**Life Science Teacher’s Guide to Nebraska’s College and**

**Career Ready Standards for Science**

**2017**

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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**. At the broadest level, **standards** include broad, overarching content-based statements that describe the basic cognitive, affective, or psychomotor indicators 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 indicators 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 does not mandate the curriculum used within a local school.

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

**Organization and Structure of CCR-Science Standards**

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.

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 science topics. This 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**).

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).

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.

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. Instruction aimed toward preparing students should use crosscutting concepts and **science and engineering practices** that go beyond what is stated in the indicator to better reflect authentic science practice.

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

|  |  |  |
| --- | --- | --- |
| [**Science and Engineering Practices**](https://www.nap.edu/read/13165/chapter/7)* **[Asking Questions and Defining Problems](https://www.nap.edu/read/13165/chapter/7%22%20%5Cl%20%2254)**
* **[Developing and Using Models](https://www.nap.edu/read/13165/chapter/7%22%20%5Cl%20%2256)**
* **[Planning and Carrying Out Investigations](https://www.nap.edu/read/13165/chapter/7%22%20%5Cl%20%2259)**
* [**Analyzing and Interpreting Data**](https://www.nap.edu/read/13165/chapter/7#61)
* **[Using Mathematics and Computational Thinking](https://www.nap.edu/read/13165/chapter/7%22%20%5Cl%20%2264)**
* **[Constructing Explanations and Designing Solutions](https://www.nap.edu/read/13165/chapter/7%22%20%5Cl%20%2267)**
* **[Engaging in Argument from Evidence](https://www.nap.edu/read/13165/chapter/7%22%20%5Cl%20%2271)**
* [**Obtaining, Evaluating, and Communicating Information**](https://www.nap.edu/read/13165/chapter/7#74)
 | **Disciplinary Core Ideas**[**LS1**](https://www.nap.edu/read/13165/chapter/10#143)**: From Molecules to Organisms:  Structures and Processes**[**LS2**](https://www.nap.edu/read/13165/chapter/10#150)**: Ecosystems: Interactions, Energy,  and Dynamics**[**LS3**](https://www.nap.edu/read/13165/chapter/10#157)**: Heredity: Inheritance and of Traits**[**LS4**](https://www.nap.edu/read/13165/chapter/10#161)**: Biological Evolution: Unity & Diversity**[**PS1**](https://www.nap.edu/read/13165/chapter/9#106)**: Matter and Its Interactions**[**PS2**](https://www.nap.edu/read/13165/chapter/9#113)**: Motion and Stability: Forces and  Interactions**[**PS3**](https://www.nap.edu/read/13165/chapter/9#120)**: Energy**[**PS4**](https://www.nap.edu/read/13165/chapter/9#130)**: Waves and Their Applications in  Technologies for Information Transfer**[**ESS1**](https://www.nap.edu/read/13165/chapter/11#173)**: Earth’s Place in the Universe**[**ESS2**](https://www.nap.edu/read/13165/chapter/11#179)**: Earth’s Systems**[**ESS3**](https://www.nap.edu/read/13165/chapter/11#190)**: Earth and Human Activity**[**ETS1**](https://www.nap.edu/read/13165/chapter/12#204)**: Engineering Design** | C:\Users\sara.cooper.NDE\Desktop\Standards\Patterns.png[**Crosscutting Concepts**](https://www.nap.edu/read/13165/chapter/8)[C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.png**Patterns**](https://www.nap.edu/read/13165/chapter/8#85)[**Cause and Effect**](https://www.nap.edu/read/13165/chapter/8#87) [**Scale, Proportion, and Quantity**](https://www.nap.edu/read/13165/chapter/8#89)C:\Users\sara.cooper.NDE\Desktop\Standards\ScaleProportionQuantity.pngC:\Users\sara.cooper.NDE\Desktop\Standards\Systems.png[**Systems and System Models**](https://www.nap.edu/read/13165/chapter/8#91)C:\Users\sara.cooper.NDE\Desktop\Standards\EnergyMatter.png[**Energy and Matter**](https://www.nap.edu/read/13165/chapter/8#94)C:\Users\sara.cooper.NDE\Desktop\Standards\StructureFunction.png[**Structure and Function**](https://www.nap.edu/read/13165/chapter/8#96)C:\Users\sara.cooper.NDE\Desktop\Standards\StabilityChange.png[**Stability and Change**](https://www.nap.edu/read/13165/chapter/8#98) |



**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 call-out the importance for students to engage 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 student 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 help 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. These connections highlight the interdependence of science, engineering, and technology that drives the research, innovation, and development cycle where discoveries in science lead to new technologies developed using the engineering design process. Additionally, 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.

**Instructional Shifts**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.

*3-Dimensional teaching and learning:* Effective science teaching, learning, and assessment should integrate disciplinary core ideas, crosscutting concepts, and **science and engineering** **practices**. Integration of the three dimensions will allow students to explain scientific phenomena, design solutions to real-world challenges, and build a foundation upon which they can continue to learn and to apply science knowledge and skills within and outside the K-12 education arena.

*Integrated science:* Natural phenomena serve as the context for the work of both scientists and engineers. As students explain natural phenomena and design solutions to real-world challenges they connect ideas across science domains. The crosscutting concepts serve as tools that bridge domain boundaries and allow students to deepen their understanding of disciplinary core ideas while using **science and engineering practices** as they explore natural phenomena.

*Interdisciplinary approaches:* The overlapping skills included in the **science and engineering practices** and the intellectual tools provided by the crosscutting concepts build meaningfuland substantive connections to interdisciplinary knowledge and skills in all content areas(English Language Arts, mathematics, social studies, fine arts, career/technical education,etc.) This affords all student equitable access to learning and ensures all students are preparedfor college, career, and citizenship.

**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, 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.

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

**How to Read the Teacher’s Guide**



[**here**](https://www.nextgenscience.org/sites/default/files/Front%20Matter%20Evidence%20Statements%20PDF%20Jan%202015_1.pdf).

**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.

|  |  |  |  |
| --- | --- | --- | --- |
|  |   | **C:\Users\sara.cooper.NDE\Desktop\Standards\StructureFunction.png** | 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. |
| C:\Users\sara.cooper.NDE\Desktop\Standards\NebraskaConnection.png | *NE agricultural practices* |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\Systems.png | 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. 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 or chemical reaction level. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\StabilityChange.png | SC.HS.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. Assessment does not include the cellular processes involved in the feedback mechanism. |
| C:\Users\sara.cooper.NDE\Desktop\Standards\NebraskaConnection.png | *NE agricultural practices* |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\Systems.png | 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. |

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| The performance indicators above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*: |
| **Science and Engineering Practices****Developing and Using Models**Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world. * Develop and use a model based on evidence to illustratethe relationships between systems or between components of a system. (HS.6.1.B)
* Use a model based on evidence to illustratethe relationships between systems or between components of a system. (HS.6.1.D)

**Planning and Carrying Out Investigations**Planning and carrying out in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. * Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis forevidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS.6.1.C)

**Constructing Explanations and Designing Solutions**Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.* Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS.6.1.A)

**-------------------------------------------------------------------**[***Connections to Nature of Science***](http://nstahosted.org/pdfs/ngss/AppendixH-TheNatureOfScienceInTheNextGenerationScienceStandards-4.9.13.pdf) **Scientific Investigations Use a Variety of Methods*** Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. (HS.6.1.C)
 | **Disciplinary Core Ideas**[**LS1.A**](https://www.nap.edu/read/13165/chapter/10#143)**: Structure and Function*** Systems of specialized cells within organisms help them perform the essential functions of life. (HS.6.1.A)

C:\Users\sara.cooper.NDE\Desktop\Standards\NebraskaConnection.png All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS.6.1.A) *(Note: This Disciplinary Core Idea is also addressed by HS.9.4.A.)* * Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS.6.1.B)

