MS-ESS2-2) **ESS2.B: Plate Tectonics and Large-Scale System Interactions** ▪ Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart. (MS-ESS2-3) **ESS2.C: The Roles of Water in Earth's Surface Processes** ▪ Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. (MS-ESS2-4) ▪ The complex patterns of the changes and the movement of	**Scale Proportion and Quantity** ▪ Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-ESS2-2) **Systems and System Models** ▪ Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. (MS-ESS2-6) **Energy and Matter** ▪ Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (MS-ESS2-4) **Stability and Change** ▪ Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale. (MS-ESS2-1) ***Connections to Nature of Science*** **Scientific Knowledge is Open to Revision in Light of New Evidence** ▪ Science findings are frequently revised and/or reinterpreted based on new evidence. (MS-ESS2-3)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
the past and will continue to do so in the future. (MS-ESS2-2)	water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. (MS-ESS2-5) ▪ Global movements of water and its changes in form are propelled by sunlight and gravity. (MS-ESS2-4) ▪ Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. (MS-ESS2-6) ▪ Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations. (MS-ESS2-2) **ESS2.D: Weather and Climate** ▪ Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. (MS-ESS2-6) ▪ Because these patterns are so complex, weather can only be predicted probabilistically. (MS-ESS2-5) ▪ The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents. (MS-ESS2-6)	

Connections to other DCIs in grades 6–8:

- **MS.PS1.A** (MS-ESS2-1), (MS-ESS2-4), (MS-ESS2-5)
- **MS.PS1.B** (MS-ESS2-1), (MS-ESS2-2)
- **MS.PS2.A** (MS-ESS2-5), (MS-ESS2-6)
- **MS.PS2.B** (MS-ESS2-4)
- **MS.PS3.A** (MS-ESS2-4), (MS-ESS2-5)
- **MS.PS3.B** (MS-ESS2-1), (MS-ESS2-5), (MS-ESS2-6)
- **MS.PS3.D** (MS-ESS2-4)
- **MS.PS4.B** (MS-ESS2-6)
- **MS.LS2.B** (MS-ESS2-1), (MS-ESS2-2)
- **MS.LS2.C** (MS-ESS2-1)
- **MS.LS4.A** (MS-ESS2-3)
- **MS.ESS1.B** (MS-ESS2-1)
- **MS.ESS3.C** (MS-ESS2-1)

Articulation of DCIs across grade levels:

- **3.PS2.A** (MS-ESS2-4), (MS-ESS2-6)
- **3.LS4.A** MS-ESS2-3)
- **3.ESS2.D** (MS-ESS2-5), (MS-ESS2-6)
- **3.ESS3.B** (MS-ESS2-3)
- **4.PS3.B** (MS-ESS2-1), (MS-ESS2-4)
- **4.ESS1.C** (MS-ESS2-2), (MS-ESS2-3)
- **4.ESS2.A** (MS-ESS2-1), (MS-ESS2-2)
- **4.ESS2.B** (MS-ESS2-3)
- **4.ESS2.E** (MS-ESS2-2)
- **4.ESS3.B** (MS-ESS2-3)
- **5.PS2.B** (MS-ESS2-4)
- **5.ESS2.A** (MS-ESS2-1), (MS-ESS2-2), (MS-ESS2-5), (MS-ESS2-6)
- **5.ESS2.C** (MS-ESS2-4)
- **HS.PS1.B** (MS-ESS2-1)
- **HS.PS2.B** (MS-ESS2-4), (MS-ESS2-6)
- **HS.PS3.B** (MS-ESS2-1), (MS-ESS2-4), (MS-ESS2-6)
- **HS.PS3.D** (MS-ESS2-2), (MS-ESS2-6)
- **HS.PS4.B** (MS-ESS2-4)
- **HS.LS1.C** (MS-ESS2-1)
- **HS.LS2.B** (MS-ESS2-1), (MS-ESS2-2)
- **HS.LS4.A** (MS-ESS2-3)
- **HS.LS4.C** (MS-ESS2-3)
- **HS.ESS1.B** (MS-ESS2-6)
- **HS.ESS1.C** (MS-ESS2-2), (MS-ESS2-3)
- **HS.ESS2.A** (MS-ESS2-1), (MS-ESS2-2), (MS-ESS2-3), (MS-ESS2-4), (MS-ESS2-6)
- **HS.ESS2.B** (MS-ESS2-2), (MS-ESS2-3)
- **HS.ESS2.C** (MS-ESS2-1), (MS-ESS2-2), (MS-ESS2-4), (MS-ESS2-5)
- **HS.ESS2.D** (MS-ESS2-2), (MS-ESS2-4), (MS-ESS2-5), (MS-ESS2-6)
- **HS.ESS2.E** (MS-ESS2-1), (MS-ESS2-2)
- **HS.ESS3.D** (MS-ESS2-2)

Connections to NJSLS – English Language Arts

- **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS2-2), (MS-ESS2-3), (MS-ESS2-5)
- **RST.6-8.7** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ESS2-3)
- **RST.6-8.9** Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-ESS2-3), (MS-ESS2-5)
- **WHST.6-8.2** Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-ESS2-2)
- **WHST.6-8.8** 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. (MS-ESS2-5)
- **SL.8.5** Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-ESS2-1), (MS-ESS2-2), (MS-ESS2-6)

Connections to NJSLS – Mathematics

- **MP.2** Reason abstractly and quantitatively. (MS-ESS2-2), (MS-ESS2-3), (MS-ESS2-5)
- **6.NS.C.5** Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. (MS-ESS2-5)
- **6.EE.B.6** Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS2-2), (MS-ESS2-3)
- **7.EE.B.4** Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS2-2), (MS-ESS2-3)

MS-ESS3: Earth and Human Activity

Students who demonstrate understanding can:

- **MS-ESS3-1** Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes. [Clarification Statement: Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).]
- **MS-ESS3-2** Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. [Clarification Statement: Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods). Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).]
- **MS-ESS3-3** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. [Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).]
- **MS-ESS3-4** Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. [Clarification Statement: Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.]
- **MS-ESS3-5.** Ask questions to clarify evidence of the factors that have caused climate change over the past century. [Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables and clarifying arguments and models. ▪ Ask questions to identify and clarify evidence of an argument. (MS-ESS3-5) **Analyzing and Interpreting Data** Analyzing data 6–8 builds on grades K–5 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. (MS-ESS3-2) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 6–8 builds on grades K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. ▪ 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	**ESS3.A: Natural Resources** ▪ Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. (MS-ESS3-1) **ESS3.B: Natural Hazards** ▪ Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events. (MS-ESS3-2) **ESS3.C: Human Impacts on Earth Systems** ▪ Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3) ▪ Typically, as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-3), (MS-ESS3-4)	**Patterns** ▪ Graphs, charts, and images can be used to identify patterns in data. (MS-ESS3-2) **Cause and Effect** ▪ Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. (MS-ESS3-3) ▪ Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS3-1), (MS-ESS3-4) **Stability and Change** ▪ Stability might be disturbed either by sudden events or gradual changes that accumulate over time. (MS-ESS3-5) ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology 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. (MS-ESS3-1), (MS-ESS3-4) ▪ The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus, technology use varies from region

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
continue to do so in the future. (MS-ESS3-1) ▪ Apply scientific principles to design an object, tool, process or system. (MS-ESS3-3) **Engaging in Argument from Evidence** Engaging in argument from evidence in 6–8 builds on grades 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(s). ▪ Construct 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. (MS-ESS3-4)	**ESS3.D: Global Climate Change** ▪ Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (MS-ESS3-5)	to region and over time. (MS-ESS3-2), (MS-ESS3-3) ***Connections to Nature of Science*** **Science Addresses Questions About the Natural and Material World** ▪ Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-ESS3-4)

Connections to other DCIs in grades 6–8:

- **MS.PS1.A** (MS-ESS3-1)
- **MS.PS1.B** (MS-ESS3-1)
- **MS.PS3.A** (MS-ESS3-5)
- **MS.PS3.C** (MS-ESS3-2)
- **MS.LS2.A** (MS-ESS3-3), (MS-ESS3-4)
- **MS.LS2.C** (MS-ESS3-3), (MS-ESS3-4)
- **MS.LS4.D** (MS-ESS3-3), (MS-ESS3-4)
- **MS.ESS2.D** (MS-ESS3-1)

Articulation of DCIs across grade levels:

- **3.LS2.C** (MS-ESS3-3), (MS-ESS3-4)
- **3.LS4.D** (MS-ESS3-3), (MS-ESS3-4)
- **3.ESS3.B** (MS-ESS3-2)
- **4.PS3.D** (MS-ESS3-1)
- **4.ESS3.A** (MS-ESS3-1)
- **4.ESS3.B** (MS-ESS3-2)
- **5.ESS3.C** (MS-ESS3-3), (MS-ESS3-4)
- **HS.PS3.B** (MS-ESS3-1), (MS-ESS3-5)
- **HS.PS4.B** (MS-ESS3-5)
- **HS.LS1.C** (MS-ESS3-1)
- **HS.LS2.A** (MS-ESS3-4)
- **HS.LS2.C** (MS-ESS3-3), (MS-ESS3-4)
- **HS.LS4.C** (MS-ESS3-3), (MS-ESS3-4)
- **HS.LS4.D** (MS-ESS3-3), (MS-ESS3-4)
- **HS.ESS2.A** (MS-ESS3-1), (MS-ESS3-5)
- **HS.ESS2.B** (MS-ESS3-1), (MS-ESS3-2)
- **HS.ESS2.C** (MS-ESS3-1), (MS-ESS3-3)
- **HS.ESS2.D** (MS-ESS3-2), (MS-ESS3-3), (MS-ESS3-5)

- **HS.ESS2.E** (MS-ESS3-3), (MS-ESS3-4)
- **HS.ESS3.A** (MS-ESS3-1), (MS-ESS3-4)
- **HS.ESS3.B** (MS-ESS3-2)
- **HS.ESS3.C** (MS-ESS3-3), (MS-ESS3-4), (MS-ESS3-5)
- **HS.ESS3.D** (MS-ESS3-2); (MS-ESS3-3), (MS-ESS3-5)

Connections to NJSLS – English Language Arts

- **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS3-1), (MS-ESS3-2), (MS-ESS3-4), (MS-ESS3-5)
- **RST.6-8.7** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ESS3-2)
- **WHST.6-8.1** Write arguments focused on discipline content. (MS-ESS3-4)
- **WHST.6-8.2** Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-ESS3-1)
- **WHST.6-8.7** 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. (MS-ESS3-3)
- **WHST.6-8.8** 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. (MS-ESS3-3)
- **WHST.6-8.9** Draw evidence from informational texts to support analysis, reflection, and research. (MS-ESS3-1), (MS-ESS3-4)

