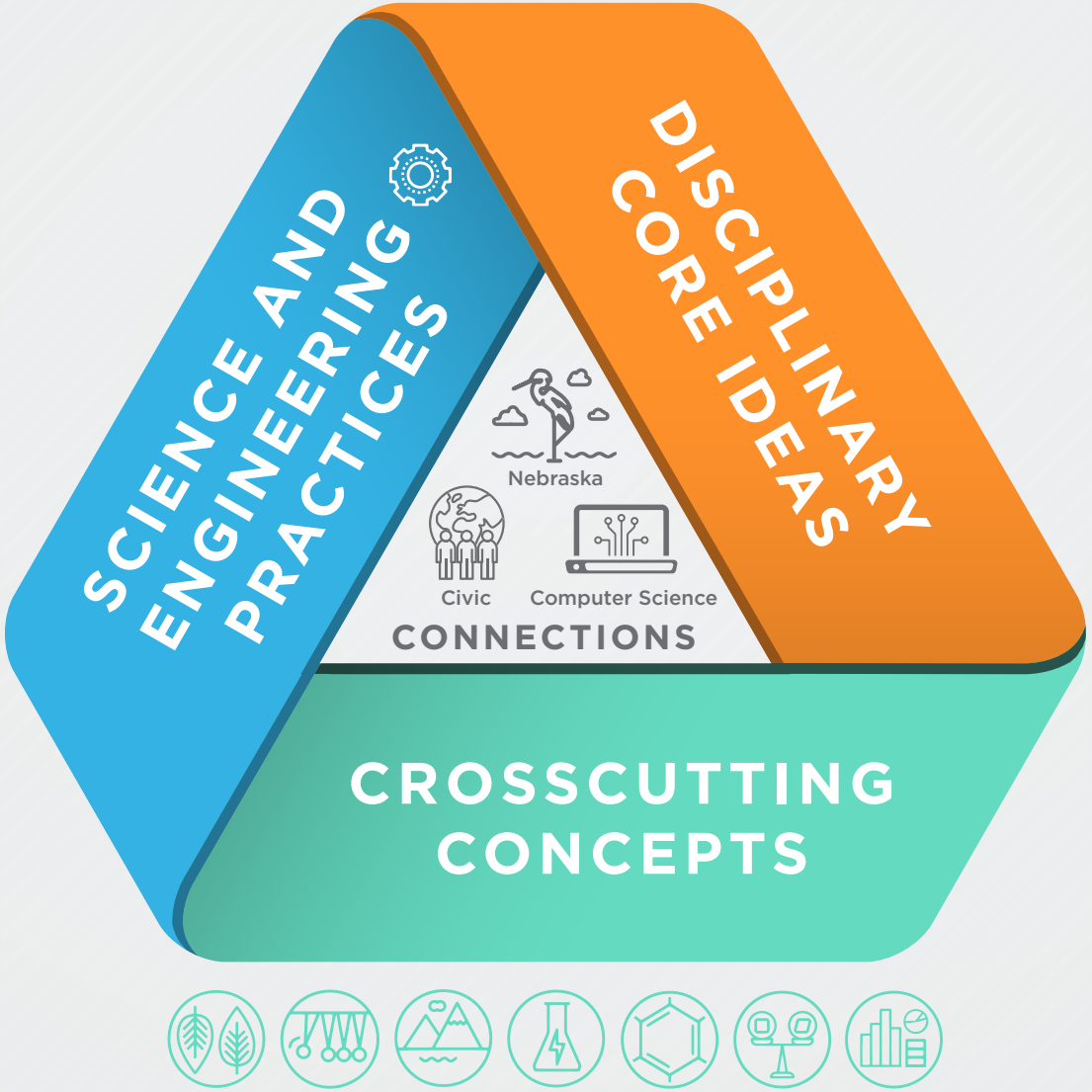
NEBRASKA'S COLLEGE AND CAREER READY

STANDARDS FOR SCIENCE



NEBRASKA DEPARTMENT OF EDUCATION

NEBRASKA'S COLLEGE AND CAREER READY STANDARDS FOR SCIENCE 2024

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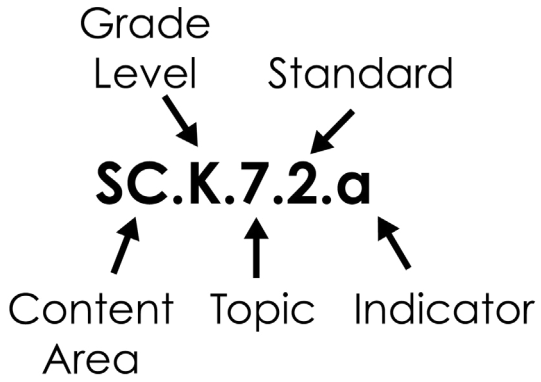
CONTENT AREA STANDARDS STRUCTURE

The overall structure of Nebraska's College and Career Ready Standards for Science (CCR-Science) reflects the two-tier structure common across all Nebraska content area standards. The two levels within the structure include **standards** and **indicators**. The standards are broad, overarching content-based statements that describe the basic cognitive, affective, or psychomotor expectations of student learning. The standards, across all grade levels, reflect long-term goals for learning. **Indicators** further describe what students must know and be able to do to meet the standard. These performance-based statements provide clear expectations related to student learning in each content area. Additionally, indicators provide guidance related to the assessment of student learning. This guidance is articulated by including ***assessment boundary*** statements.

The CCR-Science standards describe the knowledge and skills that students should learn, but they do not prescribe particular curriculum, lessons, teaching techniques, or activities. Standards describe what students are expected to know and be able to do, while the local curriculum describes how teachers will help students master the standards. A wide variety of instructional resources may be used to meet the state content area standards. Decisions about curriculum and instruction are made locally by individual school districts and classroom teachers. The Nebraska Department of Education provides guidance related to high-quality instructional materials selection and implementation. Please visit the Nebraska Instructional Materials Collaborative.

In addition to a common structure for content area standards, a consistent numbering system is used for content area standards. The numbering system is as follows:



CONTENT AREA STANDARDS OVERVIEW

Nebraska Revised Statute 79-760.01 requires the State Board of Education to adopt measurable academic content standards for the areas of reading, writing, mathematics, science, and social studies. Standards describe grade-level expectations for given content areas and provide a framework upon which Nebraska districts develop, establish, and implement curriculum. For effective teaching and learning to occur, the content area standards should drive local decisions related to instructional materials, resources, and interim, formative, and summative assessments.

The Nebraska Department of Education has identified quality criteria in the development of content area standards. These criteria ensure that standards are grounded in a strong research base of human cognition, motivation, and teaching and learning and describe essential knowledge and skills for college, career, and civic readiness. The revised science standards, written by teams of Nebraska educators and reviewed by local and national experts, were developed with the following indicators of quality:

Measurable: Standards provide benchmarks against which student progress toward learning goals can be measured.

Appropriately challenging: Standards must build in complexity so that by the end of grade 12, students are prepared for postsecondary education and the workforce.

Connected: Student learning is most effective when it connects knowledge and skills to related topics and authentic applications.

Clearly worded: Content area standards must effectively communicate what students should know and be able to do.

Scaffolded: Indicators in the Nebraska content area standards scaffold student learning by sequencing connected knowledge and skills across grades so that students build and deepen understanding and ability over time.

Specific: Specificity assures that the language used in standards and indicators is sufficiently detailed to be accurately interpreted by educators

ORGANIZATION AND STRUCTURE OF COLLEGE AND CAREER READY STANDARDS FOR SCIENCE (CCR-SCIENCE)

Nebraska's College and Career Ready Standards for Science (CCR-Science) are organized by grade level for grades K-8 and by grade span in high school. K-5 standards are organized to reflect the developmental nature of learning for elementary students and attend to the learning progressions that build foundational understandings of science. By the time students reach middle school (Grades 6-8), they build on this foundation in order to develop more sophisticated understandings of science concepts through high school. The topic progression for the CCR-Science standards is included in Appendix A: Topic Progression.

Within each grade level/span the standards are organized around topics, and each standard addresses one topic. Each CCR-Science standard begins with the common stem: "Gather, analyze, and communicate…" This stem highlights long-term learning goals associated with rigorous science standards and provides guidance for high quality classroom instruction. To facilitate high-quality instruction, students actively gather evidence from multiple sources related to the topics. Evidence is carefully analyzed in order to describe and explain natural phenomena, and then, students communicate their understanding of the content using a variety of tools and strategies. It is important to note that while topics are introduced in a spiraled model, they are connected, and deeper understanding at subsequent

grade levels and spans requires foundational understanding of multiple topics.

The indicators reflect the three dimensions of science learning outlined in A Framework for K-12 Science Education1. Each CCR-Science indicator includes a disciplinary core idea, a crosscutting concept (underline), and a **science and engineering practice** (**bold**).

Disciplinary Core Ideas (DCI)
The disciplinary core ideas are the focused, limited set of science ideas identified in the Framework as necessary for ALL students throughout their education and beyond their K-12 school years to achieve scientific literacy. The limited number of disciplinary core ideas allows more time for students and teachers to engage in the science and engineering practices as they deeply explore science ideas. To allow students to continually build on and revise their knowledge and abilities, the disciplinary core ideas are built on developmental learning progressions (Appendix A).

Crosscutting Concepts (CCC)
The crosscutting concepts are used to organize and make sense of disciplinary core ideas. They serve as tools that bridge disciplinary boundaries and deepen understanding of science content. With grade-appropriate proficiency, students are expected to use patterns (cause and effect, scale, proportion, and quantity), systems and system models (energy and matter, structure and function) and stability and change as they gather, analyze, and communicate scientific understanding.

These crosscutting concepts provide structure for synthesizing knowledge from various fields into a coherent and scientifically-based view of the world.

Science and Engineering Practices (SEP)
The **science and engineering practices** are used by students to demonstrate understanding of the disciplinary core ideas and crosscutting concepts. Engaging in the practices of science and engineering helps students understand the wide range of approaches used to investigate natural phenomena and develop solutions to challenges. Students are expected to demonstrate grade-appropriate proficiency in asking questions and defining problems, developing and using models, planning and carrying out investigations, analyzing and interpreting data, using mathematics and computational thinking, constructing explanations and designing solutions, engaging in argument from evidence, and obtaining, evaluating, and communicating information as they gather, analyze, and communicate scientific information.

Each science indicator focuses on one crosscutting concept and one **science and engineering practice** as an example to guide assessment. Curriculum, instruction, and assessment should reflect authentic science practice and be phenomena-based. Furthermore, curriculum, instruction, and assessment should use crosscutting concepts and **science and engineering practices** that go beyond what is stated in the indicator to better reflect authentic science practice. Utilizing the range of SEPs and CCCs will support deeper learning and greater understanding of the DCIs.

The following table lists the disciplinary core ideas, crosscutting concepts, and **science and engineering practices**:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• Asking Questions and Defining Problems • Developing and Using Models • Planning and Carrying Out Investigations • Analyzing and Interpreting Data • Using Mathematics and Computational Thinking • Constructing Explanations and Designing Solutions • Engaging in Argument from Evidence • Obtaining, Evaluating, and Communicating Information	LS1: From Molecules to Organisms: Structures and Processes LS2: Ecosystems: Interactions, Energy, and Dynamics LS3: Heredity: Inheritance and Variation of Traits LS4: Biological Evolution: Unity & Diversity PS1: Matter and Its Interactions PS2: Motion and Stability: Forces and Interactions PS3: Energy PS4: Waves and Their Applications in Technologies for Information Transfer ESS1: Earth's Place in the Universe ESS2: Earth's Systems ESS3: Earth and Human Activity ETS1: Engineering Design	Patterns Cause and Effect Scale, Proportion, and Quantity Systems and System Models Energy and Matter Structure and Function Stability and Change

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

Icon Titles & Descriptions

Nebraska Connections
Opportunities to teach science using topics directly relevant to our state (e.g. Ogallala Aquifer, agriculture, Nebraska-specific flora and fauna, Nebraska's rich geologic history, etc.) are listed throughout the CCR-Science standards as "Nebraska Connections." These connections allow educators to use local, regional, and state-specific contexts for teaching, learning, and assessment. Educators should use these as recommendations for investigation with students. Additionally, assessment developers have the opportunity to use the Nebraska contexts to develop Nebraska-specific examples or scenarios from which students would demonstrate their general understanding. This approach provides the opportunity for educators to draw upon Nebraska's natural environment and rich history and resources in engineering design and scientific research to support student learning.