C:\Users\sara.cooper.NDE\Desktop\Standards\NebraskaConnection.png Feedback mechanisms maintain a living system’s internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS.6.1.C)[**LS1.B**](https://www.nap.edu/read/13165/chapter/10#145)**: Growth and Development of Organisms*** In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. (HS.6.1.D)
 | **Crosscutting Concepts**C:\Users\sara.cooper.NDE\Desktop\Standards\Systems.png**Systems and System Models**Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS.6.1.B), (HS.6.1.D)**C:\Users\sara.cooper.NDE\Desktop\Standards\StructureFunction.pngStructure and Function** Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS.6.1.A)C:\Users\sara.cooper.NDE\Desktop\Standards\StabilityChange.png**Stability and Change**Feedback (negative or positive) can stabilize or destabilize a system. (HS.6.1.C) |
| *Connections to other DCIs in this grade-band:* **HS.LS3.A** (HS.6.1.A) |
| *Articulation across grade-bands:* **MS.LS1.A** (HS.6.1.A),(HS.6.1.B),(HS.6.1.C); **MS.LS3.A** (HS.6.1.A); **MS.LS3.B** (HS.6.1.A); **MS.LS1.B** (HS.6.1.D);**MS.LS3.A** (HS.6.1.D) |
| *NGSS Connections:* [Structure, Function, and Information Processing](http://ngss.nsta.org/DisplayStandard.aspx?view=topic&id=29) [**HS-LS1-1**](http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=176) (HS.6.1.A); [**HS-LS1-2**](http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=177) (HS.6.1.B); [**HS-LS1-3**](http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=178) (HS.6.1.C); [**HS-LS1-4**](http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=130)  (HS.6.1.D) |
| *ELA Connections:*  |
| *Mathematics Connections:*  |
| *Connections:* |
| *Connections:* |

**Evidence Statements: Observable features of the student performance by the end of the course.**

|  |
| --- |
| **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. |
| 1 | Articulating the explanation of phenomena |
| a | Students construct an explanation that includes the idea that regions of DNA called genes determine the structure of proteins, which carry out the essential functions of life through systems of specialized cells. |
| 2 | Evidence |
| a | Students identify and describe\* the evidence to construct their explanation, including that: |
| 1. All cells contain DNA;
 |
| 1. DNA contains regions that are called genes;
 |
| 1. The sequence of genes contains instructions that code for proteins; and
 |
| 1. Groups of specialized cells (tissues) use proteins to carry out functions that are essential to the organism.
 |
| b | Students use a variety of valid and reliable sources for the evidence (e.g., theories, simulations, peer review, students’ own investigations). |
| 3 | Reasoning |
| a | Students use reasoning to connect evidence, along with the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future, to construct the explanation. Students describe\* the following chain of reasoning in their explanation:  |
| 1. Because all cells contain DNA, all cells contain genes that can code for the formation of proteins.
 |
| 1. Body tissues are systems of specialized cells with similar structures and functions, each of whose functions are mainly carried out by the proteins they produce.
 |
| 1. Proper function of many proteins is necessary for the proper functioning of the cells.
 |
| 1. Gene sequence affects protein function, which in turn affects the function of body tissues.
 |

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| **HS.6.1.B Develop and use a model** to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular  organisms. |
| 1 | Components of the model |
| a | Students develop a model in which they identify and describe\* the relevant parts (e.g., organ system, organs, and their component tissues) and processes (e.g., transport of fluids, motion) of body systems in multicellular organisms. |
| 2 | Relationships |
| a | In the model, students describe\* the relationships between components, including: |
| 1. The functions of at least two major body systems in terms of contributions to overall function of an organism;
 |
| 1. Ways the functions of two different systems affect one another; and
 |
| 1. A system’s function and how that relates both to the system’s parts and to the overall function of the organism.
 |
| 3 | Connections |
| a | Students use the model to illustrate how the interaction between systems provides specific functions in multicellular organisms. |
| b | Students make a distinction between the accuracy of the model and actual body systems and functions it represents. |

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| **HS.6.1.C Plan and conduct an investigation** to provide evidence that feedback mechanisms maintain homeostasis. |
| 1 | Identifying the phenomenon under investigation |
| a | Students describe\* the phenomenon under investigation, which includes the following idea: that feedback mechanisms maintain homeostasis. |
| 2 | Identifying the evidence to answer this question |
| a | Students develop an investigation plan and describe\* the data that will be collected and the evidence to be derived from the data, including: |
| 1. Changes within a chosen range in the external environment of a living system; and
 |
| 1. Responses of a living system that would stabilize and maintain the system’s internal conditions (homeostasis), even though external conditions change, thus establishing the positive or negative feedback mechanism.
 |
| b | Students describe\* why the data will provide information relevant to the purpose of the investigation. |
| 3 | Planning for the investigation |
| a | In the investigation plan, students describe\*: |
| 1. How the change in the external environment is to be measured or identified;
 |
| 1. How the response of the living system will be measured or identified;
 |
| 1. How the stabilization or destabilization of the system’s internal conditions will be measured or determined;
 |
| 1. The experimental procedure, the minimum number of different systems (and the factors that affect them) that would allow generalization of results, the evidence derived from the data, and identification of limitations on the precision of data to include types and amounts; and
 |
| 1. Whether the investigation will be conducted individually or collaboratively.
 |
| 4 | Collecting the data |
| a | Students collect and record changes in the external environment and organism responses as a function of time. |
| 5 | Refining the design |
| a | Students evaluate their investigation, including: |
| 1. Assessment of the accuracy and precision of the data, as well as limitations (e.g., cost, risk, time) of the investigation, and make suggestions for refinement; and
 |
| 1. Assessment of the ability of the data to provide the evidence required.
 |
| b | If necessary, students refine the investigation plan to produce more generalizable data. |

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| **HS.6.1.D Use a model** to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. |
| 1 | Components of the model |
| a | From the given model, students identify and describe\* the components of the model relevant for illustrating the role of mitosis and differentiation in producing and maintaining complex organisms, including:  |
| 1. Genetic material containing two variants of each chromosome pair, one from each parent;
 |
| 1. Parent and daughter cells (i.e., inputs and outputs of mitosis); and
 |
| 1. A multi-cellular organism as a collection of differentiated cells.
 |
| 2 | Relationships |
| a | Students identify and describe\* the relationships between components of the given model, including: |
| 1. Daughter cells receive identical genetic information from a parent cell or a fertilized egg.
 |
| 1. Mitotic cell division produces two genetically identical daughter cells from one parent cell.
 |
| 1. Differences between different cell types within a multicellular organism are due to gene expression — not different genetic material within that organism.
 |
| 3 | Connections |
| a | Students use the given model to illustrate that mitotic cell division results in more cells that: |
| 1. Allow growth of the organism;
 |
| 1. Can then differentiate to create different cell types; and
 |
| 1. Can replace dead cells to maintain a complex organism.
 |
| b | Students make a distinction between the accuracy of the model and the actual process of cellular division. |

**SC.HS.7 Interdependent Relationships in Ecosystems**

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

|  |  |  |  |
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|  | C:\Users\sara.cooper.NDE\Desktop\Standards\CivicConnection.png | C:\Users\sara.cooper.NDE\Desktop\Standards\ScaleProportionQuantity.png | 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**.** 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. |
|  | C:\Users\sara.cooper.NDE\Desktop\Standards\CivicConnection.png | C:\Users\sara.cooper.NDE\Desktop\Standards\ScaleProportionQuantity.png | 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. 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. |
|  | C:\Users\sara.cooper.NDE\Desktop\Standards\CivicConnection.png | C:\Users\sara.cooper.NDE\Desktop\Standards\StabilityChange.png | 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. 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. |
| C:\Users\sara.cooper.NDE\Desktop\Standards\NebraskaConnection.png | *NE river systems and ecosystems* |
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|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.png | [SC.HS.7.2.D](http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=205) **Evaluate the evidence** for the role of group 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 group behaviors could include flocking, schooling, herding, and cooperative behaviors such as hunting, migrating, and swarming.  |
|  | C:\Users\sara.cooper.NDE\Desktop\Standards\EngineeringConnection'.png | C:\Users\sara.cooper.NDE\Desktop\Standards\StabilityChange.png | SC.HS.7.2.E **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. Emphasis is on testing solutions for a proposed problem related to threatened or endangered species, or to genetic variation of organisms for multiple species. |
| C:\Users\sara.cooper.NDE\Desktop\Standards\NebraskaConnection.png | *NE native species, conservation organizations, agriculture practices* |
| **C:\Users\sara.cooper.NDE\Desktop\Standards\ComputerScienceConnection.png** |  | C:\Users\sara.cooper.NDE\Desktop\Standards\Systems.png | 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. |