Connections to NJSLS – Mathematics

- **MP.2** Reason abstractly and quantitatively. (MS-ESS3-2), (MS-ESS3-5)
- **6.RP.A.1** Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-ESS3-3), (MS-ESS3-4)
- **7.RP.A.2** Recognize and represent proportional relationships between quantities. (MS-ESS3-3), (MS-ESS3-4)
- **6.EE.B.6** Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS3-1), (MS-ESS3-2), (MS-ESS3-3), (MS-ESS3-4), (MS-ESS3-5)
- **7.EE.B.4** Use variables to represent quantities in a real-world or mathematical problem and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS3-1), (MS-ESS3-2), (MS-ESS3-3), (MS-ESS3-4), (MS-ESS3-5)

MS-ETS1: Engineering Design

Students who demonstrate understanding can:

- **MS-ETS1-1** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- **MS-ETS1-2** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- **MS-ETS1-3** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- **MS-ETS1-4** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in grades 6–8 builds on K–5 experiences and progresses to specifying relationships between variables and clarifying arguments and models. ▪ Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. (MS-ETS1-1) **Developing and Using Models** Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. ▪ Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. (MS-ETS1-4)	**ETS1.A: Defining and Delimiting Engineering Problems** ▪ The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1) **ETS1.B: Developing Possible Solutions** ▪ A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) ▪ There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3) ▪ Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3) ▪ Models of all kinds are important for testing solutions. (MS-ETS1-4)	**Influence of Science, Engineering, and Technology 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. (MS-ETS1-1) ▪ The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (MS-ETS1-1)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in 6–8 builds on K–5 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. (MS-ETS1-3) **Engaging in Argument from Evidence** Engaging in argument from evidence in 6–8 builds on 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. ▪ Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-ETS1-2)	**ETS1.C: Optimizing the Design Solution** ▪ Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design. (MS-ETS1-3) ▪ The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (MS-ETS1-4)	

Connections to other DCIs in grades 6–8:

- **MS.LS1.A** (MS-LS3-1)
- **MS.LS4.A** (MS-LS3-1)

Articulation of DCIs across grade levels:

- **3.LS3.A** (MS-LS3-1), (MS-LS3-2)
- **3.LS3.B** (MS-LS3-1), (MS-LS3-2)
- **HS.LS1.A** (MS-LS3-1)
- **HS.LS1.B** (MS-LS3-1), (MS-LS3-2)
- **HS.LS3.A** (MS-LS3-1), (MS-LS3-2)
- **HS.LS3-B** (MS-LS3-1), (MS-LS3-2)

Connections to NJSLS – English Language Arts

- **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts. (MS-LS3-1), (MS-LS3-2)

- **RST.6-8.4** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics. (MS-LS3-1), (MS-LS3-2)
- **RST.6-8.7** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-LS3-1), (MS-LS3-2)
- **SL.8.5** Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-LS3-1), (MS-LS3-2)

Connections to NJSLS – Mathematics

- **MP.4** Model with mathematics. (MS-LS3-2)
- **6.SP.B.5** Summarize numerical data sets in relation to their context. (MS-LS3-2)

STATE OF NEW JERSEY
DEPARTMENT OF EDUCATION

2020 New Jersey Student Learning Standards: Science – Grades 9 through 12

HS-PS1: Matter and Its Interactions

Students who demonstrate understanding can:

- **MS-PS1-1** Develop models to describe the atomic composition of simple molecules and extended structures. [Clarification Statement: Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or diamonds. Examples of molecular-level models could include drawings, 3D ball and stick structures, or computer representations showing different molecules with different types of atoms.] [Assessment Boundary: Assessment does not include valence electrons and bonding energy, discussing the ionic nature of subunits of complex structures, or a complete depiction of all individual atoms in a complex molecule or extended structure.]

- **MS-PS1-2** Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
[Clarification Statement: Examples of reactions could include burning sugar or steel wool, fat reacting with sodium hydroxide, and mixing zinc with hydrogen chloride.] [Assessment Boundary: Assessment is limited to analysis of the following properties: density, melting point, boiling point, solubility, flammability, and odor.]

- **MS-PS1-3** Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.
[Clarification Statement: Emphasis is on natural resources that undergo a chemical process to form the synthetic material. Examples of new materials could include new medicine, foods, and alternative fuels.] [Assessment Boundary: Assessment is limited to qualitative information.]

- **MS-PS1-4** Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.
[Clarification Statement: Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawings and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.]

- **MS-PS1-5** Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.
[Clarification Statement: Emphasis is on law of conservation of matter and on physical models or drawings, including digital forms, that represent atoms.] [Assessment Boundary: Assessment does not include the use of atomic masses, balancing symbolic equations, or intermolecular forces.]

- **MS-PS1-6** Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.
[Clarification Statement: Emphasis is on the design, controlling the transfer of energy to the environment, and modification of a device using factors such as type and concentration of a

substance. Examples of designs could involve chemical reactions such as dissolving ammonium chloride or calcium chloride.] [Assessment Boundary: Assessment is limited to the criteria of amount, time, and temperature of substance in testing the device.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. ▪ Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS1-4), (HS-PS1-8) ▪ Use a model to predict the relationships between systems or between components of a system. (HS-PS1-1) **Planning and Carrying Out Investigations** Planning and carrying out investigations in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. ▪ Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS1-3) **Using Mathematics and Computational Thinking** Mathematical and computational thinking at the 9–12 builds on K–8 and progresses to using algebraic	**PS1.A: Structure and Properties of Matter** ▪ Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1) ▪ The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-1), (HS-PS1-2) ▪ The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3), *(secondary to HS-PS2-6)* ▪ A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (HS-PS1-4) **PS1.B: Chemical Reactions** ▪ Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (HS-PS1-4), (HS-PS1-5) ▪ In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. (HS-PS1-6)	**Patterns** ▪ Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS1-1), (HS-PS1-2), (HS-PS1-3), (HS-PS1-5) **Energy and Matter** ▪ In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-PS1-8) ▪ The total amount of energy and matter in closed systems is conserved. (HS-PS1-7) ▪ 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. (HS-PS1-4) **Stability and Change** ▪ Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6) ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ▪ Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS1-7)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. ▪ Use mathematical representations of phenomena to support claims. (HS-PS1-7) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9–12 builds on K–8 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. ▪ Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. (HS-PS1-5) ▪ Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) 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. (HS-PS1-2) ▪ Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)	▪ The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-2), (HS-PS1-7) **PS1.C: Nuclear Processes** ▪ Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process. (HS-PS1-8) **PS2.B: Types of Interactions** ▪ Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. *(secondary to HS-PS1-1), (secondary to HS-PS1-3)* **ETS1.C: Optimizing the Design Solution** ▪ Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. *(secondary to HS-PS1-6)*	

Connections to other DCIs in grades 9–12:

- **HS.PS3.A** (HS-PS1-4), (HS-PS1-5), (HS-PS1-8)
- **HS.PS3.B** (HS-PS1-4), (HS-PS1-6), (HS-PS1-7), (HS-PS1-8)
- **HS.PS3.C** (HS-PS1-8)
- **HS.PS3.D** (HS-PS1-4), (HS-PS1-8)
- **HS.LS1.C** (HS-PS1-1), (HS-PS1-2), (HS-PS1-4), (HS-PS1-7)
- **HS.LS2.B** (HS-PS1-7)
- **HS.ESS1.A** (HS-PS1-8)
- **HS.ESS1.C** (HS-PS1-8)
- **HS.ESS2.C** (HS-PS1-2),(HS-PS1-3)

Articulation of DCIs across grade levels:

- **MS.PS1.A** (HS-PS1-1), (HS-PS1-2), (HS-PS1-3), (HS-PS1-4), (HS-PS1-5), (HS-PS1-7), (HS-PS1-8)
- **MS.PS1.B** (HS-PS1-1), (HS-PS1-2), (HS-PS1-4), (HS-PS1-5), (HS-PS1-6), (HS-PS1-7), (HS-PS1-8)
- **MS.PS1.C** (HS-PS1-8)
- **MS.PS2.B** (HS-PS1-3), (HS-PS1-4), (HS-PS1-5)
- **MS.PS3.A** (HS-PS1-5)
- **MS.PS3.B** (HS-PS1-5)
- **MS.PS3.D** (HS-PS1-4)
- **MS.LS1.C** (HS-PS1-4), (HS-PS1-7)
- **MS.LS2.B** (HS-PS1-7)
- **MS.ESS2.A** (HS-PS1-7), (HS-PS1-8)

Connections to NJSLS – English Language Arts

- **RST.9-10.7** Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. (HS-PS1-1)
- **RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS1-3), (HS-PS1-5)
- **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS1-2), (HS-PS1-5)
- **WHST.9-12.5** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-PS1-2)
- **WHST.9-12.7** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS1-3), (HS-PS1-6)
- **WHST.11-12.8** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS1-3)
- **WHST.9-12.9** Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS1-3)
- **SL.11-12.5** Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS1-4)

Connections to NJSLS – Mathematics

- **MP.2** Reason abstractly and quantitatively. (HS-PS1-5), (HS-PS1-7)
- **MP.4** Model with mathematics. (HS-PS1-4), (HS-PS1-8)
- **HSN-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-2), (HS-PS1-3), (HS-PS1-4), (HS-PS1-5), (HS-PS1-7), (HS-PS1-8)
- **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. (HS-PS1-4), (HS-PS1-7), (HS-PS1-8)
- **HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-2), (HS-PS1-3), (HS-PS1-4), (HS-PS1-5), (HS-PS1-7), (HS-PS1-8)