Civic Science Connections
Within the CCR-Science standards, opportunities to create civic science connections have been identified. These connections are designed to highlight the importance of students engaging in the study of civic ideals, principles, and practices through participation in the act of "citizen science." Citizen science is the public involvement in inquiry and discovery of new scientific knowledge. This engagement helps students build science knowledge and skills while improving social behavior, increasing engagement, and strengthening community partnerships. Citizen science projects enlist K-12 students to collect or analyze data

for real-world research studies. Citizen science, in conjunction with the CCR-Science standards, helps bridge our K-12 students with stakeholders in the community, both locally and globally.

Computer Science Connections
Natural connections between science and computer science have been identified throughout the standards, especially in the middle level and in high school as students expand their ability to use computational thinking to develop complex models and simulations of natural and designed systems. Computers and other digital tools allow students to collect, record, organize, analyze, and communicate data as they engage in science learning.

Engineering, Technology, and Applications of Science Connections
Connections to engineering, technology, and applications of science are included at all grade levels and in all domains. They highlight the interdependence of science, engineering, and technology. Additionally, these connections drive the research and development cycle where discoveries in science lead to new technologies developed using the engineering design process. These connections call attention to the effects of scientific and technological advances on society and the environment.

Engineering Design
Performance indicators for the engineering design process are intentionally embedded in all grade levels. These indicators allow students to demonstrate their ability to define problems, develop possible solutions, and improve designs. ***These indicators should be reinforced whenever students are engaged in practicing engineering design during instruction.*** Having students engage in the engineering design process will prepare them to solve challenges both in and out of the classroom.

EDUCATOR SUPPORT & RESOURCES

Implementation
Effective science teaching, learning, and assessments should integrate disciplinary core ideas, crosscutting concepts, and **science and engineering practices**. Integration of the three dimensions will allow students to explain scientific phenomena, engage in sensemaking, design solutions to problems, and build a foundation upon which they can continue to learn and be able to apply science knowledge and skills within and outside the K-12 education arena. While each indicator incorporates the three dimensions, this alone does not drive student outcomes. Ultimately, student learning depends on how the standards are translated to instructional practices.

To support educators while they explore and implement content standards, the Nebraska Department of Education has developed the Content Area Standards Implementation Framework. The Framework is based on implementation science and includes stages from "Exploration" to "Deep Implementation," the types of work and activities associated with each stage, and roles of educators in ensuring successful implementation. The goal of the framework is to guide the alignment of standards, instruction, materials, and assessment to create a coherent system of learning.

Phenomenon-based Instruction
Three-dimensional instruction offers authentic learning experiences when students engage in describing and explaining the natural world. This involves focusing the conceptual learning on anchoring and investigative phenomena to better comprehend their observations. Students utilize evidence in the sensemaking process to build concepts in their minds. Phenomena are natural, observable events that we can explain or predict using our science knowledge (the singular form of phenomena is phenomenon).

Teachers are encouraged to adopt phenomenon-based instruction to fully engage students in three-dimensional science learning. This method can be summarized in three steps:

1. Introduce a new unit or concept with a phenomenon: Start by presenting a phenomenon that is relevant to students' lives. This engages them in asking questions about their observations and fosters a desire to learn more. Many teachers already use this approach by introducing new units or concepts with tangible examples such as pictures, videos, demonstrations, or laboratory experiences.
2. Engaging in science and engineering practices: Provide opportunities for students to gather and reason about information to explain the phenomenon. Sensemaking represents a shift in science instruction where teachers refrain from giving students direct answers. Instead, they should offer multiple opportunities for students to explore the phenomenon individually and in groups, while scaffolding their learning. This approach supports students in developing an understanding of scientific concepts and constructing their own explanations for the phenomenon.
3. Communicating understanding: Ensure students have multiple opportunities to articulate their thinking about why the phenomenon occurs. To deepen their understanding, check that student explanations progress from simple descriptions of what they observe to more complex explanations and predictions of what they think is happening with the phenomenon.

Throughout this process, teachers should not provide direct answers about the phenomenon. Instead, they should facilitate experiences that help students reach an appropriate understanding. Often, this involves engaging students in scientific arguments where they challenge each other's claims and explanations using their observations and collected evidence.

Teacher Guides

The Teacher Guides were created to provide guidance for developing effective instruction aligned to Nebraska's College and Career Ready Science Standards. They are intended to support teachers, administrators, science specialists, ESU's, instructional coaches, parents, and other stakeholders as they plan instruction and assessment at a local level.

The Teacher Guides are meant as a resource document which unwraps the indicators to support teacher's understanding of the standards. They are not meant to be used by students, and therefore they are not written in student-friendly language.

Nebraska Science Classroom Formative Task Repository

The Nebraska Science Classroom Formative Task Repository is a collection of K-12 formative tasks aligned to the indicator level of the standards. Tasks were developed by Nebraska educators and cover the breadth of the standards giving students an opportunity to provide evidence of what they can know and can do related to that standard.

Graduation Requirements

The high school life science, physical science, and Earth and space science standards are intended for **ALL** students to have learned by the end of 30 credit hours of high school science courses.

> **Rule 10**
> 003.05 Graduation Requirements. Each high school must require from grades nine through twelve at least 200 credit hours for graduation, for which at least 80 percent must be from the core curriculum. The number of credit hours given for a course may be less than the number of instructional units and may be increased up to 25 percent above the number of instructional units.

003.05A3 Science. Thirty credit hours of science with course content that includes biological, earth/space, and physical science concepts with corresponding science inquiry skills and laboratory experience.

Course examples that offer the scope and sequence to include all three domains are included in Appendix B: HS Integrated Science Course Model.

High School Plus Standards (HSP)

The High School Plus (HSP) standards represent advanced science topics designed to enhance the rigor of general science curricula or supplement additional advanced science courses. The standards were developed using postsecondary syllabi from entry level science courses for science majors (e.g. UNL LIFE 120, CHEM 109). Introducing the content to high school students will scaffold their learning providing a bridge between high school science coursework and postsecondary level coursework. If the indicator includes HSP, it is a plus standard which is supplemental.

KINDERGARTEN

The Kindergarten standards and indicators help students gather, analyze, and communicate evidence as they formulate answers to questions tailored to student interest and current topics that may include but are not limited to:

What happens if you change how hard you push or pull an object?
Students are able to apply an understanding of the effects of different strengths or different directions of pushes and pulls on the motion of an object to analyze a design solution.

What is the weather like today and how is it different from yesterday?
Students are expected to develop understanding of patterns and variations in local weather and the purpose of weather forecasting to prepare for and respond to, severe weather.

Where do animals live and why do they live there?
Students are also expected to develop understanding of what plants and animals (including humans) need to survive and the relationship between their needs and where they live.

SC.K.1 Forces and Interactions: Pushes and Pulls

SC.K.1.1 Gather, analyze, and communicate evidence of forces and their interactions.

SC.K.1.1.a **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. 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.

SC.K.1.1.b **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. Assessment does not include friction as a mechanism for change in speed.

SC.K.7 Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment

SC.K.7.2 Gather, analyze, and communicate evidence of interdependent relationships in ecosystems.

SC.K.7.2.a **Use observations to describe** patterns of what plants and animals (including humans) need to survive.

SC.K.7.2.b **Construct an argument supported by evidence for how** plants and animals (including humans) can change the environment to meet their needs.

SC.K.7.2.c **Use a model to represent** the relationship between the needs of different plants or animals (including humans) and the places they live.

NE plants and animals

SC.K.7.2.d **Communicate solutions** that will increase the positive impact of humans on the land, water, air, and/or other living things in the local environment.

NE conservation organizations and agricultural practices

SC.K.12 Weather and Climate

SC.K.12.3 Gather, analyze, and communicate evidence of weather and climate.

SC.K.12.3.a **Use and share observations** of local weather conditions to describe patterns over time. Assessment of quantitative observations limited to whole numbers and relative measures such as warmer/cooler.

SC.K.12.3.b **Ask questions to obtain information** about the purpose of weather forecasting to prepare for, and respond to, severe weather.

emphasis on blizzards, tornadoes, drought, and floods

SC.K.12.3.c **Make observations to determine** the effect of sunlight on Earth's surface.

SC.K.12.3.d **Use tools and materials to design and build a structure** that will reduce the warming effect of sunlight on an area.

SC.K.12.3.e **Ask questions, make observations, and gather information** about a situation people want to change to **define a simple problem that can be solved** through the development of a new or improved object or tool.

GRADE 1

The grade 1 standards and indicators help students gather, analyze, and communicate evidence as they formulate answers to questions tailored to student interest and current topics that may include but are not limited to:

What happens when materials vibrate?
Students are expected to develop understanding of the relationship between sound and vibrating materials.

What happens when there is no light?
Students are expected to develop understanding of the relationship between the availability of light and the ability to see objects. The idea that light travels from place to place can be understood by students at this level through determining the effect of placing objects made with different materials in the path of a beam of light.

What are some ways plants and animals meet their needs so they can survive and grow?
Students are also expected to develop understanding of how plants and animals use their external parts to help them survive, grow, and meet their needs as well as how the behaviors of parents and offspring help offspring survive.

How are parents and their children similar and different?
The understanding is developed that young plants and animals are like, but not exactly the same as, their parents.

What objects are in the sky and how do they seem to move?
Students are able to observe, describe, and predict some patterns of the movement of objects in the sky.

SC.1.2 Waves: Light and Sound
SC.1.2.1 Gather, analyze, and communicate evidence of light and sound waves.

SC.1.2.1.a **Plan and conduct investigations** to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.

SC.1.2.1.b **Make observations to construct** an evidence-based explanation that objects can be seen only when illuminated.

SC.1.2.1.c **Plan and conduct an investigation** to determine the effect of placing objects made with different materials in the path of a beam of light. Assessment does not include the speed of light.

SC.1.2.1.d **Use tools and materials to design and build** a device that uses light or sound to solve the problem of communicating over a distance. Assessment does not include technological details for how communication devices work.

SC.1.6 Structure, Function, and Information Processing
SC.1.6.2 Gather, analyze, and communicate evidence to show the relationship between structure and function in living things.

SC.1.6.2.a **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.

NE plants and animals

SC.1.6.2.b **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.

SC.1.6.2.c **Read grade appropriate texts and use media to determine** patterns in a behavior of parents and offspring that help offspring survive.

NE plants and animals

SC.1.6.2.d **Make observations to construct an evidence-based account** that young plants and animals are like, but not exactly like, their parents. Assessment does not include inheritance or animals that undergo metamorphosis or hybrids.

NE plants and animals

SC.1.11 Space Systems: Patterns and Cycles

SC.1.11.3 Gather, analyze, and communicate evidence of patterns and cycles of space systems.

SC.1.11.3.a **Use observations** of the sun, moon, and stars to describe patterns that can be predicted. Assessment of star patterns is limited to stars being seen at night and not during the day.

SC.1.11.3.b **Make observations** at different times of the year to relate the amount of daylight to the time of year. Assessment is limited to relative amounts of daylight, not quantifying the hours or time of daylight.

GRADE 2

The grade 2 standards and indicators help students gather, analyze, and communicate evidence as they formulate answers to questions tailored to student interest and current topics that may include but are not limited to:

How are materials similar and different from one another and how do the properties of the materials relate to their use?
An understanding of observable properties of materials is developed by students at this level through analysis and classification of different materials.

What do plants need to grow?
Students are expected to develop an understanding of what plants need to grow and how plants depend on animals for seed dispersal and pollination.

How many types of living things live in a place?
Students are expected to compare the diversity of life in different habitats.

How does land change and what causes it to change?
Students are able to apply their understanding of the idea that wind and water can change the shape of land to compare design solutions to slow or prevent such change.

What are the different kinds of land and bodies of water?
Students are able to use information and models to identify and represent the shapes and kinds of land and bodies of water in an area and where water is found on Earth.

SC.2.3 Structure and Properties of Matter
SC.2.3.1 Gather, analyze, and communicate evidence of the structure, properties, and interactions of matter.

SC.2.3.1.a **Plan and conduct an investigation** to describe and classify different kinds of materials by their observable properties.

Soil properties

SC.2.3.1.b **Analyze data obtained from testing different materials** to determine which materials have the properties that are best suited for an intended purpose. Assessment of quantitative measurements is limited to length and weight.

SC.2.3.1.c **Analyze data** from tests of two objects, **designed to solve the same problem**, to compare the strengths and weaknesses based on the properties.

SC.2.3.1.d **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.

SC.2.3.1.e **Construct an argument with evidence** that some changes caused by heating or cooling can be reversed and some cannot.

SC.2.7 Interdependent Relationships in Ecosystems
SC.2.7.2 Gather, analyze, and communicate evidence of interdependent relationships in ecosystems.

SC.2.7.2.a **Plan and conduct an investigation** to determine if plants need sunlight and water to grow. Assessment is limited to testing one variable at a time.