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| The performance indicators above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*: |
| **Science and Engineering Practices****Using Mathematics and Computational Thinking**Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.* Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (HS.7.2.A)
* Use mathematical representations of phenomena or design solutions to support and revise explanations. (HS.7.2.B)
* Create or revise a simulation of a phenomenon, designed device, process, or system. (HS.7.2.F)
* Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS.7.2.F)

**Constructing Explanations and Designing Solutions**Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.* Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS.7.2.E)

**Engaging in Argument from Evidence**Engaging in argument from evidence in 9–12 builds from K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.* Evaluate the claims, evidence, and reasoningbehind currently accepted explanations or solutions to determine the merits of arguments. (HS.7.2.C)
* Evaluate the evidencebehind currently accepted explanations or solutions to determine the merits of arguments. (HS.7.2.D)

**------------------------------------------------------------------**[***Connections to Nature of Science***](http://nstahosted.org/pdfs/ngss/AppendixH-TheNatureOfScienceInTheNextGenerationScienceStandards-4.9.13.pdf) **Scientific Knowledge is Open to Revision in Light of New Evidence*** Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS.7.2.B)
* Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation. (HS.7.2.C),(HS.7.2.D)
 | **Disciplinary Core Ideas**[**LS2.A**](https://www.nap.edu/read/13165/chapter/10#150)**: Interdependent Relationships in Ecosystems*** Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (HS.7.2.A),(HS.7.2.B)

[**LS2.C**](https://www.nap.edu/read/13165/chapter/10#154)**: Ecosystem Dynamics, Functioning, and Resilience**C:\Users\sara.cooper.NDE\Desktop\Standards\NebraskaConnection.png A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS.7.2.B),(HS.7.2.C)C:\Users\sara.cooper.NDE\Desktop\Standards\NebraskaConnection.png Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS.7.2.E)[**LS2.D**](https://www.nap.edu/read/13165/chapter/10#156)**: Social Interactions and Group Behavior*** Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HS.7.2.D)

[**LS4.C**](https://www.nap.edu/read/13165/chapter/10#164)**: Adaptation**C:\Users\sara.cooper.NDE\Desktop\Standards\NebraskaConnection.png Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometimes the extinction–of some species. (HS.7.2.F)[**LS4.D**](https://www.nap.edu/read/13165/chapter/10#166)**: Biodiversity and Humans** * Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). *(secondary to HS.7.2.E)*

C:\Users\sara.cooper.NDE\Desktop\Standards\NebraskaConnection.png Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. *(secondary to HS.7.2.E),* (HS.7.2.F) C:\Users\sara.cooper.NDE\Desktop\Standards\EngineeringConnection'.png[**ETS1.B**](https://www.nap.edu/read/13165/chapter/12#206)**: Developing Possible Solutions**When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. *(secondary to HS.7.2.E),(secondary to HS.7.2.F)*Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (HS.7.2.F) | **Crosscutting Concepts**C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.png**Cause and Effect**Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS.7.2.D),(HS.7.2.F)C:\Users\sara.cooper.NDE\Desktop\Standards\ScaleProportionQuantity.png**Scale, Proportion, and Quantity**The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS.7.2.A)* Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (HS.7.2.B)

C:\Users\sara.cooper.NDE\Desktop\Standards\StabilityChange.png**Stability and Change**Much of science deals with constructing explanations of how things change and how they remain stable. (HS.7.2.C),(HS.7.2.E)C:\Users\sara.cooper.NDE\Desktop\Standards\Systems.png**Systems and System Models**Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows— within and between systems at different scales. (HS.7.2.F) |
| *Connections to other DCIs in this grade-band:* **HS.ESS2.D** (HS.7.2.E),(HS.7.2.F); **HS.ESS2.E** (HS.7.2.B),(HS.7.2.C),(HS.7.2.E),(HS.7.2.F); **HS.ESS3.A** (HS.7.2.B),(HS.7.2.E), (HS.7.2.F); **HS.ESS3.C** (HS.7.2.B),(HS.7.2.E),(HS.7.2.F); **HS.ESS3.D** (HS.7.2.B),(HS.7.2.F) *Connections to HS-ETS1.B: Designing Solutions to Engineering Problems include:* **Earth and Space Science:** 15.5.B, 15.5.D |
| *Articulation across grade-bands:*  **MS.LS1.**B (HS.7.2.D); MS**.LS2.A** (HS.7.2.A),(HS.7.2.B),(HS.7.2.C); **MS.LS2.C** (HS.7.2.A),(HS.7.2.B),(HS.7.2.C),(HS.7.2.E),(HS.7.2.F); **MS.ESS2.E** (HS.7.2.C); **MS.ESS3.A** (HS.7.2.A); **MS.ESS3.C** (HS.7.2.A),(HS.7.2.B),(HS.7.2.C),(HS.7.2.E),(HS.7.2.F); **MS.ESS3.D** (HS.7.2.E); **MS.ETS1.A** (HS.7.2.F); **MS.ETS1.B** (HS.7.2.F); **MS.ETS1.C** (HS.7.2.F) |
| *NGSS Connections:* [Interdependent Relationships in Ecosystems](http://ngss.nsta.org/DisplayStandard.aspx?view=topic&id=47) [**HS-LS2-1**](http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=140) (HS.7.2.A); [**HS-LS2-2**](http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=141) (HS.7.2.B); [**HS-LS2-6**](http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=145) (HS.7.2.C); [**HS-LS2-8**](http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=147)(HS.7.2.D); [**HS-LS2-7**](http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=146)(HS.7.2.E); **HS-LS4-6** (HS.7.2.F) [Engineering Design](http://ngss.nsta.org/DisplayStandard.aspx?view=topic&id=55) [**HS-ETS1-4**](http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=205) (HS.7.2.F) |
| *ELA Connections:*  |
| *Mathematics Connections:*  |
| *Connections:* |
| *Connections:* |

**Evidence Statements: Observable features of the student performance by the end of the course.**

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| **HS.7.2.A Use mathematical and/or computational representations to support explanations** of factors that affect carrying capacity of ecosystems at  different scales**.** |
| 1 | Representation |
| a | Students identify and describe\* the components in the given mathematical and/or computational representations (e.g., trends, averages, histograms, graphs, spreadsheets) that are relevant to supporting given explanations of factors that affect carrying capacities of ecosystems at different scales. The components include:  |
| 1. The population changes gathered from historical data or simulations of ecosystems at different scales; and
 |
| 1. Data on numbers and types of organisms as well as boundaries, resources, and climate.
 |
| b | Students identify the given explanation(s) to be supported, which include the following ideas: Factors (including boundaries, resources, climate, and competition) affect carrying capacity of an ecosystem, and: |
| 1. Some factors have larger effects than do other factors.
 |
| 1. Factors are interrelated.
 |
| 1. The significance of a factor is dependent on the scale (e.g., a pond vs. an ocean) at which it occurs.
 |
| 2 | Mathematical and/or computational modeling |
| a | Students use given mathematical and/or computational representations (e.g., trends, averages, histograms, graphs, spreadsheets) of ecosystem factors to identify changes over time in the numbers and types of organisms in ecosystems of different scales. |
| 3 | Analysis |
| a | Students analyze and use the given mathematical and/or computational representations |
| 1. To identify the interdependence of factors (both living and nonliving) and resulting effect on carrying capacity; and
 |
| 1. As evidence to support the explanation and identify the factors that have the largest effect on the carrying capacity of an ecosystem for a given population.
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| **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. |
| 1 | Representation |
| a | Students identify and describe\* the components in the given mathematical representations (which include trends, averages, and graphs of the number of organisms per unit of area in a stable system) that are relevant to supporting and revising the given explanations about factors affecting biodiversity and ecosystems, including: |
| 1. Data on numbers and types of organisms are represented.
 |
| 1. Interactions between ecosystems at different scales are represented.
 |
| b | Students identify the given explanation(s) to be supported of factors affecting biodiversity and population levels, which include the following ideas: |
| 1. The populations and number of organisms in ecosystems vary as a function of the physical and biological dynamics of the ecosystem.
 |
| 1. The response of an ecosystem to a small change might not significantly affect populations, whereas the response to a large change can have a large effect on populations that then feeds back to the ecosystem at a range of scales.
 |
| 1. Ecosystems can exist in the same location on a variety of scales (e.g., plants and animals vs. microbes), and these populations can interact in ways that significantly change these ecosystems (e.g., interactions among microbes, plants, and animals can be an important factor in the resources available to both a microscopic and macroscopic ecosystem).
 |
| 2 | Mathematical Modeling |
| a | Students use the given mathematical representations (including trends, averages, and graphs) of factors affecting biodiversity and ecosystems to identify changes over time in the numbers and types of organisms in ecosystems of different scales. |
| 3 | Analysis |
| a | Students use the analysis of the given mathematical representations of factors affecting biodiversity and ecosystems  |
| 1. To identify the most important factors that determine biodiversity and population numbers of an ecosystem.
 |
| 1. As evidence to support explanation(s) for the effects of both living and nonliving factors on biodiversity and population size, as well as the interactions of ecosystems on different scales.
 |
| 1. To describe\* how, in the model, factors affecting ecosystems at one scale can cause observable changes in ecosystems at a different scale.
 |
| b | Students describe\* the given mathematical representations in terms of their ability to support explanation(s) for the effects of modest to extreme disturbances on an ecosystems’ capacity to return to original status or become a different ecosystem. |
| 4 | Revision |
| a | Students revise the explanation(s) based on new evidence about any factors that affect biodiversity and populations (e.g., data illustrating the effect of a disturbance within the ecosystem). |