HS-PS2: Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

- **HS-PS2-1** Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
  [Clarification Statement: Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object sliding down a ramp, or a moving object being pulled by a constant force.] [Assessment Boundary: Assessment is limited to one-dimensional motion and to macroscopic objects moving at non-relativistic speeds.]
- **HS-PS2-2** Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.
  [Clarification Statement: Emphasis is on the quantitative conservation of momentum in interactions and the qualitative meaning of this principle.] [Assessment Boundary: Assessment is limited to systems of two macroscopic bodies moving in one dimension.]
- **HS-PS2-3** Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.
  [Clarification Statement: Examples of evaluation and refinement could include determining the success of the device at protecting an object from damage and modifying the design to improve it. Examples of a device could include a football helmet or a parachute.] [Assessment Boundary: Assessment is limited to qualitative evaluations and/or algebraic manipulations.]
- **HS-PS2-4** Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
  [Clarification Statement: Emphasis is on both quantitative and conceptual descriptions of gravitational and electric fields.] [Assessment Boundary: Assessment is limited to systems with two objects.]
- **HS-PS2-5** Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.
  [Assessment Boundary: Assessment is limited to designing and conducting investigations with provided materials and tools.]
- **HS-PS2-6** Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
  [Clarification Statement: Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.] [Assessment Boundary: Assessment is limited to provided molecular structures of specific designed materials.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical and empirical models. ▪ Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS2-5) **Analyzing and Interpreting Data** Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. ▪ Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-PS2-1) **Using Mathematics and Computational Thinking** Mathematical and computational thinking at the 9–12 builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and	**PS1.A: Structure and Properties of Matter** ▪ The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (secondary to HS-PS2-6) **PS2.A: Forces and Motion** ▪ Newton's second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1) ▪ Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. (HS-PS2-2) ▪ If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PS2-2), (HS-PS2-3) **PS2.B: Types of Interactions** ▪ Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4) ▪ Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS-PS2-4), (HS-PS2-5) ▪ Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. (HS-PS2-6), *(secondary to HS-PS1-1), (secondary to HS-PS1-3)*	**Patterns** ▪ Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS2-4) **Cause and Effect** ▪ Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-1), (HS-PS2-5) ▪ Systems can be designed to cause a desired effect. (HS-PS2-3) **Systems and System Models** ▪ When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (HS-PS2-2) **Structure and Function** ▪ 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. (HS-PS2-6) ***Connections to Nature of Science*** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** ▪ Theories and laws provide explanations in science. (HS-PS2-1), (HS-PS2-4) ▪ Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-1), (HS-PS2-4)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. ▪ Use mathematical representations of phenomena to describe explanations. (HS-PS2-2), (HS-PS2-4) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. ▪ Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. (HS-PS2-3) **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. ▪ Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6)	**PS3.A: Definitions of Energy** ▪ "Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents. *(secondary to HS-PS2-5)* **ETS1.A: Defining and Delimiting Engineering Problems** ▪ Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. *(secondary to HS-PS2-3)* **ETS1.C: Optimizing the Design Solution** ▪ Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. *(secondary to HS-PS2-3)*	

Connections to other DCIs in grades 9–12:

- **HS.PS3.A** (HS-PS2-4), (HS-PS2-5)
- **HS.PS3.C** (HS-PS2-1)
- **HS.PS4.B** (HS-PS2-5)
- **HS.ESS1.A** (HS-PS2-1), (HS-PS2-2), (HS-PS2-4)
- **HS.ESS1.B** (HS-PS2-4)
- **HS.ESS1.C** (HS-PS2-1),(HS-PS2-2), (HS-PS2-4)
- **HS.ESS2.A** (HS-PS2-5)
- **HS.ESS2.C** (HS-PS2-1), (HS-PS2-4)
- **HS.ESS3.A** (HS-PS2-4), (HS-PS2-5)

Articulation of DCIs across grade levels:

- **MS.PS1.A** (HS-PS2-6)
- **MS.PS2.A** (HS-PS2-1), (HS-PS2-2), (HS-PS2-3)
- **MS.PS2.B** (HS-PS2-4), (HS-PS2-5), (HS-PS2-6)
- **MS.PS3.C** (HS-PS2-1), (HS-PS2-2), (HS-PS2-3)
- **MS.ESS1.B** (HS-PS2-4), (HS-PS2-5)

Connections to NJSLS – English Language Arts

- **RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS2-1), (HS-PS2-6)
- **RST.11-12.7** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS2-1)
- **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS2-6)
- **WHST.9-12.7** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS2-3), (HS-PS2-5)
- **WHST.11-12.8** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS2-5)
- **WHST.9-12.9** Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS2-1), (HS-PS2-5)

Connections to NJSLS – Mathematics

- **MP.2** Reason abstractly and quantitatively. (HS-PS2-1), (HS-PS2-2), (HS-PS2-4)
- **MP.4** Model with mathematics. (HS-PS2-1), (HS-PS2-2), (HS-PS2-4)
- **HSN-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS2-1), (HS-PS2-2), (HS-PS2-4), (HS-PS2-5), (HS-PS2-6)
- **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-1), (HS-PS2-2), (HS-PS2-4), (HS-PS2-5), (HS-PS2-6)

HS-PS3: Energy

Students who demonstrate understanding can:

- **HS-PS3-1** Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
  [Clarification Statement: Emphasis is on explaining the meaning of mathematical expressions used in the model.] [Assessment Boundary: Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields.]
- **HS-PS3-2** Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).
  [Clarification Statement: Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an object above the earth, and the energy stored between two electrically-charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations.]
- **HS-PS3-3** Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
  [Clarification Statement: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency.] [Assessment Boundary: Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.]
- **HS-PS3-4** Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).
  [Clarification Statement: Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.] [Assessment Boundary: Assessment is limited to investigations based on materials and tools provided to students.]
- **HS-PS3-5** Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.
  [Clarification Statement: Examples of models could include drawings, diagrams, and texts, such as drawings of what happens when two charges of opposite polarity are near each other.] [Assessment Boundary: Assessment is limited to systems containing two objects.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. ▪ Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS3-2), (HS-PS3-5) **Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. ▪ Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS3-4) **Using Mathematics and Computational Thinking** Mathematical and computational thinking at the 9–12 builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used	**PS3.A: Definitions of Energy** ▪ Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HS-PS3-1), (HS-PS3-2) ▪ At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS-PS3-2) (HS-PS3-3) ▪ These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2) **PS3.B: Conservation of Energy and Energy Transfer** ▪ Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1) ▪ Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1), (HS-PS3-4) ▪ Mathematical expressions, which quantify how the stored energy in a	**Cause and Effect** ▪ 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. (HS-PS3-5) **Systems and System Models** ▪ 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. (HS-PS3-4) ▪ 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. (HS-PS3-1) **Energy and Matter** ▪ 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. (HS-PS3-3) ▪ Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems. (HS-PS3-2) ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** ▪ Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
based on mathematical models of basic assumptions. ▪ Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-PS3-1) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. ▪ Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS3-3)	system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1) ▪ The availability of energy limits what can occur in any system. (HS-PS3-1) ▪ Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PS3-4) **PS3.C: Relationship Between Energy and Forces** ▪ When two objects interacting through a field change relative position, the energy stored in the field is changed. (HS-PS3-5) **PS3.D: Energy in Chemical Processes** ▪ Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (HS-PS3-3), (HS-PS3-4) **ETS1.A: Defining and Delimiting Engineering Problems** ▪ Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. *(secondary to HS-PS3-3)*	to increase benefits while decreasing costs and risks. (HS-PS3-3) ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ▪ Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS3-1)

Connections to other DCIs in grades 9–12:

- **HS.PS1.A** (HS-PS3-2)
- **HS.PS1.B** (HS-PS3-1), (HS-PS3-2);
- **HS.PS2.B** (HS-PS3-2), (HS-PS3-5)
- **HS.LS2.B** (HS-PS3-1)
- **HS.ESS1.A** (HS-PS3-1), (HS-PS3-4)
- **HS.ESS2.A** (HS-PS3-1),(HS-PS3-2), (HS-PS3-4)
- **HS.ESS2.D** (HS-PS3-4)
- **HS.ESS3.A** (HS-PS3-3)

Articulation of DCIs across grade levels:

- **MS.PS1.A** (HS-PS3-2)
- **MS.PS2.B** (HS-PS3-2), (HS-PS3-5)
- **MS.PS3.A** (HS-PS3-1), (HS-PS3-2), (HS-PS3-3)
- **MS.PS3.B** (HS-PS3-1), (HS-PS3-3), (HS-PS3-4)
- **MS.PS3.C** (HS-PS3-2), (HS-PS3-5)
- **MS.ESS2.A** (HS-PS3-1), (HS-PS3-3)

Connections to NJSLS – English Language Arts

- **RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS3-4)
- **WHST.9-12.7** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS3-3), (HS-PS3-4), (HS-PS3-5)
- **WHST.11-12.8** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS3-4), (HS-PS3-5)
- **WHST.9-12.9** Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS3-4), (HS-PS3-5)
- **SL.11-12.5** Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS3-1), (HS-PS3-2), (HS-PS3-5)

Connections to NJSLS – Mathematics

- **MP.2** Reason abstractly and quantitatively. (HS-PS3-1), (HS-PS3-2), (HS-PS3-3), (HS-PS3-4), (HS-PS3-5)
- **MP.4** Model with mathematics. (HS-PS3-1), (HS-PS3-2), (HS-PS3-3), *(HS-PS3-4),* (HS-PS3-5)
- **HSN-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS3-1), (HS-PS3-3)
- **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. (HS-PS3-1), (HS-PS3-3)
- **HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS3-1), (HS-PS3-3)

HS- PS4: Waves and Their Applications in Technologies for Information Transfer

Students who demonstrate understanding can:

- **HS-PS4-1** Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
  [Clarification Statement: Examples of data could include electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the earth.] [Assessment Boundary: Assessment is limited to algebraic relationships and describing those relationships qualitatively.]
- **HS-PS4-2** Evaluate questions about the advantages of using a digital transmission and storage of information.
  [Clarification Statement: Examples of advantages could include that digital information is stable because it can be stored reliably in computer memory, transferred easily, and copied and shared rapidly. Disadvantages could include issues of easy deletion, security, and theft.]
- **HS-PS4-3** Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.
  [Clarification Statement: Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include resonance, interference, diffraction, and photoelectric effect.] [Assessment Boundary: Assessment does not include using quantum theory.]
- **HS-PS4-4** Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.
  [Clarification Statement: Emphasis is on the idea that photons associated with different frequencies of light have different energies, and the damage to living tissue from electromagnetic radiation depends on the energy of the radiation. Examples of published materials could include trade books, magazines, web resources, videos, and other passages that may reflect bias.] [Assessment Boundary: Assessment is limited to qualitative descriptions.]
- **HS-PS4-5** Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.
  [Clarification Statement: Examples could include solar cells capturing light and converting it to electricity; medical imaging; and communications technology.] [Assessment Boundary: Assessments are limited to qualitative information. Assessments do not include band theory.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in grades 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations. ▪ Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design. (HS-PS4-2) **Using Mathematics and Computational Thinking** Mathematical and computational thinking at – 12 builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. ▪ Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-PS4-1) **Engaging in Argument from Evidence** Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed worlds. Arguments may also come from current scientific or historical episodes in science. ▪ Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions	**PS3.D: Energy in Chemical Processes** ▪ Solar cells are human-made devices that likewise capture the sun's energy and produce electrical energy. *(secondary to HS-PS4-5)* **PS4.A: Wave Properties** ▪ The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. (HS-PS4-1) ▪ Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. (HS-PS4-2), (HS-PS4-5) ▪ Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other. (Boundary: The discussion at this grade level is qualitative only; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.) (HS-PS4-3) **PS4.B: Electromagnetic Radiation** ▪ Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. (HS-PS4-3) ▪ When light or longer wavelength electromagnetic radiation is	**Cause and Effect** ▪ Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS4-1) ▪ 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. (HS-PS4-4) ▪ Systems can be designed to cause a desired effect. (HS-PS4-5) **Systems and System 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. (HS-PS4-3) **Stability and Change** ▪ Systems can be designed for greater or lesser stability. (HS-PS4-2) ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** ▪ Science and engineering complement each other in the cycle known as research and development (R&D). (HS-PS4-5) **Influence of Engineering, Technology, and Science on Society and the Natural World** ▪ Modern civilization depends on major technological systems. (HS-PS4-2), (HS-PS4-5)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
to determine the merits of arguments. (HS-PS4-3) **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. ▪ Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible. (HS-PS4-4) ▪ Communicate technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS4-5)	absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells. (HS-PS4-4) ▪ Photoelectric materials emit electrons when they absorb light of a high-enough frequency. (HS-PS4-5) **PS4.C: Information Technologies and Instrumentation** ▪ Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them. (HS-PS4-5)	▪ Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-PS4-2) ***Connections to Nature of Science*** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** ▪ A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HS-PS4-3)

Connections to other DCIs in grades 9–12:

- **HS.PS1.C** (HS-PS4-4)
- **HS.PS1.C** (HS-PS4-4)
- **HS.LS1.C** (HS-PS4-4)
- **HS.PS3.A** (HS-PS4-4), (HS-PS4-5)
- **HS.ESS2.D** (HS-PS4-3)
- **HS.PS3.D** (HS-PS4-3), (HS-PS4-4)
- **HS.ESS1.A** (HS-PS4-3)
- **HS.ESS2.A** (HS-PS4-1)
- **HS.ESS2.D** (HS-PS4-3)

Articulation of DCIs across grade levels:

- **MS.PS3.D** (HS-PS4-4)
- **MS.PS4.A** (HS-PS4-1), (HS-PS4-2), (HS-PS4-5)
- **MS.PS4.B** (HS-PS4-1), (HS-PS4-2), (HS-PS4-3), (HS-PS4-4), (HS-PS4-5)
- **MS.PS4.C** (HS-PS4-2), (HS-PS4-5)
- **MS.LS1.C** (HS-PS4-4)
- **MS.ESS2.D** (HS-PS4-4)

Connections to NJSLS - English Language Arts

- **RST.9-10.8** Determine if the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. (HS-PS4-2), (HS-PS4-3), (HS-PS4-4)
- **RST.11-12.1** Write arguments focused on discipline-specific content. (HS-PS4-3), (HS-PS4-4)
- **RST.11-12.7** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS4-1), (HS-PS4-4)
- **RST.11-12.8** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-PS4-2), (HS-PS4-3), (HS-PS4-4)
- **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS4-5)
- **WHST.11-12.8** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS4-4)

Connections to NJSLS – Mathematics

- **MP.2** Reason abstractly and quantitatively. (HS-PS4-1), (HS-PS4-3)
- **MP.4** Model with mathematics. (HS-PS4-1)
- **HSA-SSE.A.1** Interpret expressions that represent a quantity in terms of its context. (HS-PS4-1), (HS-PS4-3)
- **HSA-SSE.B.3** Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS4-1), (HS-PS4-3)
- **HSA.CED.A.4** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS4-1), (HS-PS4-3)

HS-LS1: From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can:

- **HS-LS1-1** Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells. [Assessment Boundary: Assessment does not include identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the biochemistry of protein synthesis.]
- **HS-LS1-2** Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. [Clarification Statement: Emphasis is on functions at the organism system level such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system.] [Assessment Boundary: Assessment does not include interactions and functions at the molecular or chemical reaction level.]
- **HS-LS1-3** Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. [Clarification Statement: Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, and root development in response to water levels.] [Assessment Boundary: Assessment does not include the cellular processes involved in the feedback mechanism.]
- **HS-LS1-4** Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. [Assessment Boundary: Assessment does not include specific gene control mechanisms or rote memorization of the steps of mitosis.]
- **HS-LS1-5** Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. [Clarification Statement: Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. Examples of models could include diagrams, chemical equations, and conceptual models.] [Assessment Boundary: Assessment does not include specific biochemical steps.]
- **HS-LS1-6** Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules. [Clarification Statement: Emphasis is on using evidence from models and simulations to support explanations.] [Assessment Boundary: Assessment does not include the details of the specific chemical reactions or identification of macromolecules.]
- **HS-LS1-7** Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy. [Clarification Statement: Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration.] [Assessment Boundary: Assessment should not include identification of the steps or specific processes involved in cellular respiration.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. ▪ Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-2) ▪ Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-4), (HS-LS1-5), (HS-LS1-7) **Planning and Carrying Out Investigations** Planning and carrying out in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. ▪ Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-LS1-3) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with	**LS1.A: Structure and Function** ▪ Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1) ▪ All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS-LS1-1) *(Note: This Disciplinary Core Idea is also addressed by HS-LS3-1.)* ▪ Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2) ▪ Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3) **LS1.B: Growth and Development of Organisms** ▪ In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues	**Systems and System 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. (HS-LS1-2), (HS-LS1-4) **Energy and Matter** ▪ 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. (HS-LS1-5), (HS-LS1-6) ▪ Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS1-7) **Structure and Function** ▪ 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. (HS-LS1-1) **Stability and Change** ▪ Feedback (negative or positive) can stabilize or destabilize a system. (HS-LS1-3) ***Connections to Nature of Science*** **Scientific Investigations Use a Variety of Methods** ▪ Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. (HS-LS1-3)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
scientific ideas, principles, and theories. ▪ Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) 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. (HS-LS1-1) ▪ Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) 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. (HS-LS1-6)	and organs that work together to meet the needs of the whole organism. (HS-LS1-4) **LS1.C: Organization for Matter and Energy Flow in Organisms** ▪ The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HS-LS1-5) ▪ The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. (HS-LS1-6) ▪ As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HS-LS1-6), (HS-LS1-7) ▪ As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. (HS-LS1-7)	

Connections to other DCIs in grades 9–12

- **HS.PS1.B** (HS-LS1-5), (HS-LS1-6), (HS-LS1-7)
- **HS.PS2.B** (HS-LS1-7)
- **HS.LS3.A** (HS-LS1-1)
- **HS.PS3.B** (HS-LS1-5), (HS-LS1-7)

Articulation of DCIs across grade levels:

- **MS.PS1.A** (HS-LS1-6)
- **MS.PS1.B** (HS-LS1-5), (HS-LS1-6), (HS-LS1-7)
- **MS.PS3.D** (HS-LS1-5), (HS-LS1-6), (HS-LS1-7)
- **MS.LS1.A** (HS-LS1-1), (HS-LS1-2), (HS-LS1-3), (HS-LS1-4)
- **MS.LS1.B** (HS-LS1-4)
- **MS.LS1.C** (HS-LS1-5), (HS-LS1-6), (HS-LS1-7)
- **MS.LS2.B** (HS-LS1-5), (HS-LS1-7)
- **MS.ESS2.E** (HS-LS1-6)
- **MS.LS3.A** (HS-LS1-1), (HS-LS1-4)
- **MS.LS3.B** (HS-LS1-1)

Connections to NJSLS – English Language Arts

- **RST.11-12.1** Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. (HS-LS1-1), (HS-LS1-6)
- **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS1-1), (HS-LS1-6)
- **WHST.9-12.5** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-LS1-6)
- **WHST.9-12.7** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-LS1-3)
- **WHST.11-12.8** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-LS1-3)
- **WHST.9-12.9** Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS-1-1), (HS-LS1-6)
- **SL.11-12.5** Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-LS1-2), (HS-LS1-4), (HS-LS1-5), (HS-LS1-7)

Connections to NJSLS – Mathematics

- **MP.4** Model with mathematics. (HS-LS1-4)
- **HSF-IF.C.7** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. (HS-LS1-4)
- **HSF-BF.A.1** Write a function that describes a relationship between two quantities. (HS-LS1-4)

HS-LS2: Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

- **HS-LS2-1** Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
  [Clarification Statement: Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate, and competition. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets.] [Assessment Boundary: Assessment does not include deriving mathematical equations to make comparisons.]
- **HS-LS2-1** Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
  [Clarification Statement: Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.] [Assessment Boundary: Assessment is limited to provided data.]
- **HS-LS2-1** Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
  [Clarification Statement: Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration in different environments.] [Assessment Boundary: Assessment does not include the specific chemical processes of either aerobic or anaerobic respiration.]
- **HS-LS2-1** Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
  [Clarification Statement: Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem.] [Assessment Boundary: Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.]
- **HS-LS2-1** Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere. [Clarification Statement: Examples of models could include simulations and mathematical models.] [Assessment Boundary: Assessment does not include the specific chemical steps of photosynthesis and respiration.]
- **HS-LS2-1** Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
  [Clarification Statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.]
- **HS-LS2-1** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
  [Clarification Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.]
- **HS-LS2-1** Evaluate the evidence for the role of group behavior on individual and species’ chances to survive and reproduce.
  [Clarification Statement: Emphasis is on: (1) distinguishing between group and individual behavior, (2) identifying evidence supporting the outcomes of group behavior, and (3) developing logical and reasonable arguments based on evidence. Examples of group behaviors could include

flocking, schooling, herding, and cooperative behaviors such as hunting, migrating, and swarming.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show how relationships among variables between systems and their components in the natural and designed worlds. ▪ Develop a model based on evidence to illustrate the relationships between systems or components of a system. (HS-LS2-5) **Using Mathematics and Computational Thinking** Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. ▪ Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (HS-LS2-1) ▪ Use mathematical representations of phenomena or design solutions to support and revise explanations. (HS-LS2-2) ▪ Use mathematical representations of phenomena or design solutions to support claims. (HS-LS2-4)	**LS2.A: Interdependent Relationships in Ecosystems** ▪ Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (HS-LS2-1), (HS-LS2-2) **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** ▪ Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (HS-LS2-3) ▪ Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up	**Cause and Effect** ▪ Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS2-8) **Scale, Proportion, and Quantity** ▪ The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-LS2-1) ▪ Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (HS-LS2-2) **Systems and System 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. (HS-LS2-5) **Energy and Matter** ▪ Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS2-4) ▪ Energy drives the cycling of matter within and between systems. (HS-LS2-3) **Stability and Change** ▪ Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6), (HS-LS2-7)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
	the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (HS-LS2-4) ▪ Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. (HS-LS2-5) **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** ▪ A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2), (HS-LS2-6) ▪ Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7)	***Connections to Nature of Science*** **Scientific Knowledge is Open to Revision in Light of New Evidence** ▪ Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-2), (HS-LS2-3) ▪ Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation. (HS-LS2-6), (HS-LS2-8)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
	LS2.D: Social Interactions and Group Behavior ▪ Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HS-LS2-8) **LS4.D: Biodiversity and Humans** ▪ Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). *(secondary to HS-LS2-7)* ▪ Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. *(secondary to HS-LS2-7)* (Note: This Disciplinary Core Idea is also addressed by HS-LS4-6.) **PS3.D: Energy in Chemical Processes** ▪ The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. *(secondary to HS-LS2-5)* **ETS1.B: Developing Possible Solutions** ▪ When evaluating solutions, it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. *(secondary to HS-LS2-7).*	