SC.2.7.2.b **Develop a simple model** that mimics the function of an animal in dispersing seeds or pollinating plants.

SC.2.7.2.c **Make observations** of plants and animals **to compare** the diversity of life in different habitats. Assessment does not include specific animal and plant names in specific habitats.

NE habitats

SC.2.13 Earth's Systems: Processes That Shape the Earth

SC.2.13.3 Gather, analyze, and communicate evidence of the processes that shape the earth.

SC.2.13.3.a **Use information from several sources to provide evidence** that Earth events can occur quickly or slowly. Assessment does not include quantitative measurements of timescales.

Flooding and tornadoes quickly cause change; wind slowly formed the Sandhills

SC.2.13.3.b **Compare multiple solutions designed to** slow or prevent wind or water from changing the shape of the land.

Soil conservation

SC.2.13.3.c **Develop a model to represent** the shapes and kinds of land and bodies of water in an area. Assessment does not include quantitative scaling in models.

Human made dams, sandbagging, windbreaks, terracing

SC.2.13.3.d **Obtain information to identify** where water is found on Earth and that it can be solid or liquid.

NE water bodies

GRADE 3

The grade 3 standards and indicators help students gather, analyze, and communicate evidence as they formulate answers to questions tailored to student interest and current topics that may include but are not limited to:

How do equal and unequal forces on an object affect the object?
Students are able to determine the effects of balanced and unbalanced forces on the motion of an object and the cause and effect relationships of electrical or magnetic interactions between two objects not in contact with each other.

How can magnets be used?
Students are able to apply their understanding of magnetic interactions to define a simple design problem that can be solved with magnets.

How do organisms vary in their traits?
Students are expected to develop an understanding of the similarities and differences of organisms' life cycles. Students develop an understanding that organisms have different inherited traits and that the environment can also affect the traits that an organism develops. In addition, students are able to construct an explanation using evidence for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.

How are plants, animals, and environments of the past similar or different from current plants, animals, and environments?
Students are expected to develop an understanding of types of organisms that lived long ago, and also about the nature of their environments.

What happens to organisms when their environment changes?
Students are expected to develop an understanding of the idea that when the environment changes some organisms survive and reproduce, some move to new locations, some move into the transformed environment, and some die.

What is typical weather in different parts of the world and during different times of the year?
Students are able to organize and use data to describe typical weather conditions expected during a particular season.

How can the impact of weather-related hazards be reduced?
By applying their understanding of weather-related hazards, students are able to make a claim about the merit of a design solution that reduces the impacts of such hazards.

SC.3.1 Forces and Interactions: Motion and Stability

SC.3.1.1 Gather, analyze, and communicate evidence of forces and their interactions.

SC.3.1.1.a **Plan and conduct an investigation** to provide evidence of the effects of balanced and unbalanced forces on the motion of an object. 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.

SC.3.1.1.b **Make observations and/or measurements** of an object's motion to provide evidence that a pattern can be used to predict future motion. Assessment does not include technical terms such as period and frequency.

SC.3.1.1.c **Ask questions** to determine cause and effect relationships of electrical or magnetic interactions between two objects not in contact with each other. Assessment is limited to forces produced by objects that can be manipulated by students. Electrical interactions are limited to static electricity.

SC.3.1.1.d **Define a simple design problem** that can be solved by applying scientific ideas about magnets.

SC.3.7 Interdependent Relationships in Ecosystems

SC.3.7.2 Gather, analyze, and communicate evidence of the interdependent relations in ecosystems.

SC.3.7.2.a **Construct an argument** that some animals form groups that help members survive.

NE animals

SC.3.7.2.b **SC.3.7.2.b Analyze and interpret data** from fossils to provide evidence of the organisms and environments in which they lived long ago. Assessment does not include identification of specific fossils or present plants and animals. Assessment is limited to major fossil types and relative ages.

NE fossils; NE geologic history

SC.3.7.2.c **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.

NE habitats

SC.3.7.2.d **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. Assessment is limited to a single environmental change. Assessment does not include the greenhouse effect or climate change.

NE habitats

SC.3.7.2.e **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.

SC.3.9 Inheritance and Variation: Life Cycles and Traits

SC.3.9.3 Gather and analyze data to communicate an understanding of inheritance and variation of traits through life cycles and environmental influences.

SC.3.9.3.a **Develop models** to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death. Assessment of plant life cycles is limited to those of flowering plants. Assessment does not include details of human reproduction.

NE plants and animals

SC.3.9.3.b **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. Assessment does not include genetic mechanisms of inheritance and prediction of traits. Assessment is limited to non-human examples.

NE plants and animals

SC.3.9.3.c **Use evidence to support the explanation** that traits can be influenced by the environment.

NE plants, animals, and habitats

SC.3.9.3.d **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.

NE plants, animals, and habitats

SC.3.12 Weather and Climate

SC.3.12.4 Gather and analyze data to communicate an understanding of weather and climate.

SC.3.12.4.a **Represent data** in table, pictograph, and bar graph displays to describe typical weather conditions expected during a particular season. Assessment of graphical displays is limited to pictographs and bar graphs. Assessment does not include climate change.

NE weather and climate

SC.3.12.4.b **Obtain and combine information** to describe climates in different regions of the world.

SC.3.12.4.c **Make a claim about the merit of a design solution** that reduces the impacts of a weather-related hazard.

GRADE 4

The grade 4 standards and indicators help students gather, analyze, and communicate evidence as they formulate answers to questions tailored to student interest and current topics that may include but are not limited to:

What are waves and what are some of the things they can do?
Students are able to use a model of waves to describe patterns of waves in terms of amplitude and wavelength, and that waves can cause objects to move.

What is energy and how is it related to motion?
Students are able to use evidence to construct an explanation of the relationship between the speed of an object and the energy of that object.

How is energy transferred?
Students are expected to develop an understanding that energy can be transferred from place to place by sound, light, heat, and electrical currents or from object to object through collisions.

How can energy be used to solve a problem?
They apply their understanding of energy to design, test, and refine a device that converts energy from one form to another.

How do internal and external structures support the survival, growth, behavior, and reproduction of plants and animals?
Students are expected to develop an understanding that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. By developing a model, students describe that an object can be seen when light reflected from its surface enters the eye.

How can water, ice, wind and vegetation change the land?
Students are expected to develop understanding of the effects of weathering or the rate of erosion by water, ice, wind or vegetation. They apply their knowledge of natural Earth processes to generate and compare multiple solutions to reduce the impacts of such processes on humans.

What patterns of Earth's features can be determined with the use of maps?
In order to describe patterns of Earth's features, students analyze and interpret data from maps.

SC.4.2 Waves: Waves and Information

SC.4.2.1 Gather, analyze, and communicate evidence of waves and the information they transfer.

SC.4.2.1.a **Develop a model** of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move. Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.

SC.4.2.1.b **Generate and compare multiple solutions** that use patterns to transfer information.

SC.4.4 Energy: Conservation and Transfer

SC.4.4.2 Gather, analyze and communicate evidence of energy conservation and transfer.

SC.4.4.2.a Use evidence to **construct an explanation** relating the speed of an object to the energy of that object. Assessment does not include quantitative measures of changes in the speed of an object or on any precise or quantitative definition of energy.

SC.4.4.2.b **Make observations** to provide evidence that energy can be transferred from place to place by sound, light, heat, and electrical currents. Assessment does not include quantitative measurements of energy.

NE energy producers

SC.4.4.2.c **Ask questions** and predict outcomes about the changes in energy that occur when objects collide. Assessment does not include quantitative measurements of energy.

SC.4.4.2.d Apply scientific ideas to **design, test, and refine a device** that converts energy from one form to another. 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.

SC.4.4.2.e **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.

SC.4.4.2.f **Obtain and combine information** to describe that energy and fuels are derived from natural resources and that their uses affect the environment.

NE ethanol production

SC.4.6 Structure, Function, and Information Processing

SC.4.6.3 Gather and analyze data to communicate an understanding of structure, function and information processing of living things.

SC.4.6.3.a **Develop a model** to describe that light reflecting from objects and entering the eyes allows objects to be seen. Assessment does not include knowledge of specific colors reflected and seen, the cellular mechanisms of vision, or how the retina works.

SC.4.6.3.b **Construct an argument** that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. Assessment is limited to macroscopic structures within plant and animal systems.

NE plants and animals

SC.4.6.3.c **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. Assessment does not include the mechanisms by which the brain stores and recalls information or the mechanisms of how sensory receptors function.

NE plants and animals

SC.4.13 Earth's Systems: Processes That Shape the Earth

SC.4.13.4 Gather and analyze data to communicate an understanding of Earth's systems and processes that shape the Earth.

SC.4.13.4.a **Identify evidence** from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time. 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.

NE fossils and geologic history

SC.4.13.4.b **Make observations and/or measurements** to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. Assessment is limited to a single form of weathering or erosion.

SC.4.13.4.c **Analyze and interpret data** from maps to describe patterns of Earth's features.

SC.4.13.4.d **Generate and compare multiple solutions** to reduce the impacts of natural Earth processes on humans.
Assessment is limited to earthquakes, floods, tsunamis, and volcanic eruptions.

GRADE 5

The grade 5 standards and indicators help students gather, analyze, and communicate evidence as they formulate answers to questions tailored to student interest and current topics that may include but are not limited to:

When matter changes, does its weight (mass) change?
Students are able to describe that matter is made of particles too small to be seen through the development of a model. Students develop an understanding of the idea that regardless of the type of change that matter undergoes, the total weight of matter is conserved.

Can new substances be created by combining other substances?
Students determine whether the mixing of two or more substances results in new substance.

How does matter cycle through ecosystems and where does the energy in food come from and what is it used for?
Students develop an understanding of the idea that plants get the materials they need for growth chiefly from air and water. Using models, students can describe the movement of matter among plants, animals, decomposers, and the environment and that energy in animals' food was once energy from the sun.

How much water can be found in different places on Earth and how does water move through the Earth system?
Students describe and graph data to provide evidence about the distribution of water on Earth. Through the development of a model using an example students are able to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. This model will also allow students to define a simple design problem that relates to the conservation of fresh water.

How do lengths and directions of shadows or relative lengths of day and night change from day to day, and how does the appearance of some stars change in different seasons?
Students are expected to develop an understanding of patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.

SC.5.3 Structure and Properties of Matter
SC.5.3.1 Gather, analyze, and communicate evidence of structure and properties of matter.

SC.5.3.1.a **Develop a model** to describe that matter is made of particles too small to be seen. Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.

SC.5.3.1.b **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. Assessment does not include distinguishing mass and weight.

SC.5.3.1.c **Make observations and measurements** to identify materials based on their properties. Assessment does not include density or distinguishing mass and weight.

SC.5.3.1.d **Conduct an investigation** to determine whether the mixing of two or more substances results in new substances.

SC.5.8 Matter and Energy in Organisms and Ecosystems
SC.5.8.2 Gather and analyze data to communicate understanding of matter and energy in organisms and ecosystems.

SC.5.8.2.a **Use models** to describe that energy in animals' food (used for body repair, growth, and motion and to maintain body warmth) was once energy from the sun.

SC.5.8.2.b **Support an argument** that plants get the materials they need for growth chiefly from air and water.

SC.5.8.2.c **Develop a model** to describe the movement of matter among plants, animals, decomposers, and the environment. Assessment does not include molecular explanations or the biochemical mechanisms of photosynthesis.

NE ecosystems

SC.5.11 Space Systems: Earth's Stars and Solar System

SC.5.11.3 Gather and analyze data to communicate understanding of space systems: Earth's stars and solar system.

SC.5.11.3.a **Support an argument** that the gravitational force exerted by Earth on objects is directed down toward Earth's center. Assessment does not include mathematical representation of gravitational force.

SC.5.11.3.b **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 is limited to relative distances, not sizes, of stars. Assessment does not include other factors that affect apparent brightness (such as stellar masses, age, and stage).

SC.5.11.3.c **Represent data in graphical displays** to reveal patterns of daily changes in the length and direction of shadows, length of day and night, and the seasonal appearance of some stars in the night sky. Assessment does not include causes of seasons.

SC.5.13 Earth's Systems

SC.5.13.4 Gather and analyze data to communicate understanding of Earth's systems.

SC.5.13.4.a **Develop a model** using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. Assessment is limited to the interactions of two systems at a time.

NE systems

SC.5.13.4.b **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 is limited to oceans, lakes, rivers, glaciers, groundwater, and polar ice caps but does not include the atmosphere.

NE bodies of water

SC.5.13.4.c **Obtain and combine information** about ways individual communities use science ideas to protect the Earth's resources and environment.

NE conservation organizations

SC.5.13.4.d **Define a simple design problem** that can be solved by applying scientific ideas about the conservation of fresh water on Earth.