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| **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. |
| 1 | Identifying the given explanation and the supporting claims, evidence, and reasoning. |
| a | Students identify the given explanation that is supported by the claims, evidence, and reasoning to be evaluated, and which includes the following idea: The complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. |
| b | From the given materials, students identify: |
| 1. The given claims to be evaluated;
 |
| 1. The given evidence to be evaluated; and
 |
| 1. The given reasoning to be evaluated.
 |
| 2 | Identifying any potential additional evidence that is relevant to the evaluation |
| a | Students identify and describe\* additional evidence (in the form of data, information, or other appropriate forms) that was not provided but is relevant to the explanation and to evaluating the given claims, evidence, and reasoning: |
| 1. The factors that affect biodiversity;
 |
| 1. The relationships between species and the physical environment in an ecosystem; and
 |
| 1. Changes in the numbers of species and organisms in an ecosystem that has been subject to a modest or extreme change in ecosystem conditions.
 |
| 3 | Evaluating and critiquing |
| a | Students describe\* the strengths and weaknesses of the given claim in accurately explaining a particular response of biodiversity to a changing condition, based on an understanding of the factors that affect biodiversity and the relationships between species and the physical environment in an ecosystem. |
| b | Students use their additional evidence to assess the validity and reliability of the given evidence and its ability to support the argument that resiliency of an ecosystem is subject to the degree of change in the biological and physical environment of an ecosystem. |
| c | Students assess the logic of the reasoning, including the relationship between degree of change and stability in ecosystems, and the utility of the reasoning in supporting the explanation of how: |
| 1. Modest biological or physical disturbances in an ecosystem result in maintenance of relatively consistent numbers and types of organisms.
 |
| 1. Extreme fluctuations in conditions or the size of any population can challenge the functioning of ecosystems in terms of resources and habitat availability, and can even result in a new ecosystem.
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| **HS.7.2.D Evaluate the evidence** for the role of group behavior on individual and species’ chances to survive and reproduce. |
| 1 | Identifying the given explanation and the supporting evidence |
| a | Students identify the given explanation that is supported by the evidence to be evaluated, and which includes the following idea: Group behavior can increase the chances for an individual and a species to survive and reproduce. |
| b | Students identify the given evidence to be evaluated. |
| 2 | Identifying any potential additional evidence that is relevant to the evaluation |
| a | Students identify additional evidence (in the form of data, information, or other appropriate forms) that was not provided but is relevant to the explanation and to evaluating the given evidence, and which includes evidence for causal relationships between specific group behaviors (e.g., flocking, schooling, herding, cooperative hunting, migrating, swarming) and individual survival and reproduction rates. |
| 3 | Evaluating and critiquing |
| a | Students use their additional evidence to assess the validity, reliability, strengths, and weaknesses of the given evidence along with its ability to support logical and reasonable arguments about the outcomes of group behavior.  |
| b | Students evaluate the given evidence for the degree to which it supports a causal claim that group behavior can have a survival advantage for some species, including how the evidence allows for distinguishing between causal and correlational relationships, and how it supports cause and effect relationships between various kinds of group behavior and individual survival rates (for example, the relationship between moving in a group and individual survival rates, compared to the survival rate of individuals of the same species moving alone or outside of the group). |

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| **HS.7.2.E Design, evaluate, and refine a solution** for increasing the positive impacts of human activities on the environment and biodiversity. |
| 1 | Using scientific knowledge to generate the design solution |
| a | Students design a solution that involves reducing the negative effects of human activities on the environment and biodiversity, and that relies on scientific knowledge of the factors affecting changes and stability in biodiversity. Examples of factors include but are not limited to: |
| 1. Overpopulation;
 |
| 1. Overexploitation;
 |
| 1. Habitat destruction;
 |
| 1. Pollution;
 |
| 1. Introduction of invasive species; and
 |
| 1. Changes in climate.
 |
| b | Students describe\* the ways the proposed solution decreases the negative effects of human activity on the environment and biodiversity. |
| 2 | Describing criteria and constraints, including quantification when appropriate |
| a | Students describe\* and quantify (when appropriate) the criteria (amount of reduction of impacts and human activities to be mitigated) and constraints (for example, cost, human needs, and environmental impacts) for the solution to the problem, along with the tradeoffs in the solution. |
| 3 | Evaluating potential solutions |
| a | Students evaluate the proposed solution for its impact on overall environmental stability and changes.  |
| b | Students evaluate the cost, safety, and reliability, as well as social, cultural, and environmental impacts, of the proposed solution for a select human activity that is harmful to an ecosystem. |
| 4 | Refining and/or optimizing the design solution |
| a | Students refine the proposed solution by prioritizing the criteria and making tradeoffs as necessary to further reduce environmental impact and loss of biodiversity while addressing human needs. |

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| **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. |
| 1 | Representation |
| a | Students create or revise a simulation that:  |
| 1. Models effects of human activity (e.g., overpopulation, overexploitation, adverse habitat alterations, pollution, invasive species, changes in climate) on a threatened or endangered species or to the genetic variation within a species; and
 |
| 1. Provides quantitative information about the effect of the solutions on threatened or endangered species.
 |
| b | Students describe\* the components that are modeled by the computational simulation, including human activity (e.g., overpopulation, overexploitation, adverse habitat alterations, pollution, invasive species, changes in climate) and the factors that affect biodiversity. |
| c | Students describe\* the variables that can be changed by the user to evaluate the proposed solutions, tradeoffs, or other decisions. |
| 2 | Computational modeling |
| a | Students use logical and realistic inputs for the simulation that show an understanding of the reliance of ecosystem function and productivity on biodiversity, and that take into account the constraints of cost, safety, and reliability as well as cultural, and environmental impacts. |
| b | Students use the simulation to identify possible negative consequences of solutions that would outweigh their benefits. |
| 3 | Analysis |
| a | Students compare the simulation results to expected results. |
| b | Students analyze the simulation results to determine whether the simulation provides sufficient information to evaluate the solution.  |
| c | Students identify the simulation’s limitations. |
| d | Students interpret the simulation results, and predict the effects of the specific design solutions on biodiversity based on the interpretation. |
| 4 | Revision |
| a | Students revise the simulation as needed to provide sufficient information to evaluate the solution. |

**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.

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|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\EnergyMatter.png | SC.HS.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. Assessment does not include specific biochemical steps. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\EnergyMatter.png | 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. Emphasis is on using evidence from models and simulations to support explanations. Assessment does not include the details of the specific chemical reactions or identification of macromolecules. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\EnergyMatter.png | 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. Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration. Assessment should not include identification of the steps or specific processes involved in cellular respiration. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\EnergyMatter.png | 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. Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration in different environments. Assessment does not include the specific chemical processes of either aerobic or anaerobic respiration. |
| C:\Users\sara.cooper.NDE\Desktop\Standards\NebraskaConnection.png | *NE ethanol production* |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\EnergyMatter.png | 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. 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. |
| C:\Users\sara.cooper.NDE\Desktop\Standards\NebraskaConnection.png | *NE agricultural practices*  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\Systems.png | 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. Examples of models could include simulations and mathematical models. Assessment does not include the specific chemical steps of photosynthesis and respiration. |