Connections to other DCIs in grades 9–12

- **HS.PS1.B** (HS-LS2-3), (HS-LS2-5)
- **HS.PS3.B** (HS-LS2-3), (HS-LS2-4)
- **HS.PS3.D** (HS-LS2-3), (HS-LS2-4)
- **HS.ESS2.A** (HS-LS2-3)
- **HS.ESS2.D** (HS-LS2-5),(HS-LS2-7)
- **HS.ESS2.E** (HS-LS2-2),(HS-LS2-6), (HS-LS2-7)
- **HS.ESS3.A** (HS-LS2-2),(HS-LS2-7)
- **HS.ESS3.C** (HS-LS2-2),(HS-LS2-7)
- **HS.ESS3.D** (HS-LS2-2)

Articulation of DCIs across grade levels:

- **MS.PS1.B** (HS-LS2-3)
- **MS.PS3.D** (HS-LS2-3), (HS-LS2-4), (HS-LS2-5)
- **MS.LS1.B** (HS-LS2-8)
- **MS.LS1.C** (HS-LS2-3), (HS-LS2-4), (HS-LS2-5)
- **MS.LS2.A** (HS-LS2-1), (HS-LS2-2), (HS-LS2-6)
- **MS.LS2.B** (HS-LS2-3), (HS-LS2-4), (HS-LS2-5)
- **MS.LS2.C** (HS-LS2-1), (HS-LS2-2), (HS-LS2-6), (HS-LS2-7)
- **MS.ESS2.A** (HS-LS2-5)
- **MS.ESS2.E** (HS-LS2-6)
- **MS.ESS3.A** (HS-LS2-1)
- **MS.ESS3.C** (HS-LS2-1), (HS-LS2-2), (HS-LS2-6), (HS-LS2-7)
- **MS.ESS3.D** (HS-LS2-7)

Connections to NJSLS – English Language Arts

- **RST.9-10.8** Determine if the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. (HS-LS2-6), (HS-LS2-7), (HS-LS2-8)
- **RST.11-12.1** Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. (HS-LS2-1), (HS-LS2-2), (HS-LS2-3), (HS-LS2-6), (HS-LS2-8)
- **RST.11-12.7** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-LS2-6), (HS-LS2-7), (HS-LS2-8)
- **RST.11-12.8** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-LS2-6), (HS-LS2-7), (HS-LS2-8)
- **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS2-1), (HS-LS2-2), (HS-LS2-3)
- **WHST.9-12.5** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-LS2-3)
- **WHST.9-12.7** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-LS2-7)

Connections to NJSLS – Mathematics

- **MP.2** Reason abstractly and quantitatively. (HS-LS2-1), (HS-LS2-2), (HS-LS2-4), (HS-LS2-6), (HS-LS2-7)
- **MP.4** Model with mathematics. (HS-LS2-1), (HS-LS2-2), (HS-LS2-4)
- **HSN-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-LS2-1), (HS-LS2-2), (HS-LS2-4), (HS-LS2-7)
- **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. (HS-LS2-1), (HS-LS2-2), (HS-LS2-4), (HS-LS2-7)
- **HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-LS2-1), (HS-LS2-2), (HS-LS2-4), (HS-LS2-7)
- **HSS-ID.A.1** Represent data with plots on the real number line. (HS-LS2-6)
- **HSS-IC.A.1** Understand statistics as a process for making inferences about population parameters based on a random sample from that population. (HS-LS2-6)
- **HSS-IC.B.6** Evaluate reports based on data. (HS-LS2-6)

HS- LS3: Heredity: Inheritance and Variation of Traits

Students who demonstrate understanding can:

- **HS-LS3-1** Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
  [Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.]
- **HS-LS3-1** Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.
  [Clarification Statement: Emphasis is on using data to support arguments for the way variation occurs.] [Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.]
- **HS-LS3-1** Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.
  [Clarification Statement: Emphasis is on the use of mathematics to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits.] [Assessment Boundary: Assessment does not include Hardy-Weinberg calculations.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations. ▪ Ask questions that arise from examining models or a theory to clarify relationships. (HS-LS3-1) **Analyzing and Interpreting Data** Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. ▪ Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation	**LS1.A: Structure and Function** ▪ All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins. *(secondary to HS-LS3-1) (Note: This Disciplinary Core Idea is also addressed by HS-LS1-1.)* **LS3.A: Inheritance of Traits** ▪ Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or	**Cause and Effect** ▪ Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS3-1), (HS-LS3-2) **Scale, Proportion, and Quantity** ▪ 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). (HS-LS3-3) ***Connections to Nature of Science*** **Science is a Human Endeavor** ▪ Technological advances have influenced the progress of science and science has influenced advances in technology. (HS-LS3-3) ▪ Science and engineering are influenced by society and society

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (HS-LS3-3) **Engaging in Argument from Evidence** Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. ▪ Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence. (HS-LS3-2)	structural functions, and some have no as-yet known function. (HS-LS3-1) **LS3.B: Variation of Traits** ▪ In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. (HS-LS3-2) ▪ Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. (HS-LS3-2), (HS-LS3-3)	is influenced by science and engineering. (HS-LS3-3)

Connections to other DCIs in grades 9–12:

- **HS.LS2.A** (HS-LS3-3)
- **HS.LS2.C** (HS-LS3-3)
- **HS.LS4.B** (HS-LS3-3)
- **HS.LS4.C** (HS-LS3-3)

Articulation of DCIs across grade levels:

- **MS.LS2.A** (HS-LS3-3)
- **MS.LS3.A** (HS-LS3-1), (HS-LS3-2)
- **MS.LS3.B** (MS.LS2.A (HS-LS3-3)
- **MS.LS3.A** (HS-LS3-1), (HS-LS3-2)
- **MS.LS3.B** (HS-LS3-1), (HS-LS3-2), (HS-LS3-3)
- **MS.LS4.C** (HS-LS3-3)
- **MS.LS4.C** (HS-LS3-3)

Connections to NJSLS – English Language Arts

- **RST.11-12.1** Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. (HS-LS3-1), (HS-LS3-2)
- **RST.11-12.9** Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-LS3-1)
- **WHST.9-12.1** Write arguments focused on discipline-specific content. (HS-LS3-2)

Connections to NJSLS – Mathematics

- **MP.2** Reason abstractly and quantitatively. (HS-LS3-2), (HS-LS3-3)

HS-LS4: Biological Evolution: Unity and Diversity

Students who demonstrate understanding can:

- **HS-LS4-1** Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. [Clarification Statement: Emphasis is on a conceptual understanding of the role each line of evidence has relating to common ancestry and biological evolution. Examples of evidence could include similarities in DNA sequences, anatomical structures, and order of appearance of structures in embryological development.]

- **HS-LS4-2** Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment. [Clarification Statement: Emphasis is on using evidence to explain the influence each of the four factors has on number of organisms, behaviors, morphology, or physiology in terms of ability to compete for limited resources and subsequent survival of individuals and adaptation of species. Examples of evidence could include mathematical models such as simple distribution graphs and proportional reasoning.] [Assessment Boundary: Assessment does not include other mechanisms of evolution, such as genetic drift, gene flow through migration, and co-evolution.]

- **HS-LS4-3** Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait. [Clarification Statement: Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations.] [Assessment Boundary: Assessment is limited to basic statistical and graphical analysis. Assessment does not include allele frequency calculations.]

- **HS-LS4-4** Construct an explanation based on evidence for how natural selection leads to adaptation of populations.
  [Clarification Statement: Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations.]

- **HS-LS4-5** Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
  [Clarification Statement: Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, fishing, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.]