NE conservation organizations

SC.5.13.4.e **Define a simple design problem** reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

GRADE 6

The grade 6 standards and indicators help students gather, analyze, and communicate evidence as they formulate answers to questions tailored to student interest and current topics that may include but are not limited to:

How can energy be transferred from one object or system to another?
Students are expected to know the difference between energy and temperature and begin to develop an understanding of the relationship between force and energy. Students are also expected to apply an understanding of design to the process of energy transfer.

How do the structures of organisms contribute to life's functions?
Students are expected to understand that all organisms are made of cells, that special structures are responsible for particular functions in organisms, and that for many organisms the body is a system of multiple interacting subsystems that form a hierarchy from cells to the body.

How do organisms grow, develop, and reproduce?
Students are expected to explain how select structures, functions, and behaviors of organisms change in predictable ways as they progress from birth to old age.

What factors interact and influence weather and climate?
Students are expected to construct and use models to develop an understanding of the factors that determine weather and climate. A systems approach is also important here, examining the feedbacks between systems as energy from the sun is transferred between systems and circulates through the oceans and atmosphere.

How does water move through Earth's systems?
Students understand how Earth's geosystems operate by modeling the flow of energy and cycling of matter within and among different systems.

SC.6.4 Energy

SC.6.4.1 Gather, analyze, and communicate evidence of energy.

SC.6.4.1.a Apply scientific principles to **design, construct, and test a device** that either minimizes or maximizes thermal energy transfer. Assessment does not include calculating the total amount of thermal energy transferred.

SC.6.4.1.b **Define the criteria and constraints of a design problem** with sufficient precision to ensure a successful solution, taking into account relevant scientific principle and potential impacts on people and the natural environment that may limit possible solutions.

SC.6.4.1.c **Plan an investigation** to determine the relationships among the energy transferred, type of matter, mass, and change in average kinetic energy of particles as measured by the temperature of the sample. Assessment does not include calculating the total amount of thermal energy transferred.

SC.6.4.1.d **Construct, use, and present arguments** to support the claim that when kinetic energy of an object changes, energy is transferred to or from the object. Assessment does not include calculations of energy.

SC.6.6 Structure and Function and Information Processing

SC.6.6.2 Gather, analyze, and communicate evidence of the relationship between structure and function in living things.

SC.6.6.2.a **Conduct an investigation** to provide evidence that living things are made of cells; either one cell or many varied cells.

SC.6.6.2.b **Develop and use a model** to describe the function of a cell as a whole and ways parts of a cell contribute to the function. 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.

SC.6.6.2.c **Use argument supported by evidence** for how the body is a system of interacting subsystems composed of groups of cells. 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.

SC.6.6.2.d **Gather and synthesize information** that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or stored as memories. Assessment does not include mechanisms for the transmission of this information.

SC.6.9 Growth, Development, and Reproduction of Organisms

SC.6.9.3 Gather, analyze, and communicate evidence of the inheritance and variation of traits.

SC.6.9.3.a **Construct an argument** based on evidence for how plant and animal adaptations affect the probability of successful reproduction.

monarchs/milkweed; seed dispersal in prairie grasses

SC.6.9.3.b **Construct a scientific explanation** based on evidence for how environmental and genetic factors influence the growth of organisms. Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.

NE plants and animals

SC.6.9.3.c **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. Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.

SC.6.12 Weather and Climate

SC.6.12.4 Gather, analyze, and communicate evidence of factors and interactions that affect weather and climate.

SC.6.12.4.a **Collect data** to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions. Assessment does not include recalling the names of cloud types or weather symbols used on weather maps or the reported diagrams from weather stations.

NE weather conditions

SC.6.12.4.b **Develop and use a model** to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. Assessment does not include the dynamics of the Coriolis effect.

SC.6.12.4.c **Ask questions** to clarify evidence of the factors that have caused the change in global temperatures over thousands of years.

SC.6.12.4.d **Analyze and interpret data** on weather and climate to forecast future catastrophic events and inform the development of technologies to mitigate their effect.

SC.6.13 Earth's Systems

SC.6.13.5 Gather, analyze, and communicate evidence of the flow of energy and cycling of matter associated with Earth's materials and processes.

SC.6.13.5.a **Develop a model** to describe how the water cycle is driven by the sun's energy and the force of gravity.

A quantitative understanding of the latent heat of vaporization and fusion is not assessed.

NE systems

GRADE 7

The grade 7 standards and indicators help students gather, analyze, and communicate evidence as they formulate answers to questions tailored to student interest and current topics that may include but are not limited to:

How does thermal energy affect particles?
Students will be able to provide molecular level descriptions that explain states of matter and changes between states.

Why do different pure substances have different physical and chemical properties and how do those properties determine how substances are used?
Students are expected to understand what occurs at the atomic molecular scales.

What happens when new materials are formed?
Students are expected to provide molecular level descriptions to explain that chemical reactions involve regrouping of atoms to form new substances and that atoms rearrange during chemical reactions.

How do organisms obtain and use energy?
Students are expected to use conceptual and physical models to explain the transfer of energy and cycling of matter as they construct explanations for the role of photosynthesis in cycling matter in ecosystems.

How does matter and energy move through an ecosystem?
Students are expected to construct explanations for the cycling of matter in organisms and the interaction of organisms to obtain matter and energy from an ecosystem to survive and grow.

How do organisms interact with other organisms in the physical environment to obtain matter and energy?
Students are expected to understand that organisms and populations of organisms are dependent on their environmental interactions both with other organisms and with non-living factors.

How do people figure out that Earth and life on Earth have changed over time?
Students are expected to examine geoscience data in order to understand the processes and events in Earth's history.

How do the materials in and on Earth's crust change over time?
Students are expected to understand how Earth's geosystems operate by modeling the flow of energy and the cycling of matter within and among different systems.

How do human activities affect Earth's systems?
Students are expected to understand the ways that human activities impact Earth's other systems

SC.7.3 Structure and Properties of Matter
SC.7.3.1 Gather, analyze, and communicate evidence of the structure, properties, and interactions of matter.

SC.7.3.1.a **Develop models** to describe the atomic composition of simple molecules. Assessment does not include valence electrons and bonding energy, discussing the ionic nature of subunits of complex structures, or a complete description of all individual atoms in a complex molecule or extended structure is not required.

SC.7.3.1.b **Gather and make sense of information** to describe how natural materials may undergo chemical reactions to create new synthetic materials and have an impact on society. Assessment is limited to qualitative information.

SC.7.3.1.c **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.

SC.7.5 Chemical Reactions

SC.7.5.2 Gather, analyze, and communicate evidence of chemical reactions.

SC.7.5.2.a **Analyze and interpret data** on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. Assessment is limited to analysis of the following properties: density, melting point, boiling point, solubility, flammability, and odor.

SC.7.5.2.b **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. Assessment does not include the use of atomic masses, balancing symbolic equations, or intermolecular forces.

SC.7.5.2.c **Undertake a design project** to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes. Assessment is limited to the criteria of amount, time, and temperature of substance in testing the device.

SC.7.5.2.d **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.

SC.7.7 Interdependent Relationships in Ecosystems

SC.7.7.3 Gather, analyze, and communicate evidence of interdependent relationships in ecosystems.

SC.7.7.3.a **Construct an explanation** that predicts patterns of interactions among organisms across multiple ecosystems.

NE ecosystems

SC.7.7.3.b **Develop and use a model** to describe how stable ecosystems maintain biodiversity and ecosystem services.

NE endangered species and reintroduction of species

SC.7.7.3.c **Evaluate competing design solutions** using a systematic process to determine how well they meet the criteria and constraints of the problem.

SC.7.7.3.d Apply scientific principles to **design a method for monitoring and increasing positive human impact** on the environment.

SC.7.8 Matter and Energy in Organisms and Ecosystems

SC.7.8.4 Gather, analyze, and communicate evidence of the flow of energy and cycling of matter in organisms and ecosystems.

SC.7.8.4.a **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. Assessment does not include the biochemical mechanisms of photosynthesis.

NE food webs

SC.7.8.4.b **Develop a model** to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as matter moves through an organism. Assessment does not include details of the chemical reactions for photosynthesis or respiration.

SC.7.8.4.c **Analyze and interpret data** to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

NE plants and animals

SC.7.8.4.d **Develop a model** to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. Assessment does not include the use of chemical reactions to describe the processes.

NE ecosystems

SC.7.8.4.e **Construct an argument** supported by evidence that changes to physical or biological components of an ecosystem affect populations.

NE ecosystems

SC.7.13 Earth's Systems

SC.7.13.5 Gather, analyze, and communicate evidence of the flow of energy and cycling of matter associated with Earth's materials and processes.

SC.7.13.5.a **Develop a model** to describe the cycling of Earth's materials and the flow of energy that drives this process. Assessment does not include the identification and naming of minerals.

SC.7.13.5.b **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.

NE resources

SC.7.13.5.c **Construct an argument** supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

Food security and NE agriculture

SC.7.14 History of Earth

SC.7.14.6 Gather, analyze, and communicate evidence to explain Earth's history.

SC.7.14.6.a **Construct an explanation** based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.

NE geographic features

SC.7.14.6.b **Analyze and interpret data** on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of past plate motions. Paleomagnetic anomalies in oceanic and continental crust are not assessed.

SC.7.14.6.c **Analyze and interpret data** on geologic hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

GRADE 8

The grade 8 standards and indicators help students gather, analyze, and communicate evidence as they formulate answers to questions tailored to student interest and current topics that may include but are not limited to:

How can one describe physical interactions between objects and within systems of objects?
Students will be expected to apply Newton's Third Law of Motion to relate forces to explain the motion of objects. Students also apply ideas about gravitational, electrical, and magnetic forces to explain a variety of phenomena including beginning ideas about why some materials attract each other while other repel.

How does the energy of an object change related to its mass, speed, and position in a system?
Students understand that objects that are moving have kinetic energy and that objects may also contain stored (potential) energy, depending on their relative positions.

What are the characteristic properties of waves and how can they be used?
Students are expected to describe and predict characteristic properties and behaviors of waves when the waves interact with matter. Students can apply an understanding of waves as a means to send digital information.

What factors cause genes to change and how does that affect the structure and function of organisms?
Students are expected to understand the ways humans can select for specific traits, the role of technology, genetic modification, and the nature of ethical responsibilities related to selective breeding.

How does genetic variation among organisms in a species affect survival and reproduction? How does the environment influence genetic traits in populations over multiple generations?
Students are expected to analyze data from the fossil record to describe evidence of the history of life on Earth and can construct explanations for similarities in organisms. They have a beginning understanding of the role of variation in natural selection and how this leads to speciation.

What is Earth's place in the Universe? What makes up our solar system and how can the motion of Earth explain seasons and eclipses?
Students are expected to examine the Earth's place in relation to the solar system, Milky Way galaxy, and universe. There is a strong emphasis on a systems approach, using models of the solar system to explain astronomical and other observations of the cyclic patterns of eclipses, tides, and seasons

SC.8.1 Forces and Interactions
SC.8.1.1 Gather, analyze, and communicate evidence of forces and interactions.

SC.8.1.1.a Apply Newton's Third Law to **design a solution** to a problem involving the motion of two colliding objects.
Assessment is limited to vertical or horizontal interactions in one dimension.

SC.8.1.1.b **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.

SC.8.1.1.c **Plan an investigation** to provide evidence of Newton's Laws that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. 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; does not include use of trigonometry.

SC.8.1.1.d **Ask questions** about data to determine the factors that affect the strength of electrical and magnetic forces. Assessment about questions that require quantitative answers is limited to proportional reasoning and algebraic thinking.

SC.8.1.1.e **Construct and present arguments** using evidence to support the claim that gravitational interactions are attractive and depend on both the mass and distance of interacting objects. Assessment does not include Newton's Law of Gravitation or Kepler's Laws.

SC.8.1.1.f **Conduct an investigation** and evaluate the experimental design to provide evidence that electrical and magnetic fields exist between objects exerting forces on each other even though the objects are not in contact. Assessment is limited to electric and magnetic fields, and limited to qualitative evidence for the existence of fields.

SC.8.2 Waves and Electromagnetic Radiation

SC.8.2.2 Gather, analyze, and communicate evidence of waves and electromagnetic radiation.

SC.8.2.2.a **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. Assessment does not include electromagnetic waves and is limited to standard repeating waves.

SC.8.2.2.b **Develop and use a model** to describe that Light and mechanical waves are reflected, absorbed, or transmitted through various materials. Assessment is limited to qualitative applications pertaining to light and mechanical waves.

SC.8.2.2.c **Gather and make sense of information** to support the claim that the structure of analog and digital signals allows for encoding and transmission of information.