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| The performance indicators above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*: |
| **Science and Engineering Practices****Developing and Using Models**Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. * Use a model based on evidence to illustratethe relationships between systems or between components of a system. (HS.8.3.A),(HS.8.3.C)
* Develop a model based on evidence to illustrate the relationships between systems or components of a system. (HS.8.3.F)

**Using Mathematics and Computational Thinking**Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.* Use mathematical representations of phenomena or design solutions to support claims. (HS.8.3.E)

**Constructing Explanations and Designing Solutions**Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.* Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS.8.3.B),(HS.8.3.D)

**--------------------------------------------------------**[***Connections to Nature of Science***](http://nstahosted.org/pdfs/ngss/AppendixH-TheNatureOfScienceInTheNextGenerationScienceStandards-4.9.13.pdf) **Scientific Knowledge is Open to Revision in Light of New Evidence*** Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS.8.3.D)
 | **Disciplinary Core Ideas**[**LS1.C**](https://www.nap.edu/read/13165/chapter/10#147)**: Organization for Matter and Energy Flow in Organisms** * The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HS.8.3.A)
* The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. (HS.8.3.B)
* As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HS.8.3.B),(HS.8.3.C)
* As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment.(HS.8.3.C)

[**LS2.B**](https://www.nap.edu/read/13165/chapter/10#152)**: Cycles of Matter and Energy Transfer in Ecosystems** * Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (HS.8.3.D)

C:\Users\sara.cooper.NDE\Desktop\Standards\NebraskaConnection.png Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (HS.8.3.E)* Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. (HS.8.3.F)

[**PS3.D**](https://www.nap.edu/read/13165/chapter/9#128)**: Energy in Chemical Processes*** The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. *(secondary to HS.8.3.F)*
 | **Crosscutting Concepts**C:\Users\sara.cooper.NDE\Desktop\Standards\Systems.png**Systems and System Models**Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS.8.3.F)C:\Users\sara.cooper.NDE\Desktop\Standards\EnergyMatter.png**Energy and Matter** Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS.8.3.A), (HS.8.3.B)* Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.(HS.8.3.C),(HS.8.3.E)
* Energy drives the cycling of matter within and between systems. (HS.8.3.D)
 |
| *Connections to other DCIs in this grade-band:*  **HS.PS1.B** (HS.8.3.A),(HS.8.3.B),(HS.8.3.C),(HS.8.3.D),(HS.8.3.F); **HS.PS2.B** (HS.8.3.C); **HS.PS3.B** (HS.8.3.A),(HS.8.3.C),(HS.8.3.D),(HS.8.3.E); **HS.PS3.D** (HS.8.3.D),(HS.8.3.E); **HS.ESS2.A** (HS.8.3.D); **HS.ESS2.D** (HS.8.3.F) |
| *Articulation across grade-bands:*  **MS.PS1.A** (HS.8.3.B); **MS.PS1.B** (HS.8.3.A),(HS.8.3.B),(HS.8.3.C),(HS.8.3.D); **MS.PS3.D** (HS.8.3.A),(HS.8.3.B),(HS.8.3.C),(HS.8.3.D),(HS.8.3.E),(HS.8.3.F); **MS.LS1.C** (HS.8.3.A),(HS.8.3.B),(HS.8.3.C),(HS.8.3.D),(HS.8.3.E),(HS.8.3.F); **MS.LS2.B** (HS.8.3.A),(HS.8.3.C),(HS.8.3.D),(HS.8.3.E),(HS.8.3.F); **MS.ESS2.A**(HS.8.3.F); **MS.ESS2.E** (HS.8.3.B) |
| *NGSS Connections:* [Matter and Energy in Organisms and Ecosystems](http://ngss.nsta.org/DisplayStandard.aspx?view=topic&id=46) [**HS-LS1-5**](http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=131) (HS.8.3.A); [**HS-LS1-6**](http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=132) (HS.8.3.B); [**HS-LS1-7**](http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=133) (HS.8.3.C); [**HS-LS2-3**](http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=142) (HS.8.3.D); [**HS-LS2-4**](http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=143) (HS.8.3.E); [**HS-LS2-5**](http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=144) (HS.8.3.F) |
| *ELA Connections:*  |
| *Mathematics Connections:*  |
| *Connections:* |
| *Connections:* |

**Evidence Statements: Observable features of the student performance by the end of the course.**

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| **HS.8.3.A Use a model** to illustrate how photosynthesis transforms light energy into stored chemical energy. |
| 1 | Components of the model |
| a | From the given model, students identify and describe\* the components of the model relevant for illustrating that photosynthesis transforms light energy into stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen, including: |
| 1. Energy in the form of light;
 |
| 1. Breaking of chemical bonds to absorb energy;
 |
| 1. Formation of chemical bonds to release energy; and
 |
| 1. Matter in the form of carbon dioxide, water, sugar, and oxygen.
 |
| 2 | Relationships |
| a | Students identify the following relationship between components of the given model: Sugar and oxygen are produced by carbon dioxide and water by the process of photosynthesis. |
| 3 | Connections |
| c | Students use the given model to illustrate: |
| 1. The transfer of matter and flow of energy between the organism and its environment during photosynthesis; and
 |
| 1. Photosynthesis as resulting in the storage of energy in the difference between the energies of the chemical bonds of the inputs (carbon dioxide and water) and outputs (sugar and oxygen).
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| **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. |
| 1 | Articulating the explanation of phenomena |
| a | Students construct an explanation that includes: |
| 1. The relationship between the carbon, hydrogen, and oxygen atoms from sugar molecules formed in or ingested by an organism and those same atoms found in amino acids and other large carbon-based molecules; and
 |
| 1. That larger carbon-based molecules and amino acids can be a result of chemical reactions between sugar molecules (or their component atoms) and other atoms.
 |
| 2 | Evidence |
| a | Students identify and describe\* the evidence to construct the explanation, including: |
| 1. All organisms take in matter (allowing growth and maintenance) and rearrange the atoms in chemical reactions.
 |
| 1. Cellular respiration involves chemical reactions between sugar molecules and other molecules in which energy is released that can be used to drive other chemical reactions.
 |
| 1. Sugar molecules are composed of carbon, oxygen, and hydrogen atoms.
 |
| 1. Amino acids and other complex carbon-based molecules are composed largely of carbon, oxygen, and hydrogen atoms.
 |
| 1. Chemical reactions can create products that are more complex than the reactants.
 |
| 1. Chemical reactions involve changes in the energies of the molecules involved in the reaction.
 |
| b | Students use a variety of valid and reliable sources for the evidence (e.g., theories, simulations, students’ own investigations). |
| 3 | Reasoning |
| a | Students use reasoning to connect the evidence, along with the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future, to construct the explanation that atoms from sugar molecules may combine with other elements via chemical reactions to form other large carbon-based molecules. Students describe\* the following chain of reasoning for their explanation: |
| 1. The atoms in sugar molecules can provide most of the atoms that comprise amino acids and other complex carbon-based molecules.
 |
| 1. The energy released in respiration can be used to drive chemical reactions between sugars and other substances, and the products of those reactions can include amino acids and other complex carbon-based molecules.
 |
| 1. The matter flows in cellular processes are the result of the rearrangement of primarily the atoms in sugar molecules because those are the molecules whose reactions release the energy needed for cell processes.
 |
| 4 | Revising the explanation |
| a | Given new evidence or context, students revise or expand their explanation about the relationships between atoms in sugar molecules and atoms in large carbon-based molecules, and justify their revision. |