- **HS-LS4-6** Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
  [Clarification Statement: Emphasis is on testing solutions for a proposed problem related to threatened or endangered species, or to genetic variation of organisms for multiple species.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. ▪ Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (HS-LS4-3) **Using Mathematics and Computational Thinking** Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. ▪ Create or revise a simulation of a phenomenon, designed device, process, or system. (HS-LS4-6) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. ▪ Construct an explanation based on valid and reliable evidence obtained from a variety of sources	**LS4.A: Evidence of Common Ancestry and Diversity** ▪ Genetic information provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence. (HS-LS4-1) **LS4.B: Natural Selection** ▪ Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. (HS-LS4-2), (HS-LS4-3) ▪ The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (HS-LS4-3) **LS4.C: Adaptation** ▪ Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. (HS-LS4-2) ▪ Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to	**Patterns** ▪ Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-LS4-1), (HS-LS4-3) **Cause and Effect** ▪ Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS4-2), (HS-LS4-4), (HS-LS4-5), (HS-LS4-6) ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ▪ Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. (HS-LS4-1), (HS-LS4-4) ***Connections to Nature of Science*** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** ▪ A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HS-LS4-1)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
(including students' own investigations, models, theories, simulations, peer review) 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. (HS-LS4-2), (HS-LS4-4) **Engaging in Argument from Evidence** Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current or historical episodes in science. ▪ Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS4-5) **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. ▪ Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-LS4-1)	survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. (HS-LS4-3), (HS-LS4-4) ▪ Adaptation also means that the distribution of traits in a population can change when conditions change. (HS-LS4-3) ▪ Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometimes the extinction–of some species. (HS-LS4-5), (HS-LS4-6) ▪ Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5) **LS4.D: Biodiversity and Humans** ▪ Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (HS-LS4-6)	

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
	(Note: This Disciplinary Core Idea is also addressed by HS-LS2-7.) **ETS1.B: Developing Possible Solutions** ▪ When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. *(secondary to HS-LS4-6)* ▪ Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. *(secondary to HS-LS4-6)*	

Connections to other DCIs in grades 9–12:

- **HS.LS2.A** (HS-LS4-2), (HS-LS4-3), (HS-LS4-4), (HS-LS4-5)
- **HS.LS2.D** (HS-LS4-2), (HS-LS4-3), (HS-LS4-4), (HS-LS4-5)
- **HS.LS3.A** (HS-LS4-1)
- **HS.LS3.B** (HS-LS4-1), (HS-LS4-2), (HS-LS4-3), (HS-LS4-5)
- **HS.ESS1.C** (HS-LS4-1)
- **HS.ESS2.D** (HS-LS4-6)
- **HS.ESS2.E** (HS-LS4-2), (HS-LS4-5), (HS-LS4-6)
- **HS.ESS3.A** (HS-LS4-2), (HS-LS4-5), (HS-LS4-6)
- **HS.ESS3.C** (HS-LS4-6)
- **HS.ESS3.D** (HS-LS4-6)

Articulation of DCIs across grade levels:

- **MS.LS2.A** (HS-LS4-2), (HS-LS4-3), (HS-LS4-5)
- **MS.LS2.C** (HS-LS4-5), (HS-LS4-6)
- **MS.LS3.A** (HS-LS4-1)
- **MS.LS3.B** (HS-LS4-1), (HS-LS4-2), (HS-LS4-3)
- **MS.LS4.A** (HS-LS4-1)
- **MS.LS4.B** (HS-LS4-2), (HS-LS4-3), (HS-LS4-4)
- **MS.LS4.C** (HS-LS4-2), (HS-LS4-3), (HS-LS4-4), (HS-LS4-5)
- **MS.ESS1.C** (HS-LS4-1)
- **MS.ESS3.C** (HS-LS4-5), (HS-LS4-6)

Connections to NJSLS – English Language Arts

- **RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS4-1), (HS-LS4-2), (HS-LS4-3), (HS-LS4-4)
- **RST.11-12.8** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-LS4-5)
- **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS4-1), (HS-LS4-2), (HS-LS4-3), (HS-LS4-4)
- **WHST.9-12.5** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-LS4-6)
- **WHST.9-12.7** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-LS4-6)
- **WHST.9-12.9** Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS4-1), (HS-LS4-2), (HS-LS4-3), (HS-LS4-4), (HS-LS4-5)
- **SL.11-12.4** Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. (HS-LS4-1), (HS-LS4-2)

Connections to NJSLS – Mathematics

- **MP.2** Reason abstractly and quantitatively. (HS-LS4-1), (HS-LS4-2), (HS-LS4-3), (HS-LS4-4), (HS-LS4-5)
- **MP.4** Model with mathematics. (HS-LS4-2)

HS-ESS1: Earth's Place in the Universe

Students who demonstrate understanding can:

- **HS-ESS1-1** Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation. [Clarification Statement: Emphasis is **on** the energy transfer mechanisms that allow energy from nuclear fusion in the sun's core to reach Earth. Examples of evidence for the model include observations of the masses and lifetimes of other stars, as well as the ways that the sun's radiation varies due to sudden solar flares ("space weather"), the 11-year sunspot cycle, and non-cyclic variations over centuries.] [Assessment Boundary: Assessment does not include details of the atomic and sub-atomic processes involved with the sun's nuclear fusion.]
- **HS-ESS1-2** Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe. [Clarification Statement: Emphasis is on the astronomical evidence of the red shift of light from galaxies as an indication that the universe is currently expanding, the cosmic microwave background as the remnant radiation from the Big Bang, and the observed composition of ordinary matter of the universe, primarily found in stars and interstellar gases (from the spectra of electromagnetic radiation from stars), which matches that predicted by the Big Bang theory (3/4 hydrogen and 1/4 helium).]
- **HS-ESS1-3** Communicate scientific ideas about the way stars, over their life cycle, produce elements. [Clarification Statement: Emphasis is on the way nucleosynthesis, and therefore the different elements created, varies as a function of the mass of a star and the stage of its lifetime.] [Assessment Boundary: Details of the many different nucleosynthesis pathways for stars of differing masses are not assessed.]
- **HS-ESS1-4** Use mathematical or computational representations to predict the motion of orbiting objects in the solar system. [Clarification Statement: Emphasis is on Newtonian gravitational laws governing orbital motions, which apply to human-made satellites as well as planets and moons.] [Assessment Boundary: Mathematical representations for the gravitational attraction of bodies and Kepler's Laws of orbital motions should not deal with more than two bodies, nor involve calculus.]
- **HS-ESS1-5** Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks. [Clarification Statement: Emphasis is on the ability of plate tectonics to explain the ages of crustal rocks. Examples include evidence of the ages oceanic crust increasing with distance from mid-ocean ridges (a result of plate spreading) and the ages of North American continental crust decreasing with distance away from a central ancient core of the continental plate (a result of past plate interactions).]
- **HS-ESS1-6** Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history. [Clarification Statement: Emphasis is on using available evidence within the solar system to reconstruct the early history of Earth, which formed along with the rest of the solar system 4.6 billion years ago. Examples of evidence include the absolute ages of ancient materials (obtained by radiometric dating of meteorites, moon rocks, and Earth's oldest minerals), the sizes and compositions of solar system objects, and the impact cratering record of planetary surfaces.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). ▪ Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS1-1) **Using Mathematical and Computational Thinking** Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. ▪ Use mathematical or computational representations of phenomena to describe explanations. (HS-ESS1-4) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.	**ESS1.A: The Universe and Its Stars** ▪ Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. (MS-ESS1-1) ▪ Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (MS-ESS1-2) **ESS1.C: The History of Planet Earth** ▪ Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches. *(HS.ESS1.C GBE) (secondary to MS-ESS2-3)* **ESS2.A: Earth's Materials and Systems** ▪ All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. (MS-ESS2-1) ▪ The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. (MS-ESS2-2) **ESS2.B: Plate Tectonics and Large-Scale System Interactions** ▪ Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart. (MS-ESS2-3)	**Patterns** ▪ Empirical evidence is needed to identify patterns. (HS-ESS1-5) **Scale, Proportion, and Quantity** ▪ The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-ESS1-1) ▪ 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). (HS-ESS1-4) **Energy and Matter** ▪ Energy cannot be created or destroyed–only moved between one place and another place, between objects and/or fields, or between systems. (HS-ESS1-2) ▪ In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-ESS1-3) **Stability and Change** ▪ Much of science deals with constructing explanations of how things change and how they remain stable. (HS-ESS1-6) ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** ▪ Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. (HS-ESS1-2), (HS-ESS1-4)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
▪ Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, theories, simulations, peer review) 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. (HS-ESS1-2) ▪ Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion. (HS-ESS1-6) **Engaging in Argument from Evidence** Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. ▪ Evaluate evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-ESS1-5) **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. ▪ Communicate scientific ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally,	**ESS1.A: The Universe and Its Stars** ▪ The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years. (HS-ESS1-1) ▪ The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (HS-ESS1-2), (HS-ESS1-3) ▪ The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe. (HS-ESS1-2) ▪ Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode. (HS-ESS1-2), (HS-ESS1-3) **ESS1.B: Earth and the Solar System** ▪ Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system. (HS-ESS1-4) **ESS1.C: The History of Planet Earth** ▪ Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. (HS-ESS1-5) ▪ Although active geologic processes, such as plate tectonics and erosion,	***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ▪ Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. (HS-ESS1-2) ▪ Science assumes the universe is a vast single system in which basic laws are consistent. (HS-ESS1-2) **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** ▪ A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HS-ESS1-2), (HS-ESS1-6) ▪ Models, mechanisms, and explanations collectively serve as tools in the development of a scientific theory. (HS-ESS1-6)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
graphically, textually, and mathematically). (HS-ESS1-3)	have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history. (HS-ESS1-6) **ESS2.B: Plate Tectonics and Large-Scale System Interactions** ▪ Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. *(ESS2.B Grade 8 GBE), (secondary to HS-ESS1-5)* **PS1.C: Nuclear Processes** ▪ Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials. *(secondary to HS-ESS1-5), (secondary to HS-ESS1-6)* **PS3.D: Energy in Chemical Processes and Everyday Life** ▪ Nuclear Fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation. *(secondary to HS-ESS1-1)* **PS4.B Electromagnetic Radiation** ▪ Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities. *(secondary to HS-ESS1-2)*	

Connections to other DCIs in grades 9–12:

- **HS.PS1.A** (HS-ESS1-2), (HS-ESS1-3)
- **HS.PS1.C** (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-3)
- **HS.PS2.A** (HS-ESS1-6)
- **HS.PS2.B** (HS-ESS1-4), (HS-ESS1-6)
- **HS.PS3.A** (HS-ESS1-1), (HS-ESS1-2)
- **HS.PS3.B** (HS-ESS1-2), (HS-ESS1-5)
- **HS.PS4.A** (HS-ESS1-2)
- **HS.ESS2.A** (HS-ESS1-5)

Articulation of DCIs across grade levels:

- **MS.PS1.A** (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-3)
- **MS.PS2.A** (HS-ESS1-4);
- **MS.PS2.B** (HS-ESS1-4), (HS-ESS1-6);
- **MS.PS4.B** (HS-ESS1-1), (HS-ESS1-2)
- **MS.ESS1.A** (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-3),(HS-ESS1-4)
- **MS.ESS1.B** (HS-ESS1-4), (HS-ESS1-6)
- **MS.ESS1.C** (HS-ESS1-5), (HS-ESS1-6)
- **MS.ESS2.A** (HS-ESS1-1), (HS-ESS1-5), (HS-ESS1-6)
- **MS.ESS2.B** (HS-ESS1-5), (HS-ESS1-6)
- **MS.ESS2.D** (HS-ESS1-

Connections to NJSLS – English Language Arts

- **RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-5), (HS-ESS1-6)
- **RST.11-12.8** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ESS1-5), (HS-ESS1-6)
- **WHST.9-12.1** Write arguments focused on discipline-specific content. (HS-ESS1-6)
- **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-ESS1-2), (HS-ESS1-3), (HS-ESS1-5)
- **SL.11-12.4** Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience. (HS-ESS1-3)
- **SL.8.5** Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-ESS2-1), (MS-ESS2-2), (MS-ESS2-6)