SC.8.4 Energy

SC.8.4.3 Gather, analyze, and communicate evidence of energy.

SC.8.4.3.a **Construct and interpret graphical displays of data** to describe the relationships of kinetic energy to the mass and speed of an object.

SC.8.4.3.b **Develop a model** to describe that when the arrangement of objects interacting at a distance changes, then different amounts of potential energy are stored in the system. Assessment is limited to two objects. Assessment is limited to electric, magnetic, and gravitational interactions.

SC.8.9 Heredity: Inheritance and Variation of Traits

SC.8.9.4 Gather, analyze, and communicate evidence of the inheritance and variation of traits.

SC.8.9.4.a **Develop and use a model** to describe why structural changes to genes (mutations) may result in harmful, beneficial, or neutral effects to structure and function of organisms. Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.

SC.8.9.4.b **Gather and synthesize information** about technologies that have changed the way humans influence inheritance of desired traits in organisms.

NE agriculture practices

SC.8.10 Natural Selection and Adaptations

SC.8.10.5 Gather, analyze, and communicate evidence of natural selection and adaptations.

SC.8.10.5.a **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. Assessment does not include the names of individual species or geological eras in the fossil record.

NE Geological History

SC.8.10.5.b **Apply scientific ideas to construct an explanation** for the anatomical similarities and differences among and between modern and fossil organisms to infer evolutionary relationships.

NE Geological History

SC.8.10.5.c **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.

SC.8.10.5.d **Use mathematical representations** to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. Assessment does not include Hardy Weinberg calculations.

NE plants and animals

SC.8.11 Space Systems

SC.8.11.6 Gather, analyze, and communicate evidence of the interactions among bodies in space.

SC.8.11.6.a **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.

SC.8.11.6.b **Develop and use a model** to describe the role of gravity in the motions within the galaxy and the solar system. Assessment does not include Kepler's Laws of orbital motion or the apparent retrograde motion of planets as viewed from Earth.

SC.8.11.6.c **Analyze and interpret data** to determine scale properties of objects in the solar system. Assessment does not include recalling facts about properties of the planets and other solar system bodies.

SC.8.14 History of Earth

SC.8.14.7 Gather, analyze, and communicate evidence to explain Earth's history.

SC.8.14.7.a **Construct a scientific explanation** based on evidence found within rock strata, including index fossils, for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history. Assessment does not include recalling the names of specific periods or epochs and events within them.

NE Geological History

HS PHYSICAL SCIENCES

The physical science standards and indicators help students gather, analyze, and communicate evidence as they formulate answers to questions tailored to student interest and current topics that may include but are not limited to:

How can one explain the structure and properties of matter?
Students are expected to develop understanding of the substructure of atoms and provide more mechanistic explanations of the properties of substances. Students are able to use the periodic table as a tool to explain and predict the properties of elements.

How do substances combine or change (react) to make new substances? How does one characterize and explain these reactions and make predictions about them?"
Students will be able to explain important biological and geophysical phenomena. Students are also able to apply an understanding of the process of optimization in engineering design to chemical reaction systems.

How can one explain and predict interactions between objects and within systems of objects?
Students are expected to build an understanding of forces and interactions, total momentum of a system of objects is conserved when there is no net force on the system, and predict the gravitational and electrostatic forces between objects. Students are able to apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.

How is energy transferred and conserved?
Students are expected to develop an understanding that energy at both the macroscopic and the atomic scale can be accounted for as either motions of particles or energy associated with the configuration (relative positions) of particles. In some cases, the energy associated with the configuration of particles can be thought of as stored in fields.

How are waves used to transfer energy and send and store information?
Students are expected to apply understanding of how wave properties and the interactions of electromagnetic radiation with matter can transfer information across long distances, store information, and investigate nature on many scales.

SC.HS.1 Forces and Interactions
SC.HS.1.1 Gather, analyze, and communicate evidence of forces and interactions.

SC.HS.1.1.a **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. Assessment is limited to one-dimensional motion and to macroscopic objects moving at non-relativistic speeds.

SC.HS.1.1.b **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. Assessment is limited to systems of two macroscopic bodies moving in one dimension.

NE roadside and highway safety

SC.HS.1.1.c **Apply science and engineering ideas to design, evaluate, and refine** a device that minimizes the force on a macroscopic object during a collision. Assessment is limited to qualitative evaluations and/or algebraic manipulations.

SC.HS.1.1.d **Use mathematical representations** of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. Assessment is limited to systems with two objects.

SC.HS.1.1.e **Plan and conduct an investigation** to provide evidence that an electrical current can produce a magnetic field and that a changing magnetic field can produce an electrical current. Assessment is limited to designing and conducting investigations with provided materials and tools.

NE energy producers

SC.HS.2 Waves and Electromagnetic Radiation

SC.HS.2.2 Gather, analyze, and communicate evidence of the interactions of waves.

SC.HS.2.2.a **Use mathematical representations** to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. Assessment is limited to algebraic relationships and describing those relationships qualitatively.

SC.HS.2.2.b **Evaluate claims** about the advantages of digital transmission and storage of information.

SC.HS.2.2.c **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. Assessment does not include using quantum theory.

SC.HS.2.2.d **Evaluate the validity and reliability of claims** in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter. Assessment is limited to qualitative descriptions.

SC.HS.2.2.e **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. Assessments are limited to qualitative information. Assessments do not include band theory.

SC.HS.3 Structure and Properties of Matter

SC.HS.3.3 Gather, analyze, and communicate evidence of the structure, properties, and interactions of matter.

SC.HS.3.3.a **Use the periodic table as a model** to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.

NE Geology

SC.HS.3.3.b **Plan and conduct an investigation** to gather evidence to compare the structure of substances at the macro scale to infer the strength of electrical forces between particles. Assessment does not include Raoult's law calculations of vapor pressure.

SC.HS.3.3.c **Develop models** to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay. Assessment does not include quantitative calculation of energy released. Assessment is limited to alpha, beta, and gamma radioactive decays.

NE Geologic history and nuclear power production

SC.HS.3.3.d **Communicate scientific and technical information** about why the molecular-level structure is important in the functioning of designed materials. Assessment is limited to provided molecular structures of specific designed materials.

NE manufacturers

SC.HS.4 Energy

SC.HS.4.4 Gather, analyze, and communicate evidence of the interactions of energy.

SC.HS.4.4.a **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. 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.

SC.HS.4.4.b **Develop and use models** to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects).

SC.HS.4.4.c **Design, build, and refine a device** that works within given constraints to convert one form of energy into another form of energy. Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.

NE energy producers

SC.HS.4.4.d **Analyze a major global challenge** to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

SC.HS.4.4.e **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). Assessment is limited to investigations based on materials and tools provided to students.

SC.HS.4.4.f **Develop and use a model** of two objects interacting through electrical or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. Assessment is limited to systems containing two objects.

SC.HS.5 Chemical Reactions

SC.HS.5.5 Gather, analyze, and communicate evidence of chemical reactions.

SC.HS.5.5.a **Construct and revise an explanation** for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. Assessment is limited to chemical reactions involving main group elements and combustion reactions.

NE energy and ethanol production

SC.HS.5.5.b **Develop a model** to illustrate that the release or absorption of energy from a chemical reaction system depends on the changes in total bond energy. Assessment does not include calculating the total bond energy changes during a chemical reaction from the bond energies of reactants and products.

NE energy and ethanol production

SC.HS.5.5.c **Apply scientific principles** and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. Assessment is limited to simple reactions in which there are only two reactants; evidence from temperature, concentration, and rate data; and qualitative relationships between rate and temperature.

NE energy and ethanol production

SC.HS.5.5.d **Refine the design** of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. Assessment is limited to specifying the change in only one variable at a time. Assessment does not include calculating equilibrium constants and concentrations.

NE energy and ethanol production

SC.HS.5.5.e **Design a solution** to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

SC.HS.5.5.f **Use mathematical representations** to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. Assessment does not include complex chemical reactions.

NE energy and ethanol production

HS LIFE SCIENCES

The life science standards and indicators help students gather, analyze, and communicate evidence as they formulate answers to questions tailored to student interest and current topics that may include but are not limited to:

How do the structures of organisms enable life's functions?
Students are expected to investigate explanations for the structure and function of cells as the basic units of life, the hierarchical systems of organisms, and the role of specialized cells for maintenance and growth. Students will demonstrate understanding of how systems of cells function together to support the life processes.

How are the characteristics from one generation related to the previous generation?
High school students demonstrate understanding of the relationship of DNA and chromosomes in the processes of cellular division that pass traits from one generation to the next. Students can determine why individuals of the same species vary in how they look, function, and behave. Ethical issues related to genetic modification of organisms and the nature of science can be described.

How do organisms obtain and use energy they need to live and grow? How do matter and energy move through ecosystems?
Students will be expected to develop understanding of organisms' interactions with each other and their physical environment, how organisms obtain resources, change the environment, and how these changes affect both organisms and ecosystems. Students will use mathematical concepts to construct explanations for the role of energy in the cycling of matter in organisms and ecosystems.

How do organisms interact with the living and non-living environment to obtain matter and energy?
Students will be expected to investigate the role of biodiversity in ecosystems and the role of animal behavior on survival of individuals and species. Students will develop increased understanding of interactions among organisms and how those interactions influence the dynamics of ecosystems.

How can there be so many similarities among organisms yet so many different plants, animals, and microorganisms? How does biodiversity affect humans?
Students will be expected to demonstrate understanding of the factors causing natural selection and the process of evolution of species over time. They demonstrate understanding of how multiple lines of evidence contribute to the strength of scientific theories of natural selection and evolution

SC.HS.6 Structure and Function

SC.HS.6.1 Gather, analyze, and communicate evidence of the relationship between structure and function in living things.

SC.HS.6.1.a **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 does not include identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the biochemistry of protein synthesis.

NE agricultural practices

SC.HS.6.1.b **Develop and use a model** to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. Assessment does not include interactions and functions at the molecular or chemical reaction level.

SC.HS.6.1.c **Plan and conduct an investigation** to provide evidence that feedback mechanisms maintain homeostasis. Assessment does not include the cellular processes involved in the feedback mechanism.

NE agricultural practices

SC.HS.6.1.d **Use a model** to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. Assessment does not include specific gene control mechanisms or rote memorization of the steps of mitosis.

SC.HS.7 Interdependent Relationships in Ecosystems

SC.HS.7.2 Gather, analyze, and communicate evidence of interdependent relationships in ecosystems.

SC.HS.7.2.a **Use mathematical and/or computational representations to support explanations** of factors that affect carrying capacity of ecosystems at different scales. Assessment does not include deriving mathematical equations to make comparisons.

SC.HS.7.2.b **Use mathematical representations** to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. Assessment is limited to provided data.

SC.HS.7.2.c **Evaluate the claims, evidence, and reasoning** that the interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

NE river systems and ecosystems

SC.HS.7.2.d **Evaluate the evidence** for how group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives.

SC.HS.7.2.e **Design, evaluate, and refine a solution** for increasing the positive impacts of human activities on the environment and biodiversity.

NE native species, conservation organizations, agriculture practices

SC.HS.7.2.f **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. Assessment is limited to testing solutions for a proposed problem related to threatened or endangered species, or to genetic variation of organisms for multiple species.

SC.HS.8 Matter and Energy in Organisms and Ecosystems

SC.HS.8.3 Gather, analyze, and communicate evidence of the flow of energy and cycling of matter in organisms and ecosystems.

SC.HS.8.3.a **Use a model** to illustrate how photosynthesis transforms light energy into stored chemical energy. Assessment does not include specific biochemical steps.

SC.HS.8.3.b **Construct and revise an explanation** based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other molecules to form the four basic macromolecules. Assessment does not include the details of the specific chemical reactions or identification of macromolecules.

SC.HS.8.3.c **Use a model** to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules are broken and bonds in new compounds are formed resulting in a net transfer of energy. Assessment should not include identification of the steps or specific processes involved in cellular respiration.

SC.HS.8.3.d **Construct and revise an explanation** based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions. Assessment does not include the specific chemical processes of either aerobic or anaerobic respiration.

NE ethanol production

SC.HS.8.3.e **Use mathematical representations** to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.

NE agricultural practices

SC.HS.8.3.f **Develop a model** to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere. Assessment does not include the specific chemical steps of photosynthesis and respiration.

SC.HS.9 Heredity: Inheritance and Variation of Traits

SC.HS.9.4 Gather, analyze, and communicate evidence of the inheritance and variation of traits.

SC.HS.9.4.a **Develop and use a model** to explain the relationships between the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring. Assessment does not include the phases of meiosis or the molecular mechanism of specific steps in the process.