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| **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. |
| 1 | Components of the model |
| a | From a given model, students identify and describe\* the components of the model relevant for their illustration of cellular respiration, including: |
| 1. Matter in the form of food molecules, oxygen, and the products of their reaction (e.g., water and CO2);
 |
| 1. The breaking and formation of chemical bonds; and
 |
| 1. Energy from the chemical reactions.
 |
| 2 | Relationships |
| a | From the given model, students describe\* the relationships between components, including:  |
| 1. Carbon dioxide and water are produced from sugar and oxygen by the process of cellular respiration; and
 |
| 1. The process of cellular respiration releases energy because the energy released when the bonds that are formed in CO2 and water is greater than the energy required to break the bonds of sugar and oxygen.
 |
| 3 | Connections |
| a | Students use the given model to illustrate that: |
| 1. The chemical reaction of oxygen and food molecules releases energy as the matter is rearranged, existing chemical bonds are broken, and new chemical bonds are formed, but matter and energy are neither created nor destroyed.
 |
| 1. Food molecules and oxygen transfer energy to the cell to sustain life’s processes, including the maintenance of body temperature despite ongoing energy transfer to the surrounding environment.
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| **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. |
| 1 | Articulating the explanation of phenomena |
| a | Students construct an explanation that includes that:  |
| 1. Energy from photosynthesis and respiration drives the cycling of matter and flow of energy under aerobic or anaerobic conditions within an ecosystem.
 |
| 1. Anaerobic respiration occurs primarily in conditions where oxygen is not available.
 |
| 2 | Evidence |
| a | Students identify and describe\* the evidence to construct the explanation, including: |
| 1. All organisms take in matter and rearrange the atoms in chemical reactions.
 |
| 1. Photosynthesis captures energy in sunlight to create chemical products that can be used as food in cellular respiration.
 |
| 1. Cellular respiration is the process by which the matter in food (sugars, fats) reacts chemically with other compounds, rearranging the matter to release energy that is used by the cell for essential life processes.
 |
| b | Students use a variety of valid and reliable sources for the evidence, which may include theories, simulations, peer review, and students’ own investigations. |
| 3 | Reasoning |
| a | Students use reasoning to connect evidence, along with the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future, to construct their explanation. Students describe\* the following chain of reasoning used to construct their explanation:  |
| 1. Energy inputs to cells occur either by photosynthesis or by taking in food.
 |
| 1. Since all cells engage in cellular respiration, they must all produce products of respiration.
 |
| 1. The flow of matter into and out of cells must therefore be driven by the energy captured by photosynthesis or obtained by taking in food and released by respiration.
 |
| 1. The flow of matter and energy must occur whether respiration is aerobic or anaerobic.
 |
| 4 | Revising the explanation |
| a | Given new data or information, students revise their explanation and justify the revision (e.g., recent discoveries of life surrounding deep sea ocean vents have shown that photosynthesis is not the only driver for cycling matter and energy in ecosystems). |

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| **HS.8.3.E Use mathematical representations** to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. |
| 1 | Representation |
| a | Students identify and describe\* the components in the mathematical representations that are relevant to supporting the claims. The components could include relative quantities related to organisms, matter, energy, and the food web in an ecosystem. |
| b | Students identify the claims about the cycling of matter and energy flow among organisms in an ecosystem. |
| 2 | Mathematical modeling |
| a | Students describe\* how the claims can be expressed as a mathematical relationship in the mathematical representations of the components of an ecosystem  |
| b | Students use the mathematical representation(s) of the food web to:  |
| 1. Describe\* the transfer of matter (as atoms and molecules) and flow of energy upward between organisms and their environment;
 |
| 1. Identify the transfer of energy and matter between tropic levels; and
 |
| 1. Identify the relative proportion of organisms at each trophic level by correctly identifying producers as the lowest trophic level having the greatest biomass and energy and consumers decreasing in numbers at higher trophic levels.
 |
| 3 | Analysis |
| a | Students use the mathematical representation(s) to support the claims that include the idea that matter flows between organisms and their environment. |
| b | Students use the mathematical representation(s) to support the claims that include the idea that energy flows from one trophic level to another as well as through the environment. |
| c | Students analyze and use the mathematical representation(s) to account for the energy not transferred to higher trophic levels but which is instead used for growth, maintenance, or repair, and/or transferred to the environment, and the inefficiencies in transfer of matter and energy. |

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| **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. |
| 1 | Components of the model |
| a | Students use evidence to develop a model in which they identify and describe\* the relevant components, including: |
| 1. The inputs and outputs of photosynthesis;
 |
| 1. The inputs and outputs of cellular respiration; and
 |
| 1. The biosphere, atmosphere, hydrosphere, and geosphere.
 |
| 2 | Relationships |
| a | Students describe\* relationships between components of their model, including: |
| 1. The exchange of carbon (through carbon-containing compounds) between organisms and the environment; and
 |
| 1. The role of storing carbon in organisms (in the form of carbon-containing compounds) as part of the carbon cycle.
 |
| 3 | Connections |
| a | Students describe\* the contribution of photosynthesis and cellular respiration to the exchange of carbon within and among the biosphere, atmosphere, hydrosphere, and geosphere in their model. |
| b | Students make a distinction between the model’s simulation and the actual cycling of carbon via photosynthesis and cellular 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.

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|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.png | 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. |
| C:\Users\sara.cooper.NDE\Desktop\Standards\NebraskaConnection.png | *NE agricultural practices*  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.png | 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. Emphasis is on using data to support arguments for the way variation occurs. Assessment does not include the phases of meiosis or the molecular mechanism of specific steps in the process. |
| C:\Users\sara.cooper.NDE\Desktop\Standards\NebraskaConnection.png | *NE plants and animals* |
|  | C:\Users\sara.cooper.NDE\Desktop\Standards\CivicConnection.png | C:\Users\sara.cooper.NDE\Desktop\Standards\ScaleProportionQuantity.png | SC.HS.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. Assessment does not include Hardy-Weinberg calculations. |
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| The performance indicators above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*: |
|  **Science and Engineering Practices****Developing and Using Models**Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).* Use a model to provide mechanistic accounts of phenomena.

 (HS.9.4.A)**Analyzing and Interpreting Data**Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.* Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (HS.9.4.C)

**Engaging in Argument from Evidence**Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.* Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence. (HS.9.4.B)
 | **Disciplinary Core Ideas**[**LS1.A**](https://www.nap.edu/read/13165/chapter/10#143)**: Structure and Function*** All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins. *(secondary to HS.9.4.A) (Note: This Disciplinary Core Idea is also addressed by HS.6.1.A.)*

[**LS3.A**](https://www.nap.edu/read/13165/chapter/10#158)**: Inheritance of Traits**C:\Users\sara.cooper.NDE\Desktop\Standards\NebraskaConnection.png Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species’ characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function. (HS.9.4.A)[**LS3.B**](https://www.nap.edu/read/13165/chapter/10#160)**: Variation of Traits*** In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. (HS.9.4.B)

C:\Users\sara.cooper.NDE\Desktop\Standards\NebraskaConnection.png Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. (HS.9.4.B),(HS.9.4.C) | **Crosscutting Concepts**C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.png**Cause and Effect**Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS.9.4.A),(HS.9.4.B)C:\Users\sara.cooper.NDE\Desktop\Standards\ScaleProportionQuantity.png**Scale, Proportion, and Quantity** Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). (HS.9.4.C)**---------------------------------------------**[***Connections to Nature of Science***](http://nstahosted.org/pdfs/ngss/AppendixH-TheNatureOfScienceInTheNextGenerationScienceStandards-4.9.13.pdf) **Science is a Human Endeavor** * Technological advances have influenced the progress of science and science has influenced advances in technology. (HS.9.4.C)
* Science and engineering are influenced by society and society is influenced by science and engineering. (HS.9.4.C)
 |
| *Connections to other DCIs in this grave-band:* **HS.LS2.A** (HS.9.4.C); **HS.LS2.C** (HS.9.4.C); **HS.LS4.B** (HS.9.4.C); **HS.LS4.C** (HS.9.4.C) |
| *Articulation across grade-bands:* ); **MS.LS2.A**(HS.9.4.C);**MS.LS3.A** (HS.9.4.A),(HS.9.4.B);**MS.LS3.B**(HS.9.4.A),(HS.9.4.B),(HS.9.4.C);**MS.LS4.C**(HS.9.4.C) |
| *NGSS Connections:* [Inheritance and Variation of Traits](http://ngss.nsta.org/DisplayStandard.aspx?view=topic&id=48) [**HS-LS3-1**](http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=153) (HS.9.4.A); [**HS-LS3-2**](http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=154) (HS.9.4.B); [**HS-LS3-3**](http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=155) (HS.9.4.C) |
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| *Mathematics Connections:*  |
| *Connections:* |
| *Connections:* |