Connections to NJSLS – Mathematics

- **MP.2** Reason abstractly and quantitatively. (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-3), (HS-ESS1-4), (HS-ESS1-5), (HS-ESS1-6)
- **MP.4** Model with mathematics. (HS-ESS1-1), (HS-ESS1-4)
- **HSN-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-4), (HS-ESS1-5), (HS-ESS1-6)
- **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-4), (HS-ESS1-5), (HS-ESS1-6)
- **HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-4), (HS-ESS1-5), (HS-ESS1-6)
- **HSA-SSE.A.1** Interpret expressions that represent a quantity in terms of its context. (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-4)
- **HSA-CED.A.2** Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-4)
- **HSA-CED.A.4** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-4)
- **HSF-IF.B.5** Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. (HS-ESS1-6)
- **HSS-ID.B.6** Represent data on two quantitative variables on a scatter plot, and describe how those variables are related. (HS-ESS1-6)
- **7.EE.B.4** Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS2-2),

HS- ESS2: Earth’s Systems

Students who demonstrate understanding can:

- **HS-ESS2-1** Develop a model to illustrate how Earth’s internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.
  [Clarification Statement: Emphasis is on how the appearance of land features (such as mountains, valleys, and plateaus) and sea-floor features (such as trenches, ridges, and seamounts) are a result of both constructive forces (such as volcanism, tectonic uplift, and orogeny) and destructive mechanisms (such as weathering, mass wasting, and coastal erosion).] [Assessment Boundary: Assessment does not include memorization of the details of the formation of specific geographic features of Earth’s surface.]
- **HS-ESS2-2** Analyze geoscience data to make the claim that one change to Earth’s surface can create feedbacks that cause changes to other Earth systems.
  [Clarification Statement: Examples should include climate feedbacks, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth’s surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent.]
- **HS-ESS2-3** Develop a model based on evidence of Earth’s interior to describe the cycling of matter by thermal convection.
  [Clarification Statement: Emphasis is on both a one-dimensional model of Earth, with radial layers determined by density, and a three-dimensional model, which is controlled by mantle convection and the resulting plate tectonics. Examples of evidence include maps of Earth’s three-dimensional structure obtained from seismic waves, records of the rate of change of Earth’s magnetic field (as constraints on convection in the outer core), and identification of the composition of Earth’s layers from high-pressure laboratory experiments.]
- **HS-ESS2-4** Use a model to describe how variations in the flow of energy into and out of Earth’s systems result in changes in climate.
  [Clarification Statement: Examples of the causes of climate change differ by timescale, over 1–10 years: large volcanic eruption, ocean circulation; 10–100s of years: changes in human activity, ocean circulation, solar output; 10–100s of thousands of years: changes to Earth's orbit and the orientation of its axis; and 10–100s of millions of years: long-term changes in atmospheric composition.] [Assessment Boundary: Assessment of the results of changes in climate is limited to changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.]
- **HS-ESS2-5** Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
  [Clarification Statement: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by

testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids).]

- **HS-ESS2-6** Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
[Clarification Statement: Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.]

- **HS-ESS2-7** Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.
[Clarification Statement: Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth's other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms.] [Assessment Boundary: Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). ▪ Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-1), (HS-ESS2-3), (HS-ESS2-6) ▪ Use a model to provide mechanistic accounts of phenomena. (HS-ESS2-4) **Planning and Carrying Out Investigations** Planning and carrying out investigations in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.	**ESS1.B: Earth and the Solar System** ▪ Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes. *(secondary to HS-ESS2-4)* **ESS2.A: Earth Materials and Systems** ▪ Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-1), (HS-ESS2-2) ▪ Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model	**Cause and Effect** ▪ Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS2-4) **Energy and Matter** ▪ The total amount of energy and matter in closed systems is conserved. (HS-ESS2-6) ▪ Energy drives the cycling of matter within and between systems. (HS-ESS2-3) **Structure and Function** ▪ 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. (HS-ESS2-5)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
▪ Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-ESS2-5) **Analyzing and Interpreting Data** Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. ▪ Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-ESS2-2) **Engaging in Argument from Evidence** Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. ▪ Construct an oral and written argument or counter-arguments based on data and evidence. (HS-ESS2-7)	of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement of denser materials toward the interior. (HS-ESS2-3) ▪ The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4) **ESS2.B: Plate Tectonics and Large-Scale System Interactions** ▪ The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle, providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection. (HS-ESS2-3) ▪ Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust. *(ESS2.B Grade 8 GBE)* (HS-ESS2-1)	**Stability and Change** ▪ Much of science deals with constructing explanations of how things change and how they remain stable. (HS-ESS2-7) ▪ Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS2-1) ▪ Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS2-2) ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** ▪ Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. (HS-ESS2-3) ***Influence of Engineering, Technology, and Science on Society and the Natural World*** ▪ New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ESS2-2)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
	ESS2.C: The Roles of Water in Earth's Surface Processes ▪ The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks. (HS-ESS2-5) **ESS2.D: Weather and Climate** ▪ The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. (HS-ESS2-2), (HS-ESS2-4) ▪ Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6), (HS-ESS2-7) ▪ Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6), (HS-ESS2-4) **ESS2.E: Biogeology** ▪ The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it. (HS-ESS2-7) **PS4.A: Wave Properties** ▪ Geologists use seismic waves and their reflection at interfaces between layers to probe structures	

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
	deep in the planet. *(secondary to HS-ESS2-3)*	

Connections to other DCIs in in grades 9–12:

- **HS.PS1.A** (HS-ESS2-5), (HS-ESS2-6)
- **HS.PS1.B** (HS-ESS2-5), (HS-ESS2-6)
- **HS.PS2.B** (HS-ESS2-1), (HS-ESS2-3)
- **HS.PS3.A** (HS-ESS2-4)
- **HS.PS3.B** (HS-ESS2-2), (HS-ESS2-3), (HS-ESS2-4), (HS-ESS2-5)
- **HS.PS3.D** (HS-ESS2-3), (HS-ESS2-6)
- **HS.PS4.B** (HS-ESS2-2)
- **HS.LS1.C** (HS-ESS2-6)
- **HS.LS2.A** (HS-ESS2-7)
- **HS.LS2.B** (HS-ESS2-2), (HS-ESS2-6)
- **HS.LS2.C** (HS-ESS2-2), (HS-ESS2-4), (HS-ESS2-7)
- **HS.LS4.A** (HS-ESS2-7)
- **HS.LS4.B** (HS-ESS2-7)
- **HS.LS4.C** (HS-ESS2-7)
- **HS.LS4.D** (HS-ESS2-2), (HS-ESS2-7)
- **HS.ESS1.C** (HS-ESS2-4)
- **HS.ESS3.C** (HS-ESS2-2), (HS-ESS2-4), (HS-ESS2-5), (HS-ESS2-6)
- **HS.ESS3.D** (HS-ESS2-2), (HS-ESS2-4), (HS-ESS2-6)

Articulation of DCIs across grade levels:

- **MS.PS1.A** (HS-ESS2-3), (HS-ESS2-5), (HS-ESS2-6)
- **MS.PS1.B** (HS-ESS2-3)
- **MS.PS2.B** (HS-ESS2-1), (HS-ESS2-3)
- **MS.PS3.A** (HS-ESS2-3), (HS-ESS2-4)
- **MS.PS3.B** (HS-ESS2-3), (HS-ESS2-4)
- **MS.PS3.D** (HS-ESS2-2), (HS-ESS2-4), (HS-ESS2-6)
- **MS.PS4.B** (HS-ESS2-2), (HS-ESS2-4), (HS-ESS2-5), (HS-ESS2-6)
- **MS.LS1.C** (HS-ESS2-4)
- **MS.LS2.A** (HS-ESS2-7)
- **MS.LS2.B** (HS-ESS2-1), (HS-ESS2-2), (HS-ESS2-4), (HS-ESS2-6)
- **MS.LS2.C** (HS-ESS2-2), (HS-ESS2-4), (HS-ESS2-7)
- **MS.LS4.A** (HS-ESS2-7)
- **MS.LS4.B** (HS-ESS2-7)
- **MS.LS4.C** (HS-ESS2-2), (HS-ESS2-7)
- **MS.ESS1.C** (HS-ESS2-1), (HS-ESS2-7)
- **MS.ESS2.A** (HS-ESS2-1), (HS-ESS2-2), (HS-ESS2-3), (HS-ESS2-4), (HS-ESS2-5), (HS-ESS2-6), (HS-ESS2-7)
- **MS.ESS2.B** (HS-ESS2-1), (HS-ESS2-2), (HS-ESS2-3), (HS-ESS2-4), (HS-ESS2-6)
- **MS.ESS2.C** (HS-ESS2-1), (HS-ESS2-2), (HS-ESS2-4), (HS-ESS2-5), (HS-ESS2-6), (HS-ESS2-7)
- **MS.ESS2.D** (HS-ESS2-1), (HS-ESS2-2), (HS-ESS2-4), (HS-ESS2-5)
- **MS.ESS3.C** (HS-ESS2-2), (HS-ESS2-4), (HS-ESS2-6), (HS-ESS2-7)
- **MS.ESS3.D** (HS-ESS2-2), (HS-ESS2-4), (HS-ESS2-6))

Connections to NJSLS – English Language Arts

- **RST.11-12.1** Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. (HS-ESS2-2),(HS-ESS2-3)
- **RST.11-12.2** Determine the central ideas, themes, or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. (HS-ESS2-2)
- **WHST.9-12.1** Write arguments focused on discipline-specific content. (HS-ESS2-7)
- **WHST.9-12.7** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-ESS2-5)
- **SL.11-12.5** Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-ESS2-1), (HS-ESS2-3), (HS-ESS2-4)

Connections to NJSLS – Mathematics

- **MP.2** Reason abstractly and quantitatively. (HS-ESS2-1), (HS-ESS2-2), (HS-ESS2-3), (HS-ESS2-4), (HS-ESS2-6)
- **MP.4** Model with mathematics. (HS-ESS2-1), (HS-ESS2-3), (HS-ESS2-4), (HS-ESS2-6)
- **HSN-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-ESS2-1), (HS-ESS2-2), (HS-ESS2-3), (HS-ESS2-4), (HS-ESS2-6)
- **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS2-1), (HS-ESS2-3), (HS-ESS2-4), (HS-ESS2-6)
- **HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS2-1), (HS-ESS2-2), (HS-ESS2-3), (HS-ESS2-4), (HS-ESS2-5), (HS-ESS2-6)

HS ESS3: Earth and Human Activity

Students who demonstrate understanding can:

- **HS-ESS3-1** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and climate change have influenced human activity.
  [Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.]
- **HS-ESS3-2** Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
  [Clarification Statement: Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems—not what should happen.]
- **HS-ESS3-3** Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
  [Clarification Statement: Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning.] [Assessment Boundary: Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.]
- **HS-ESS3-4** Evaluate or refine a technological solution that reduces impacts of human activities on **climate change and other** natural systems.
  [Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).]
- **HS-ESS3-5** Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
  [Clarification Statement: Examples of evidence, for both data and climate model outputs, are for climate changes (such as precipitation and temperature) and their associated impacts (such as on sea level, glacial ice volumes, or atmosphere and ocean composition).] [Assessment Boundary: Assessment is limited to one example of a climate change and its associated impacts.]