NE agricultural practices

SC.HS.9.4.b **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. Assessment does not include the phases of meiosis or the molecular mechanism of specific steps in the process.

NE plants and animals

SC.HS.9.4.c **Apply concepts of statistics and probability** to explain the variation and distribution of expressed traits in a population. Assessment does not include Hardy-Weinberg calculations.

NE plants and animals

SC.HS.10 Biological Evolution

SC.HS.10.5 Gather, analyze, and communicate evidence of biological evolution.

SC.HS.10.5.a **Communicate scientific** information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.

NE fossil record

SC.HS.10.5.b **Construct an explanation** based on evidence that natural selection 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 reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment. Assessment does not include other mechanisms of evolution, such as genetic drift, gene flow through migration, and co-evolution.

NE plants and animals

SC.HS.10.5.c **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. Assessment is limited to basic statistical and graphical analysis. Assessment does not include allele frequency calculations.

NE plants and animals

SC.HS.10.5.d **Construct an explanation** based on evidence for how natural selection leads to adaptation of populations.

SC.HS.10.5.e **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.

NE plants and animals

HS EARTH AND SPACE SCIENCES

The earth and space science standards and indicators help students gather, analyze, and communicate evidence as they formulate answers to questions tailored to student interests and current topics that may include but are not limited to:

What is the universe and what goes on in stars? What are the predictable patterns caused by Earth's movement in the solar system?
Students examine the processes governing the formation, evolution, and workings of the solar system and universe in order to understand how matter in the universe formed and how short-term changes in the behavior of the sun directly affect humans. Engineering and technology play a large role here in obtaining and analyzing data that support theories of the formation of the solar system and universe.

How do people reconstruct and date events in Earth's planetary history? Why do the continents move?
Students can construct explanations for the scales of time over which Earth processes operate. An important aspect of the earth and space sciences involves making inferences about events in Earth's history based on a data record that is increasingly incomplete the farther one goes back in time.

How do the properties and movements of water shape Earth's surface and affect its systems?
Students develop models and explanations for the ways that feedbacks between different Earth systems control the appearance of Earth's surface. Central to this in the tension between internal systems, which are largely responsible for creating and at Earth's surface and the sun-driven surface systems that tear down land through weathering and erosion. Students understand the role water plays in affecting weather and understand chemical cycles in Earth's systems.

What regulates weather and climate?
Students understand the system interactions that control weather and climate. Students can understand the analysis and interpretation of different kinds of geoscience data allow student to construct explanations for the many factors that drive climate change over a wide range of timescales.

How do humans depend on Earth's resources? How do people model and predict the effects of human activities?
Students understand the complex and significant interdependencies between humans and the rest of Earth's systems through the impacts of natural hazards, our dependencies on natural resources, and the environmental impacts of human activities

SC.HS.11 Space Systems
SC.HS11.1. Gather, analyze, and communicate evidence to defend that the universe changes over time.

SC.HS.11.1.a **Use a model** based on evidence to illustrate how the stages of stars and the role of nuclear fusion in a star's core releases energy that reaches Earth in the form of radiation. Assessment does not include details of the atomic and sub-atomic processes involved with the sun's nuclear fusion.

SC.HS.11.1.b **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.

SC.HS.11.1.c **Communicate scientific ideas** about the way stars, throughout their stellar stages, produce elements. Details of the many different nucleosynthesis pathways for stars of differing masses are not assessed.

SC.HS.11.1.d **Use mathematical or computational representations** to predict the motion of orbiting objects in the solar system. 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.

SC.HS.12 Weather and Climate

SC.HS.12.2 Gather, analyze, and communicate evidence to support that Earth's climate and weather are influenced by energy flow through Earth systems.

SC.HS.12.2.a **Construct an explanation based on evidence** for how the sun's energy moves among Earth's systems.

SC.HS.12.2.b **Use a model** to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. 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.

SC.HS.12.2.c **Analyze geoscience data** and the results from global climate models to make an evidence-based forecast of the current rate and scale of global or regional climate changes.

NE data

SC.HS.12.2.d **Evaluate the validity and reliability** of past and present models of Earth conditions to make projections of future climate trends and their impacts.

SC.HS.13 Earth's Systems

SC.HS.13.3 Gather, analyze, and communicate evidence to defend the position that Earth's systems are interconnected and impact one another.

SC.HS.13.3.a **Analyze geoscience data** to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

NE geologic time scale and fossil record

SC.HS.13.3.b **Develop a model** based on evidence of Earth's interior to describe the cycling of matter.

SC.HS.13.3.c **Construct an argument based on evidence** to explain the multiple processes that cause Earth's plates to move.

SC.HS.13.3.d **Plan and conduct an investigation** of the properties of water and their effects on Earth materials, surface processes, and groundwater systems.

NE water systems

SC.HS.13.3.e **Develop a quantitative model** to describe the cycling of carbon and other nutrients among the hydrosphere, atmosphere, geosphere, and biosphere, today and in the geological past.

SC.HS.14 History of Earth

SC.HS.14.4 Gather, analyze, and communicate evidence to interpret Earth's history.

SC.HS.14.4.a **Evaluate evidence** of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the differences in age, structure, and composition of crustal and sedimentary rocks.

SC.HS.14.4.b **Apply scientific reasoning** and evidence from ancient Earth materials, meteorites, and other planetary surfaces to reconstruct Earth's formation and early history.

SC.HS.14.4.c **Develop a model** to illustrate how Earth's internal and surface processes operate over time to form, modify, and recycle continental and ocean floor features. Assessment does not include memorization of the details of the formation of specific geographic

features of Earth's surface.

NE water systems and surface processes

SC.HS.14.4.d **Construct an argument** based on evidence to validate coevolution of Earth's systems and life on Earth. Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems.

SC.HS.15 Sustainability

SC.HS.15.5 Gather, analyze, and communicate evidence to describe the interactions between society, environment, and economy.

SC.HS.15.5.a **Construct an explanation based on evidence** for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

NE historical events

SC.HS.15.5.b **Evaluate competing design solutions** for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

SC.HS.15.5.c **Use a computational simulation** to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. Assessment is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.

NE resource management

SC.HS.15.5.d **Evaluate or refine a technological solution** that increases positive impacts of human activities on natural systems.

SC.HS.15.5.e **Evaluate a solution to a complex real-world problem** based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

SC.HS.15.5.f **Use a computational representation** to illustrate the relationships among Earth systems and the degree to which those relationships are being modified due to human activity. Assessment does not include running computational representations but is limited to using the published results of scientific computational models.

PLUS STANDARDS (OPTIONAL)

The High School Plus (HSP) standards represent advanced science topics designed to enhance the rigor of general science curricula or supplement additional advanced science courses. The standards were developed using postsecondary syllabi from entry level science courses for science majors (e.g. UNL LIFE 120, CHEM 109). Introducing the content to high school students will scaffold their learning providing a bridge between high school science coursework and postsecondary level coursework.

PHYSICS

SC.HSP.1 Forces, Interactions, and Motion

SC.HSP.1.1 Gather, analyze, and communicate evidence of forces, interactions, and motion.

SC.HSP.1.1.a **Generate and interpret mathematical and graphical representations** to describe the relationships between position, velocity, acceleration and time. Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to no acceleration and objects undergoing a constant acceleration, including projectile motion, free fall, and circular motion. Examples should also include both average and instantaneous velocities. Assessment is limited to one and two-dimensional motion and to objects moving at non-relativistic speeds.

SC.HSP.1.1.b **Use mathematical and pictorial models** as applied to Newton's second law of motion describing the relationship among the net force on a macroscopic object, its mass, and its acceleration. Examples include drawing and using free body diagrams to analyze the net force on the object and the resulting motion; vectors including decomposition and recomposition, addition and subtraction. Assessment is limited to two-dimensional motion.

SC.HSP.1.1.c **Use mathematical representations** of momentum to predict the outcome of a collision. Emphasis is on the quantitative conservation of momentum in interactions and the qualitative meaning of this principle. **Assessment is limited to quantitative analysis of systems of two macroscopic bodies moving in one-dimension and qualitative analysis of multiple macroscopic bodies moving in two or three-dimensions.**

SC.HSP.1.1.d **Apply scientific and engineering ideas** to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. 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 by applying the impulse-momentum theorem. Examples of a device could include a football helmet or an airbag. **Assessment is limited to qualitative evaluations and/or algebraic manipulations.**

SC.HSP.1.1.e **Use mathematical representations** of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. Emphasis is on both quantitative and conceptual descriptions of forces from gravitational and electric sources. **Assessment can be expanded to systems with multiple objects.**

SC.HSP.2 Waves, Electromagnetic Radiation, and Optics

SC.HSP.2.2 Gather, analyze, and communicate evidence of the interactions of waves and optics.

SC.HSP.2.2.a **Use mathematical representations** to describe the relationships among the frequency, wavelength, and speed of waves traveling in various media. 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. Examples also include descriptive changes in observed frequency based on relative motion of observer or source (Doppler effect). **Assessment is limited to algebraic relationships and describing those relationships qualitatively.**

SC.P.2.2.b **Develop and use models** to predict interactions of longitudinal and transverse waves in various media. Examples could include P, S and Surface seismic waves, water waves, and waves on a spring. Emphasis is on structure and function of waves.

SC.HSP.2.2.c **Develop and use models** to describe the behavior of light at the boundary of various media. Emphasis is on both geometric (ray diagrams) and algebraic models (mirror and thin lens equation, Snell's Law).

SC.HSP.2.2.d **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. 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, photoelectric effect and the idea that photons associated with different frequencies of light have different energies. **Assessment includes qualitative and quantitative models of light.**

SC.HSP.2.2.e **Use evidence to support explanations** for causes of emission and absorption spectra of electromagnetic radiation. Emphasis is on the idea that photons associated with different frequencies of light have different energies. This could include the displacement and broadening of spectral lines (redshift and blueshift). Examples could include different elements absorb or emit specific frequencies of light. Assessment is limited to qualitative descriptions.

SC.HSP.2.2.f **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. Examples could include solar cells capturing light and converting it to electricity; medical imaging; communications technology; lasers. **Assessments are limited to qualitative information. Assessments do not include band theory.**

SC.HSP.4 Energy: Physics

SC.HSP.4.3 Gather, analyze, and communicate evidence of the interactions of energy.

SC.HSP.4.3.a **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. Emphasis is on explaining the meaning of mathematical expressions used in the model including the Work-Energy theorem. **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.**

SC.HSP.4.3.b **Plan and conduct an investigation** to rate the power and efficiency used in performing work on a system. Emphasis is on the quantitative determination of power in interactions. Examples could include use of pulleys and electric motors.

SC.HSP.4.3.c **Design, build, and refine a device** that works within given constraints to convert one form of energy into another form of energy. Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, generators, heat engines and heat pumps. Examples of constraints could include use of renewable energy forms and efficiency. **Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.**

SC.HSP.4.3.d **Analyze a major global challenge** to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. Examples could include analysis of renewable energy systems for electricity generation and the effect of autonomous electric cars on the economy, society and the environment.

SC.HSP.4.3.e **Plan and conduct an investigation** to provide evidence for the transfer of thermal energy within a system based on the Laws of Thermodynamics. Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually, such as changes in entropy of a system. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water, changes from kinetic to thermal energy, and heat engines and heat pumps. **Assessment is limited to investigations based on materials and tools provided to students.**

SC.HSP.4.3.f **Develop and use a model** of two objects interacting through gravitational, electric, or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. 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 is limited to systems containing two objects.**

SC.HSP.16 Electricity and Magnetism

SC.HSP.16.4 Gather, analyze, and communicate evidence of electricity and magnetism.

SC.HSP.16.4.a **Use mathematical representations** of field forces to describe and predict forces at a distance between objects. Emphasis is on both quantitative and conceptual descriptions of forces from gravitational and electric sources. **Assessment can be expanded to systems with multiple objects.**

SC.HSP.16.4.b **Use models** to visualize and describe gravitational, magnetic and electrical fields and predict resulting forces on nearby objects. Examples of fields include point charges, charged parallel plates/rings/spheres, and bar magnets. Also could include electromagnetic forces, such as the magnetic force acting on a moving charge. **Assessment is limited to descriptive analysis of the fields and the forces they produce.**

SC.HSP.16.4.c **Use mathematical representations** to provide evidence that describes and predicts relationships between power, current, voltage, and resistance. Emphasis is on insulators and conductors accounting for Ohm's Law, total resistance for combinations of resistors and P=IV.

SC.HSP.16.4.d **Evaluate competing design solutions** for construction and use of electrical consumer products accounting for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. Examples could include efficiency of light bulbs (visible intensity vs. power) and thermal energy limits of wire.