**Evidence Statements: Observable features of the student performance by the end of the course.**

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| **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. |
| 1 | Components of the model: |
| a | From the given model, students identify and describe\* the components of the model relevant for their mechanistic descriptions.  |
| b | From the given model, students identify the relevant different scales on which the factors operate. |
| 2 | Relationships |
| a | Students identify and describe\* the relationships between components of the given model. |
| b | Students describe\* the relationships between components of the model as either causal or correlational. |
| 3 | Connections |
| a | Students use the given model to provide a mechanistic account of the relationship between factors represented in the model. |

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| **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. |
| 1 | Developing a claim |
| a | Students make a claim that includes the idea that inheritable genetic variations may result from:  |
| 1. New genetic combinations through meiosis;
 |
| 1. Viable errors occurring during replication; and
 |
| 1. Mutations caused by environmental factors.
 |
| 2 | Identifying scientific evidence |
| a | Students identify and describe\* evidence that supports the claim, including: |
| 1. Variations in genetic material naturally result during meiosis when corresponding sections of chromosome pairs exchange places.
 |
| 1. Genetic mutations can occur due to:
 |
| 1. errors during replication; and/or
 |
| 1. environmental factors.
 |
| 1. Genetic material is inheritable.
 |
| b | Students use scientific knowledge, literature, student-generated data, simulations and/or other sources for evidence. |
| 3 | Evaluating and critiquing evidence |
| a | Students identify the following strengths and weaknesses of the evidence used to support the claim: |
| 1. Types and numbers of sources;
 |
| 1. Sufficiency to make and defend the claim, and to distinguish between causal and correlational relationships; and
 |
| 1. Validity and reliability of the evidence.
 |
| 4 | Reasoning and synthesis |
| a | Students use reasoning to describe\* links between the evidence and claim, such as:  |
| 1. Genetic mutations produce genetic variations between cells or organisms.
 |
| 1. Genetic variations produced by mutation and meiosis can be inherited.
 |
| b | Students use reasoning and valid evidence to describe\* that new combinations of DNA can arise from several sources, including meiosis, errors during replication, and mutations caused by environmental factors. |
| c | Students defend a claim against counter-claims and critique by evaluating counter-claims and by describing\* the connections between the relevant and appropriate evidence and the strongest claim. |

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| **HS.9.4.C Apply concepts of statistics and probability** to explain the variation and distribution of expressed traits in a population. |
| 1 | Organizing data |
| a | Students organize the given data by the frequency, distribution, and variation of expressed traits in the population. |
| 2 | Identifying relationships |
| a | Students perform and use appropriate statistical analyses of data, including probability measures, to determine the relationship between a trait’s occurrence within a population and environmental factors. |
| 3 | Interpreting data |
| a | Students analyze and interpret data to explain the distribution of expressed traits, including: |
| 1. Recognition and use of patterns in the statistical analysis to predict changes in trait distribution within a population if environmental variables change; and
 |
| 1. Description\* of the expression of a chosen trait and its variations as causative or correlational to some environmental factor based on reliable evidence.
 |

**SC.HS.10 Biological Evolution**

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

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|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\Patterns.png | SC.HS.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. |
| C:\Users\sara.cooper.NDE\Desktop\Standards\NebraskaConnection.png | *NE fossil record* |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.png | 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. Emphasis is on using evidence to explain the influence each of the four factors has on number of organisms, behaviors, morphology, or physiology in terms of ability to compete for limited resources and subsequent survival of individuals and adaptation of species. Examples of evidence could include mathematical models such as simple distribution graphs and proportional reasoning. Assessment does not include other mechanisms of evolution, such as genetic drift, gene flow through migration, and co-evolution. |
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|  | **C:\Users\sara.cooper.NDE\Desktop\Standards\ComputerScienceConnection.png** | C:\Users\sara.cooper.NDE\Desktop\Standards\Patterns.png | 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. Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations. Assessment is limited to basic statistical and graphical analysis. Assessment does not include allele frequency calculations. |
| C:\Users\sara.cooper.NDE\Desktop\Standards\NebraskaConnection.png | *NE plants and animals* |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.png | SC.HS.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. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.png | 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. 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. |
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| The performance indicators above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*: |
| **Science and Engineering Practices****Analyzing and Interpreting Data** Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. * Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (HS.10.5.C)

**Constructing Explanations and Designing Solutions**Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.* Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS.10.5.B),(HS.10.5.D)

**Engaging in Argument from Evidence**Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current or historical episodes in science.* Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS.10.5.E)

**Obtaining, Evaluating, and Communicating Information**Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.* Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS.10.5.A)

**-----------------------------------------------------------------**[***Connections to Nature of Science***](http://nstahosted.org/pdfs/ngss/AppendixH-TheNatureOfScienceInTheNextGenerationScienceStandards-4.9.13.pdf) **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena*** A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HS.10.5.A)
 | **Disciplinary Core Ideas**C:\Users\sara.cooper.NDE\Desktop\Standards\NebraskaConnection.png[**LS4.A**](https://www.nap.edu/read/13165/chapter/10#162)**: Evidence of Common Ancestry and Diversity**Genetic information provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence. (HS.10.5.A)[**LS4.B**](https://www.nap.edu/read/13165/chapter/10#163)**: Natural Selection**C:\Users\sara.cooper.NDE\Desktop\Standards\NebraskaConnection.png Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. (HS.10.5.B),(HS.10.5.C)* The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (HS.10.5.C)

[**LS4.C**](https://www.nap.edu/read/13165/chapter/10#164)**: Adaptation*** Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment’s limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. (HS.10.5.B)
* Natural selection leads to adaptation that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. (HS.10.5.C),(HS.10.5.D)
* Adaptation also means that the distribution of traits in a population can change when conditions change. (HS.10.5.C)

C:\Users\sara.cooper.NDE\Desktop\Standards\NebraskaConnection.png Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometimes the extinction–of some species. (HS.10.5.E)* Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species’ evolution is lost. (HS.10.5.E)
 | **Crosscutting Concepts****Patterns**C:\Users\sara.cooper.NDE\Desktop\Standards\Patterns.pngDifferent patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS.10.5.A),(HS.10.5.C)**Cause and Effect**C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.pngEmpirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS.10.5.B),(HS.10.5.D),(HS.10.5.E)**---------------------------------------**[***Connections to Nature of Science***](http://nstahosted.org/pdfs/ngss/AppendixH-TheNatureOfScienceInTheNextGenerationScienceStandards-4.9.13.pdf) **Scientific Knowledge Assumes an Order and Consistency in Natural Systems*** Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. (HS.10.5.A),(HS.10.5.D)
 |
| *Connections to other DCIs in this grade-band:*  **HS.LS2.A** (HS.10.5.B),(HS.10.5.C),(HS.10.5.D),(HS.10.5.E); **HS.LS2.D** (HS.10.5.B),(HS.10.5.C),(HS.10.5.D),(HS.10.5.E); **HS.LS3.A** (HS.10.5.A); **HS.LS3.B** (HS.10.5.A),(HS.10.5.B) (HS.10.5.C),(HS.10.5.E); **HS.ESS1.C** (HS.10.5.A); **HS.ESS2.E** (HS.10.5.B),(HS.10.5.E); **HS.ESS3.A** (HS.10.5.B),(HS.10.5.E)  |
| *Articulation across grade-bands:*  **MS.LS2.A** (HS.10.5.B),(HS.10.5.C),(HS.10.5.E); **MS.LS2.C** (HS.10.5.E);  **MS.LS3.A** (HS.10.5.A); **MS.LS3.B** (HS.10.5.A),(HS.10.5.B),(HS.10.5.C); **MS.LS4.A** (HS.10.5.A); **MS.LS4.B** (HS.10.5.B),(HS.10.5.C),(HS.10.5.D); **MS.LS4.C** (HS.10.5.B),(HS.10.5.C),(HS.10.5.D),(HS.10.5.E); **MS.ESS1.C** (HS.10.5.A); **MS.ESS3.C** (HS.10.5.E) |
| *NGSS Connections:* [Natural Selection and Evolution](http://ngss.nsta.org/DisplayStandard.aspx?view=topic&id=49) [**HS-LS4-1**](http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=156) (HS.10.5.A); [**HS-LS4-2**](http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=157) (HS.10.5.B); [**HS-LS4-3**](http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=159) (HS.10.5.C); [**HS-LS4-4**](http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=161) (HS.10.5.D); [**HS-LS4-5**](http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=163) (HS.10.5.E) |
| *ELA Connections:*  |
| *Mathematics Connections:*  |
| *Connections:* |
| *Connections:* |