- **HS-ESS3-6** Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity (**i.e., climate change**). [Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. An example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations.] [Assessment Boundary: Assessment does not include running computational representations but is limited to using the published results of scientific computational models.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. ▪ Analyze data using computational models in order to make valid and reliable scientific claims. (HS-ESS3-5) **Using Mathematics and Computational Thinking** Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. ▪ Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-ESS3-3) ▪ Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-ESS3-6) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and	**ESS2.D: Weather and Climate** ▪ Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. *(secondary to HS-ESS3-6)* **ESS3.A: Natural Resources** ▪ Resource availability has guided the development of human society. (HS-ESS3-1) ▪ All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (HS-ESS3-2) **ESS3.B: Natural Hazards** ▪ Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations. (HS-ESS3-1) **ESS3.C: Human Impacts on Earth Systems** ▪ The sustainability of human societies and the biodiversity that supports them requires responsible	**Cause and Effect** ▪ Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS3-1) **Systems and System Models** ▪ 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. (HS-ESS3-6) **Stability and Change** ▪ Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS3-3), (HS-ESS3-5) ▪ Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS3-4) ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Engineering, Technology, and Science on Society and the Natural World** ▪ Modern civilization depends on major technological systems. (HS-ESS3-1), (HS-ESS3-3) ▪ Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-ESS3-2), (HS-ESS3-4)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories. ▪ Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) 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. (HS-ESS3-1) ▪ Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ESS3-4) **Engaging in Argument from Evidence** Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. ▪ Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations). (HS-ESS3-2)	management of natural resources. (HS-ESS3-3) ▪ Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4) **ESS3.D: Global Climate Change** ▪ Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (HS-ESS3-5) ▪ Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities. (HS-ESS3-6) **ETS1.B: Developing Possible Solutions** ▪ When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. *(secondary to HS-ESS3-2), (secondary HS-ESS3-4)*	▪ New technologies can have deep impacts on society and the environment, including some that were not anticipated. (HS-ESS3-3) ▪ Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ESS3-2) ***Connections to Nature of Science*** **Science is a Human Endeavor** ▪ Science is a result of human endeavors, imagination, and creativity. (HS-ESS3-3) **Science Addresses Questions About the Natural and Material World** ▪ Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions. (HS-ESS3-2) ▪ Science knowledge indicates what can happen in natural systems—not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge. (HS-ESS3-2) ▪ Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues. (HS-ESS3-2) **Scientific Investigations Use a Variety of Methods** ▪ Science investigations use diverse methods and do not always use the same set of procedures to obtain data. (HS-ESS3-5) ▪ New technologies advance scientific knowledge. (HS-ESS3-5)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
		Scientific Knowledge is Based on Empirical Evidence ▪ Science knowledge is based on empirical evidence. (HS-ESS3-5) ▪ Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (HS-ESS3-5)

Connections to other DCIs in in grades 9–12:

- **HS.PS1.B** (HS-ESS3-3)
- **HS.PS3.B** (HS-ESS3-2), (HS-ESS3-5)
- **HS.PS3.D** (HS-ESS3-2), (HS-ESS3-5)
- **HS.LS1.C** (HS-ESS3-5)
- **HS.LS2.A** (HS-ESS3-2), (HS-ESS3-3)
- **HS.LS2.B** (HS-ESS3-2), (HS-ESS3-3), (HS-ESS3-6)
- **HS.LS2.C** (HS-ESS3-3), (HS-ESS3-4), (HS-ESS3-6)
- **HS.LS4.D** (HS-ESS3-2), (HS-ESS3-3), (HS-ESS3-4), (HS-ESS3-6)
- **HS.ESS2.A** (HS-ESS3-2), (HS-ESS3-3), (HS-ESS3-6)
- **HS.ESS2.D** (HS-ESS3-5)
- **HS.ESS2.E** (HS-ESS3-3)

Articulation of DCIs across grade levels:

- **MS.PS1.B** (HS-ESS3-3)
- **MS.PS3.B** (HS-ESS3-5)
- **MS.PS3.D** (HS-ESS3-2), (HS-ESS3-5)
- **MS.LS2.A** (HS-ESS3-1), (HS-ESS3-2), (HS-ESS3-3)
- **MS.LS2.B** (HS-ESS3-2), (HS-ESS3-3)
- **MS.LS2.C** (HS-ESS3-3), (HS-ESS3-4), (HS-ESS3-6)
- **MS.LS4.C** (HS-ESS3-3)
- **MS.LS4.D** (HS-ESS3-1), (HS-ESS3-2), (HS-ESS3-3)
- **MS.ESS2.A** (HS-ESS3-1), (HS-ESS3-3), (HS-ESS3-4), (HS-ESS3-5), (HS-ESS3-6)
- **MS.ESS2.C** (HS-ESS3-6)
- **MS.ESS2.D** (HS-ESS3-5)
- **MS.ESS3.A** (HS-ESS3-1), (HS-ESS3-2), (HS-ESS3-3)
- **MS.ESS3.B** (HS-ESS3-1), (HS-ESS3-4), (HS-ESS3-5)
- **MS.ESS3.C** (HS-ESS3-2), (HS-ESS3-3), (HS-ESS3-4), (HS-ESS3-5), (HS-ESS3-6)
- **MS.ESS3.D** (HS-ESS3-4), (HS-ESS3-5), (HS-ESS3-6)
- **MS.ESS2.B** (HS-ESS2-1), (HS-ESS2-2), (HS-ESS2-3), (HS-ESS2-4), (HS-ESS2-6)
- **MS.ESS2.C** (HS-ESS2-1), (HS-ESS2-2), (HS-ESS2-4), (HS-ESS2-5), (HS-ESS2-6), (HS-ESS2-7)
- **MS.ESS2.D** (HS-ESS2-1), (HS-ESS2-2), (HS-ESS2-4), (HS-ESS2-5)
- **MS.ESS3.C** (HS-ESS2-2), (HS-ESS2-4), (HS-ESS2-6), (HS-ESS2-7)
- **MS.ESS3.D** (HS-ESS2-2), (HS-ESS2-4), (HS-ESS2)

Connections to NJSLS – English Language Arts

- **RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-ESS3-1), (HS-ESS3-2), (HS-ESS3-4), (HS-ESS3-5)
- **RST.11-12.2** Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. (HS-ESS3-5)
- **RST.11-12.7** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-ESS3-5)
- **RST.11-12.8** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ESS3-2), (HS-ESS3-4)
- **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-ESS3-1)

Connections to NJSLS – Mathematics

- **MP.2** Reason abstractly and quantitatively. (HS-ESS3-1), (HS-ESS3-2), (HS-ESS3-3), (HS-ESS3-4), (HS-ESS3-5), (HS-ESS3-6)
- **MP.4** Model with mathematics. (HS-ESS3-3), (HS-ESS3-6)
- **HSN-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-ESS3-1), (HS-ESS3-4), (HS-ESS3-5), (HS-ESS3-6)
- **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS3-1), (HS-ESS3-4), (HS-ESS3-5), (HS-ESS3-6)
- **HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS3-1), (HS-ESS3-4), (HS-ESS3-5), (HS-ESS3-6)

HS- ETS1: Engineering Design

Students who demonstrate understanding can:

- **HS-ETS1-1** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- **HS-ETS1-2** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- **HS-ETS1-3** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
- **HS-ETS1-4** Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations. ▪ Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1) **Using Mathematics and Computational Thinking** Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on	**Delimiting Engineering Problems** ▪ Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS-ETS1-1) ▪ Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HS-ETS1-1) **ETS1.B: Developing Possible Solutions** ▪ When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)	**Systems and System 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. (HS-ETS1-4) ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** ▪ New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ETS1-1), (HS-ETS1-3)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
mathematical models of basic assumptions. ▪ Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS-ETS1-4) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions 9–12 builds on K – experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories. ▪ Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-2) ▪ Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3)	▪ Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (HS-ETS1-4) **ETS1.C: Optimizing the Design Solution** ▪ Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (HS-ETS1-2)	

Connections to HS-ETS1.A: Defining and Delimiting Engineering Problems

- **Physical Science:** HS-PS2-3, HS-PS3-3

Connections to HS-ETS1.B: Designing Solutions to Engineering Problems:

- **Earth and Space Science:** HS-ESS3-2, HS-ESS3-4
- **Life Science:** HS-LS2-7, HS-LS4-6

Connections to HS-ETS1.C: Optimizing the Design Solution:

- **Physical Science:** HS-PS1-6, HS-PS2-3

Articulation of DCIs across grade levels:

- **MS.ETS1.A** (HS-ETS1-1), (HS-ETS1-2), (HS-ETS1-3), (HS-ETS1-4)
- **MS.ETS1.B** (HS-ETS1-2), (HS-ETS1-3), (HS-ETS1-4)
- **MS.ETS1.C** (HS-ETS1-2), (HS-ETS1-4)

Connections to NJSLS – English Language Arts

- **RST.11-12.7** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-ETS1-1), (HS-ETS1-3)
- **RST.11-12.8** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1), (HS-ETS1-3)
- **RST.11-12.9** Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-1), (HS-ETS1-3)

Connections to NJSLS – Mathematics

- **MP.2** Reason abstractly and quantitatively. (HS-ETS1-1), (HS-ETS1-3), (HS-ETS1-4)
- **MP.4** Model with mathematics. (HS-ETS1-1), (HS-ETS1-2), (HS-ETS1-3), (HS-ETS1-4)