SC.HSP.16.4.e **Obtain and communicate technical information** about how some technological devices use alternating current and others use direct current. Examples could include why public utilities use AC while many devices use DC and energy loss in transmission of electricity.

SC.HSP.16.4.f **Design a solution** to a problem using the fact that an electric current can produce a magnetic field and/or that a changing magnetic field can produce an electric current. Emphasis is on both quantitative and conceptual descriptions of electric and magnetic fields. Examples include designing a generator, motor or transformer. **Assessment is limited to systems with two objects.**

SC.HSP.16.4.g **Analyze a major global challenge** to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. Examples could include analysis of renewable energy systems for electricity generation and the effect of autonomous electric cars on the economy, society and the environment.

CHEMISTRY

SC.HSP.3 Structure and Properties of Matter

SC.HSP.3.1 Gather, analyze, and communicate evidence of the structure, properties, and interactions of matter.

SC.HSP.3.1.a **Use the periodic table as a model** to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. Assessment does not include quantitative understanding of ionization energy beyond relative trends.

SC.HSP.3.1.b **Plan and conduct an investigation** to gather evidence to compare the structure of substances at the macro scale to infer the strength of electrical forces between particles. Examples of intramolecular forces include bond type, polarity of bonds and, resonance structures. Examples of intermolecular forces include hydrogen bonds, dipole-dipole. **Assessment does not include Raoult's law calculations of vapor pressure.**

SC.HSP.3.1.c **Develop and use models** to predict and explain forces that are in and between molecules. Examples of intramolecular forces include bond type, polarity of bonds and, resonance structures. Examples of intermolecular forces include hydrogen bonds, dipole-dipole.

SC.HSP.3.3.d **Evaluate a solution** to a complex, real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. Examples could include the effects of concentration of solutions on the freezing/boiling point (melting of ice on roadways), aspartame and caffeine in beverages, fluoride in drinking water.

SC.HSP.3.3.e **Develop models** to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay. **Assessment is limited to alpha, beta, and gamma radioactive decays.**

SC.HSP.3.3.f **Develop and use models** to describe and predict mechanisms of the quantum mechanical model of the atom. Examples of representation include Aufbau Diagram, Hund's Rule, Pauli Exclusion, and orbital shapes, Hybridization of orbitals, and electron configuration. (This is an upper-level course indicator. It is not recommended for all students.)

SC.HSP.3.3.g **Evaluate the evidence** supporting claims about how atoms absorb and emit energy in the form of electromagnetic radiation. Examples include using mathematical relationships to demonstrate the relationship between observed light spectrum, wavelength of light and emission spectrum. (This is an upper-level course indicator. It is not recommended for all students.)

SC.HSP.3.3.h **Use mathematical representations** to quantify matter through the analysis of patterns in chemical compounds at different scales. Emphasis is on the mole concept, empirical formula, molecular formula, percent composition, and law of constant composition. (This is an upper-level course indicator. It is not recommended for all students.)

SC.HSP.4 Energy: Chemistry

SC.HSP.4.2 Gather, analyze, and communicate evidence of the interactions of energy.

SC.HSP.4.2.a **Use statistical and mathematical techniques** to describe qualitative and quantitative thermodynamic relationships. Thermodynamic relationships may include: Enthalpy, Hess's Law, Heats of Formation. Examples of data displays or graphs could include energy diagrams to communicate bond energies of products or reactants. Lab investigations may include calorimetry. (This is an upper-level course indicator. It is not recommended for all students.)

SC.HSP.4.2.b **Plan and conduct an investigation** to gather evidence of how the Kinetic Molecular Theory and gas laws are related. Examples include Dalton's Law of particle pressures, Graham's Law of Diffusion and Effusion, and empirical gas laws. (This is an upper-level course indicator. It is not recommended for all students.)

SC.HSP.4.2.c **Analyze and interpret data** to explain changes in energy within a system and/or energy flows in and out of

a system. Emphasis is on the use of mathematical expressions to describe the change in energy within the system. Investigations could include electrochemistry (electrolysis). (This is an upper-level course indicator. It is not recommended for all students.)

SC.HSP.4.2.d **Analyze a major global challenge** to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. Examples could include alternative energies, carbon footprint, and crude oil refining process.

SC.HSP.5 Chemical Reactions

SC.HSP.5.3 Gather, analyze, and communicate evidence of chemical reactions.

SC.HSP.5.3.a **Plan and conduct an investigation** to generate evidence that answers scientific questions related to changes in solution chemistry. Examples include titrations, solubility, and Le Chatelier's Principle (This is an upper-level course indicator. It is not recommended for all students.)

SC.HSP.5.3.b **Use a model** to identify electron transfer and balance a redox reaction. Emphasis would be on using half reaction method for balancing equations and understanding electron transfer. Examples include electrochemical cells and electroplating. (This is an upper-level course indicator. It is not recommended for all students.)

SC.HSP.5.3.c **Use mathematical and/or computational representations** to predict and explain relationships within chemical systems. Examples include stoichiometric calculations, gas stoichiometry, limiting reactant, empirical formula/molecular formula calculations, % comp % yield. (This is an upper-level course indicator. It is not recommended for all students.)

SC.HSP.5.3.d **Use mathematical representations** to analyze the proportion and quantity of particles in solution. Emphasis is on molarity and developing net ionic equations. (This is an upper-level course indicator. It is not recommended for all students.)

SC.HSP.5.3.e **Plan and conduct an investigation** to predict the outcome of a chemical reaction based on patterns of chemical properties. Examples of reaction types could include single replacement, double replacement, etc. Examples of patterns could include the use of solubility rules, activity series. (This is an upper-level course indicator. It is not recommended for all students.).

SC.HS.5.3.f **Construct and revise an explanation** for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

BIOLOGY

SC.HSP.6 Structure and Function

SC.HSP.6.1 Gather, analyze, and communicate evidence of the relationship between structure and function in living things.

SC.HSP.6.1.a **Construct an explanation** based on evidence for how the sequence of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.

SC.HSP.6.1.b **Develop and use a model** to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. 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 does not include interactions and functions at the molecular level.**

SC.HSP.6.1.c **Plan and conduct an investigation** to provide evidence that feedback mechanisms maintain homeostasis. Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, and root development in response to water levels.

SC.HSP.6.1.d **Use a model** to illustrate the role of cells in producing signals which maintain cellular function within organisms. Emphasis is on conceptual understanding of the types of cell signals, signal reception, signal transduction, and types of cellular responses.

SC.HSP.6.1.e **Construct an explanation** based on evidence that plants have structures that function to support survival, growth, behavior, and reproduction. Emphasis is on plant structure, growth, and development, nutrient uptake and transport, plant reproduction, and plant responses to internal and external stimuli.

SC.HSP.6.1.f **Construct an explanation** based on evidence that animals have structures that function to support survival, growth, behavior, and reproduction. Emphasis is on the basic principles of animal form and functions. Examples of basic principles could include animal nutrition, circulation, gas exchange, immunity, osmoregulation and excretion, hormonal and endocrine control, reproduction, development, neural control systems, and animal behavior.

SC.HSP.6.1.g **Use a model** to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.

SC.HSP.7 Interdependent Relationships in Ecosystems

SC.HSP.7.2 Gather, analyze, and communicate evidence of interdependent relationships in ecosystems.

SC.HSP.7.2.a **Use mathematical and/or computational representations** to support explanations of factors that affect carrying capacity of ecosystems at different scales. 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 does not include deriving mathematical equations to make comparisons.**

SC.HSP.7.2.b **Use mathematical representations** to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data. Assessment is limited to provided data.

SC.HSP.7.2.c **Evaluate the claims, evidence, and reasoning** related to the principle that complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. 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.

SC.HSP.7.2.d **Design, evaluate, and refine a solution** for increasing the positive impacts of human activities on the

environment and biodiversity. Examples of human activities can include habitat development and restoration, supporting native pollinators, reducing consumption, rotating crops, using integrated pest management.

SC.HSP.7.2.e **Create or revise a solution** to mitigate the impacts of human activity on biodiversity. Emphasis is on testing solutions for a proposed problem related to threatened or endangered species, or to genetic variation of organisms for multiple species.

SC.HSP.7.2.f **Evaluate evidence** for the role of behavior on individual and species' chances to survive and reproduce. 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 behaviors could include fixed action patterns, imprinting, kinesis, taxis, hibernation, estivation, habituation, spatial learning, associative learning, cognition, foraging behavior, agonistic behavior, altruism, social learning, flocking, schooling, herding, and cooperative behaviors such as hunting, migrating, and swarming.

SC.HSP.8 Matter and Energy in Organisms and Ecosystems

SC.HSP.8.3 Gather, analyze, and communicate evidence of the flow of energy and cycling of matter in organisms and ecosystems.

SC.HSP.8.3.a **Use a model** to illustrate how photosynthesis transforms light energy into stored chemical energy. 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.

SC.HSP.8.3.b **Construct and revise an explanation** based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other molecules to form amino acids and/or other large carbon-based molecules. Emphasis is on using evidence from models and simulations to support explanations.

SC.HSP.8.3.c **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. Emphasis is on the conceptual understanding of the steps or specific processes involved in cellular respiration.

SC.HSP.8.3.d **Construct and revise an explanation** based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions. Emphasis is on conceptual understanding of the role of metabolism in different environments.

SC.HSP.8.3.e **Use mathematical representations** to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. 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 is limited to proportional reasoning to describe the cycling of matter and flow of energy.**

SC.HSP.8.3.f **Develop a model** to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere. Examples of models could include simulations and mathematical models.

SC.HSP.8.3.g **Use models** to illustrate how atomic structure and bonding impact the properties of water and their influence on biological systems. Emphasis is on atomic structure, types of chemical bonds, and properties of water and how those properties influence organisms and ecosystems.

SC.HSP.8.3.h **Construct an explanation** based on evidence for how ATP powers cellular work and for how enzymes affect the rate of and the amount of energy needed for metabolic reactions. Emphasis is on the structure of ATP and how ATP is used to power cellular work by coupling exergonic and endergonic reactions. Emphasis is on how enzymes speed up and/or lower the activation energy needed for metabolic reactions and how the regulation of enzyme activity helps control metabolism.

SC.HSP.9 Inheritance and Variation of Traits

SC.HSP.9.4 Gather, analyze, and communicate evidence of the inheritance and variation of traits.

SC.HSP.9.4.a **Ask questions** to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.

SC.HSP.9.4.b **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. Emphasis is on using data to support arguments for the way variation occurs.

SC.HSP.9.4.c **Apply concepts of statistics and probability** to explain the variation and distribution of expressed traits in a population. 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 (examples could include Hardy-Weinberg calculations and chi-square calculations.

SC.HSP.9.4.d **Evaluate evidence** supporting claims that gene regulation can explain the variation and distribution of expressed traits in a population. Emphasis is on the differences in gene expression of multi-cellular organisms, leading to different cell types within organisms and the distribution of traits in a population.

SC.HSP.9.4.e **Construct an explanation** based on evidence for the role of biotechnology in the research and understanding of biological systems. Emphasis is on the evolution of genomes, how biotechnology allows researchers to study the sequence, expression, and function of genes, and the practical applications of biotechnology.

SC.HSP.10 Biological Evolution

SC.HSP.10.5 Gather, analyze, and communicate evidence of biological evolution.

SC.HSP.10.5.a **Communicate scientific information** that common ancestry and biological evolution are supported by multiple lines of empirical evidence. 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.

SC.HSP.10.5.b **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. 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.

SC.HSP.10.5.c **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. Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations. Examples of basic statistical and graphical analysis could include allele frequency calculations.

SC.HSP.10.5.d **Construct an explanation** based on evidence for how natural selection leads to adaptation of populations. 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.

SC.HSP.10.5.e **Evaluate 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. 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.

SC.HSP.10.5.f **Develop and use models** to illustrate patterns in the evolutionary history of biological diversity. Emphasis is on how the structure and function of bacteria, archaea, protists, fungi, plants, and animals are used in are related in the tree of life.

ANATOMY AND PHYSIOLOGY

SC.HSP.6 Structure and Function: Anatomy & Physiology

SC.HSP.6.2 Gather, analyze, and communicate evidence of the relationship between the structures and physiological processes of the *integumentary system*.


SC.HSP.6.2.a **Plan and conduct and investigation** to identify patterns of organization in the integumentary system. Information could be gathered from dissections, models, simulations, and scientific texts.


SC.HSP.6.2.b **Ask questions** to clarify the role of various structures in integumentary system function.


SC.HSP.6.2.c **Develop and use a model** to identify and describe the relationship between the structures and physiological processes of the integumentary system.


SC.HSP.6.2.d **Plan and conduct an investigation to gather evidence** that feedback mechanisms in the integumentary system help maintain homeostasis.


SC.HSP.6.2.e **Engage in arguments from evidence** for the role of cell division in integumentary system dysfunction.

SC.HSP.6.3 Gather, analyze, and communicate evidence of the relationship between the structures and physiological processes of the *skeletal system*.


SC.HSP.6.3.a **Plan and conduct an investigation** to identify patterns of organization in the skeletal system. Information could be gathered from dissections, models, simulations, and scientific texts.


SC.HSP.6.3.b **Develop and use a model** to identify and describe the relationship between the structures and physiological processes of the skeletal system.


SC.HSP.6.3.c **Obtain, evaluate, and communicate information** that feedback mechanisms in the skeletal system help maintain homeostasis.


SC.HSP.6.3.d **Develop and use a model** to explain the order of events necessary for bone formation.


SC.HSP.6.3.e **Engage in arguments from evidence** to support claims about the causes of dysfunction in the skeletal system. Evidence could include data obtained from case studies.

SC.HSP.6.4 Gather, analyze, and communicate evidence of the relationship between the structures and physiological processes of the *muscular system*.


SC.HSP.6.4.a **Plan and conduct an investigation** to identify patterns of organization in the muscular system. Information could be gathered from dissections, models, simulations, and scientific texts.


SC.HSP.6.4.b **Develop and use a model** to identify and describe the relationship between the structures and physiological processes of the muscular system.


SC.HSP.6.4.c **Engage in arguments from evidence** that muscle contraction is the result of biochemical reactions.


SC.HSP.6.4.d **Obtain, evaluate, and communicate** that feedback mechanisms in the muscular system help maintain homeostasis.


SC.HSP.6.4.e **Engage in arguments from evidence** to support claims about the causes of dysfunction in the muscular system. Evidence could include data obtained from case studies.

SC.HSP.6.5 Gather, analyze, and communicate evidence of the relationship between the structures and physiological processes of the *nervous system*.


SC.HSP.6.5.a **Plan and conduct an investigation** to identify patterns of organization in the nervous system. Information could be gathered from dissections, models, simulations, and scientific texts.


SC.HSP.6.5.b **Develop and use a model** to identify and describe the relationship between the structures and physiological processes of the nervous system.


SC.HSP.6.5.c **Engage in arguments from evidence** that production of a nerve impulse is the result of biochemical reactions.


SC.HSP.6.5.d **Obtain, evaluate, and communicate evidence** that feedback mechanisms in the nervous system help maintain homeostasis.


SC.HSP.6.5.e **Engage in arguments from evidence** to support claims about the causes of dysfunction in the nervous system. Evidence could include data obtained from case studies.

SC.HSP.6.6 Gather, analyze, and communicate evidence of the relationship between the structures and physiological processes of the *cardiovascular/respiratory systems*.


SC.HSP.6.6.a **Plan and conduct an investigation** to identify patterns of organization in the cardiovascular/respiratory systems. Information could be gathered from dissections, models, simulations, and scientific texts.


SC.HSP.6.6.b **Develop and use a model** to identify and describe the relationship between the structures and physiological processes of the cardiovascular/respiratory systems.


SC.HSP.6.6.c **Obtain, evaluate and communicate evidence** that feedback mechanisms in the cardiovascular/respiratory systems help maintain homeostasis.


SC.HSP.6.6.d **Engage in arguments from evidence** to support claims about the causes of dysfunction in the cardiovascular/respiratory systems. Evidence could include data obtained from case studies.

SC.HSP.6.7 Gather, analyze, and communicate evidence of the relationship between the structures and physiological processes of the *digestive system*.


SC.HSP.6.7.a **Plan and conduct an investigation** to identify patterns of organization in the digestive system. Information could be gathered from dissections, models, simulations, and scientific texts.


SC.HSP.6.7.b **Develop and use a model** to identify and describe the relationship between the structures and physiological processes of the digestive system.


SC.HSP.6.7.c **Obtain, evaluate and communicate evidence** that feedback mechanisms in the digestive system help maintain homeostasis.


SC.HSP.6.7.d **Engage in arguments from evidence** to support claims about the causes of dysfunction in the digestive system. Evidence could include data obtained from case studies.

SC.HSP.6.8 Gather, analyze, and communicate evidence of the relationship between the structures and physiological processes of the *urinary system*.

SC.HSP.6.8.a **Plan and conduct an investigation** to identify patterns of organization in the urinary system. Information could be gathered from dissections, models, simulations, and scientific texts.

SC.HSP.6.8.b **Develop and use a model** to identify and describe the relationship between the structures and physiological processes of the urinary system.

SC.HSP.6.8.c **Obtain, evaluate and communicate evidence** that feedback mechanisms in the urinary system help maintain homeostasis.

SC.HSP.6.8.d **Engage in arguments from evidence** to support claims about the causes of dysfunction in the urinary system. Evidence could include data obtained from case studies.

SC.HSP.6.9 Gather, analyze, and communicate evidence of the relationship between the structures and physiological processes of the *reproductive system*.

SC.HSP.6.9.a **Plan and conduct an investigation** to identify patterns of organization in the reproductive system. Information could be gathered from dissections, models, simulations, and scientific texts.

SC.HSP.6.9.b **Develop and use a model** to identify and describe the relationship between the structures and physiological processes of the reproductive system. Include spermatogenesis, oogenesis, and menstruation.

SC.HSP.6.9.c **Obtain, evaluate and communicate evidence** that feedback mechanisms in the reproductive system help maintain homeostasis.

SC.HSP.6.9.d **Engage in arguments from evidence** to support claims about the causes of dysfunction in the reproductive system. Evidence could include data obtained from case studies.

SC.HSP.17 Engineering in Health Sciences

SC.HSP.17.1 Gather, analyze, and communicate evidence of the connection between health science careers and engineering.

SC.HSP.17.1.a **Obtain, evaluate, and communicate information** related to health science careers and the various roles they fulfill within the health care system. Examples include researcher, bio-medical engineer, medical professional, technician, manufacturer and distributor, administrator, and data storage and security professional.

SC.HSP.17.1.b **Design a solution** to a complex, real-world problem affecting body systems that can be solved through engineering. Solutions could include prosthetics, mobility enhancement, engineered body parts, treatment processes, and disease control.

SC.HSP.17.1.c **Evaluate a solution** to a complex, real-world human health problem based on prioritized criteria constraints that account for interactions within and between systems. Solutions could include the effects on the human body or solutions for environmental public health issues.

SC.HSP.18 Body Systems

SC.HSP.18.1 Gather, analyze, and communicate evidence of the connections between body systems.

SC.HSP.18.1.a **Construct and revise an explanation** based on evidence for the cycling of matter and flow of energy within and between body systems.

SC.HSP.18.1.b **Develop and use models** to explain the interactions between body systems. Emphasis should also include interactions with the endocrine system.

APPENDIX A: TOPIC PROGRESSION

TOPIC/GRADE	K	1	2	3	4	5	6	7	8	HS
1. Forces & Interactions	SC.K.1			SC.3.1					SC.8.1	SC.HS.1
2. Waves & Electro-magnetic Radiation		SC.1.2			SC.4.2				SC.8.2	SC.HS.2
3. Structure & Properties of Matter			SC.2.3			SC.5.3		SC.7.3		SC.HS.3
4. Energy					SC.4.4		SC.6.4		SC.8.4	SC.HS.4
5. Chemical Reactions								SC.7.5		SC.HS.5
6. Structure & Function		SC.1.6			SC.4.6					SC.HS.6
7. Inter-dependent Relationships in Ecosystems	SC.K.7		SC.2.7	SC.3.7			SC.6.7	SC.7.7		SC.HS.7
8. Matter & Energy in Organisms & Ecosystems						SC.5.8		SC.7.8		SC.HS.8
9. Heredity: Inheritance & Variation of Traits				SC.3.9			SC.6.9		SC.8.9	SC.HS.9
10. Biological Evolution									SC.8.10	SC.HS.10
11. Space Systems		SC.1.11				SC.5.11			SC.8.11	SC.HS.11
12. Weather & Climate	SC.K.12			SC.3.12			SC.6.12			SC.HS.12
13. Earth's Systems			SC.2.13		SC.4.13	SC.5.13	SC.6.13	SC.7.13		SC.HS.13
14. History of Earth								SC.7.14	SC.8.14	SC.HS.14
15. Sustainability										SC.HS.15

APPENDIX B: HS INTEGRATED SCIENCE COURSE MODEL

This appendix provides two examples of possible high school science course sequences. The first example outlines the NE Integrated Food, Energy, and Water Model, a series of interdisciplinary classes that blend Nebraska-specific contexts with global science issues. This example of standard bundles was developed in collaboration with University of Nebraska-Lincoln faculty. The second example presents course mapping of Disciplinary Core Ideas (DCIs) into a coherent sequence as outlined in A Framework for K-12 Science Education.

Course 1: Science Foundations seeks to lay a foundation for understanding the complexities of the biological and physical domains by deeply understanding the driving principles that allow matter to exist and function as it does in the universe. The topics in this course will be explored through the lens of the Nebraska Career Education Model.

Unit 1: Newtonian Forces	**Unit 2:** Gravity/ Electro-magnetism	**Unit 3:** Energy	**Unit 4:** Waves & Electromagnetic Radiation	**Unit 5:** Earth's Interior	**Unit 6:** Structure and Properties of Matter	**Unit 7:** Molecular Level Design	**Unit 8:** Space Exploration
HS.1.1.a **HS.1.1.b** **HS.1.1.c**	**HS.1.1.d** **HS.1.1.e** **HS.4.4.f**	**HS.4.4.a** **HS.4.4.b** **HS.4.4.c** **HS.15.4.b**	**HS.2.2.a** **HS.2.2.b** **HS.2.2.c** **HS.2.2.d** **HS.2.2.e**	**HS.13.3.b** **HS.13.3.c**	**HS.3.3.a** **HS.3.3.c**	**HS.3.3.b** **HS.3.3.d**	**HS.11.5.a** **HS.11.5.b** **HS.11.5.c** **HS.11.5.d**

Course 2: Water in Society begins by expanding upon what was learned in Course 1 by taking a deeper look into matter and energy through the lens of water. It includes general chemistry concepts as they relate to water and life processes & systems. The course then focuses on how organisms and global systems maintain stability, transfer energy, and cycle matter. The final focus is on the sustainability of water.

Unit 1: Introduction to Water	**Unit 2:** Chemistry Between Life & Water	**Unit 3:** Small Systems Equilibrium	**Unit 4:** Systems: Energy in Balance	**Unit 5:** Movement of Matter in Global Systems	**Unit 6:** Sustainability of Water
SC.HS.13.3.d **SC.HS.5.5.a**	**SC.HS.8.3.a** **SC.HS.5.5.f** **SC.HS.8.3.b** **SC.HS.8.3.c** **SC.HS.5.5.b**	**SC.HS.8.3.e** **SC.HS.5.5.c** **SC.HS.5.5.d**	**SC.HS.6.1.c** **SC.HS.13.3.a** **SC.HS.4.4.e** **SC.HS.14.2.c** **SC.HS.12.1.b**	**SC.HS.13.3.e** **SC.HS.8.3.f**	**SC.HS.15.4.a** **SC.HS.12.1.c** **SC.HS.15.4.d**

Course 3: Land, Food, and People expands upon what was learned in both Course 1 and 2 taking a deeper dive into the coevolution of Earth systems and organisms. It is designed to introduce students to information, ideas, and concepts about the interactions of people, land and the demands for food. Students will investigate the history of the Earth, biological adaptation, heredity, and interdependent relationships in ecosystems. At the end of the course, students will be able to analyze, synthesize and communicate information about the dynamic relationships of land, food, and people from ethical, civic and stewardship perspectives and explain the impacts of human decisions on renewable and non-renewable resources.

Unit 1: Earth's History	**Unit 2:** Biological Evolution	**Unit 3:** Heredity: Inheritance & Variation	**Unit 4:** Structure & Function	**Unit 5:** Interdependent Relationships in Organisms	**Unit 6:** Sustainability
SC.HS.14.2.a **SC.HS.14.2.b** **HS.12.1.a** **HS.12.1.d** **SC.HS.14.2.d**	**SC.HS.10.5.a** **SC.HS.10.5.b** **SC.HS.10.5.c** **SC.HS.10.5.d** **SC.HS.10.5.e** **SC.HS.7.2.e**	**HS.9.4.a** **HS.9.4.b** **HS.9.4.c**	**HS.6.1.a** **HS.6.1.b** **HS.6.1.d**	**HS.7.2.a** **HS.7.2.b** **HS.7.2.c** **HS.8.3.d**	**HS.7.2.d** **HS.15.4.c** **HS.15.4.f** **HS.7.2.f**

NGSS Conceptual Progressions Model