**Evidence Statements: Observable features of the student performance by the end of the course.**

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| **HS.10.5.A Communicate scientific** information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. |
| 1 | Communication style and format |
| a | Students use at least two different formats (e.g., oral, graphical, textual and mathematical), to communicate scientific information, including that common ancestry and biological evolution are supported by multiple lines of empirical evidence. Students cite the origin of the information as appropriate. |
| 2 | Connecting the DCIs and the CCCs |
| a | Students identify and communicate evidence for common ancestry and biological evolution, including: |
| 1. Information derived from DNA sequences, which vary among species but have many similarities between species;
 |
| 1. Similarities of the patterns of amino acid sequences, even when DNA sequences are slightly different, including the fact that multiple patterns of DNA sequences can code for the same amino acid;
 |
| 1. Patterns in the fossil record (e.g., presence, location, and inferences possible in lines of evolutionary descent for multiple specimens); and
 |
| 1. The pattern of anatomical and embryological similarities.
 |
| b | Students identify and communicate connections between each line of evidence and the claim of common ancestry and biological evolution. |
| c | Students communicate that together, the patterns observed at multiple spatial and temporal scales (e.g., DNA sequences, embryological development, fossil records) provide evidence for causal relationships relating to biological evolution and common ancestry. |

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| **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. |
| 1 | Articulating the explanation of phenomena |
| a | Students construct an explanation that includes a description\* that evolution is caused primarily by one or more of the 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. |
| 2 | Evidence |
| a | Students identify and describe\* evidence to construct their explanation, including that: |
| 1. As a species grows in number, competition for limited resources can arise.
 |
| 1. Individuals in a species have genetic variation (through mutations and sexual reproduction) that is passed on to their offspring.
 |
| 1. Individuals can have specific traits that give them a competitive advantage relative to other individuals in the species.
 |
| b | Students use a variety of valid and reliable sources for the evidence (e.g., data from investigations, theories, simulations, peer review). |
| 3 | Reasoning |
| a | Students use reasoning to connect the evidence, along with the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future, to construct the explanation. Students describe\* the following chain of reasoning for their explanation: |
| 1. Genetic variation can lead to variation of expressed traits in individuals in a population.
 |
| 1. Individuals with traits that give competitive advantages can survive and reproduce at higher rates than individuals without the traits because of the competition for limited resources.
 |
| 1. Individuals that survive and reproduce at a higher rate will provide their specific genetic variations to a greater proportion of individuals in the next generation.
 |
| 1. Over many generations, groups of individuals with particular traits that enable them to survive and reproduce in distinct environments using distinct resources can evolve into a different species.
 |
| b | Students use the evidence to describe\* the following in their explanation:  |
| 1. The difference between natural selection and biological evolution (natural selection is a process, and biological evolution can result from that process); and
 |
| 1. The cause and effect relationship between genetic variation, the selection of traits that provide comparative advantages, and the evolution of populations that all express the trait.
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| **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. |
| 1 | Organizing data |
| a | Students organize data (e.g., using tables, graphs and charts) by the distribution of genetic traits over time. |
| b | Students describe\* what each dataset represents |
| 2 | Identifying relationships |
| a | Students perform and use appropriate statistical analyses of data, including probability measures, to determine patterns of change in numerical distribution of traits over various time and population scales. |
| 3 | Interpreting data |
| a | Students use the data analyses as evidence to support explanations about the following: |
| 1. Positive or negative effects on survival and reproduction of individuals as relating to their expression of a variable trait in a population;
 |
| 1. Natural selection as the cause of increases and decreases in heritable traits over time in a population, but only if it affects reproductive success; and
 |
| 1. The changes in distribution of adaptations of anatomical, behavioral, and physiological traits in a population.
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| **HS.10.5.D Construct an explanation** based on evidence for how natural selection leads to adaptation of populations. |
| 1 | Articulating the explanation of phenomena |
| a | Students construct an explanation that identifies the cause and effect relationship between natural selection and adaptation. |
| 2 | Evidence |
| a | Students identify and describe\* the evidence to construct their explanation, including: |
| 1. Changes in a population when some feature of the environment changes;
 |
| 1. Relative survival rates of organisms with different traits in a specific environment;
 |
| 1. The fact that individuals in a species have genetic variation (through mutations and sexual reproduction) that is passed on to their offspring; and
 |
| 1. The fact that individuals can have specific traits that give them a competitive advantage relative to other individuals in the species.
 |
| b | Students use a variety of valid and reliable sources for the evidence (e.g., theories, simulations, peer review, students’ own investigations) |
| 3 | Reasoning |
| a | Students use reasoning to synthesize the valid and reliable evidence to distinguish between cause and correlation to construct the explanation about how natural selection provides a mechanism for species to adapt to changes in their environment, including the following elements: |
| 1. Biotic and abiotic differences in ecosystems contribute to changes in gene frequency over time through natural selection.
 |
| 1. Increasing gene frequency in a population results in an increasing fraction of the population in each successive generation that carries a particular gene and expresses a particular trait.
 |
| 1. Over time, this process leads to a population that is adapted to a particular environment by the widespread expression of a trait that confers a competitive advantage in that environment.
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| **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. |
| 1 | Identifying the given claims and evidence to be evaluated |
| a | Students identify the given claims, which include the idea that changes in environmental conditions may result in: |
| 1. Increases in the number of individuals of some species;
 |
| 1. The emergence of new species over time; and
 |
| 1. The extinction of other species.
 |
| b | Students identify the given evidence to be evaluated.  |
| 2 | Identifying any potential additional evidence that is relevant to the evaluation |
| a | Students identify and describe\* additional evidence (in the form of data, information, models, or other appropriate forms) that was not provided but is relevant to the claims and to evaluating the given evidence, including: |
| 1. Data indicating the change over time in:
 |
| 1. The number of individuals in each species;
 |
| 1. The number of species in an environment; and
 |
| 1. The environmental conditions.
 |
| 1. Environmental factors that can determine the ability of individuals in a species to survive and reproduce.
 |
| 3 | Evaluating and critiquing |
| a | Students use their additional evidence to assess the validity, reliability, strengths, and weaknesses of the given evidence, along with its ability to support logical and reasonable arguments about the outcomes of group behavior.  |
| b | Students assess the ability of the given evidence to be used to determine causal or correlational effects between environmental changes, the changes in the number of individuals in each species, the number of species in an environment, and/or the emergence or extinction of species. |
| 4 | Reasoning and synthesis |
| a | Students evaluate the degree to which the given empirical evidence can be used to construct logical arguments that identify causal links between environmental changes and changes in the number of individuals or species based on environmental factors that can determine the ability of individuals in a species to survive and reproduce |

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| 2 | Identifying scientific evidence |
| a | Students identify evidence for the design solutions, including: |
| 1. Societal needs for that energy or mineral resource;
 |
| 1. The cost of extracting or developing the energy reserve or mineral resource;
 |
| 1. The costs and benefits of the given design solutions; and
 |
| 1. The feasibility, costs, and benefits of recycling or reusing the mineral resource, if applicable.
 |
| 3 | Evaluation and critique |
| a | Students evaluate the given design solutions, including: |
| 1. The relative strengths of the given design solutions, based on associated economic, environmental, and geopolitical costs, risks, and benefits;
 |
| 1. The reliability and validity of the evidence used to evaluate the design solutions; and
 |
| 1. Constraints, including cost, safety, reliability, aesthetics, cultural effects environmental effects.
 |
| 4 | Reasoning/synthesis |
| a | Students use logical arguments based on their evaluation of the design solutions, costs and benefits, empirical evidence, and scientific ideas to support one design over the other(s) in their evaluation. |
| b | Students describe\* that a decision on the “best” solution may change over time as engineers and scientists work to increase the benefits of design solutions while decreasing costs and risks. |

**Plus Standards**

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.

**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.

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|  |  | **C:\Users\sara.cooper.NDE\Desktop\Standards\StructureFunction.png** | 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. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\Systems.png | 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.**  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\StabilityChange.png | 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.  |
|  |  | **C:\Users\sara.cooper.NDE\Desktop\Standards\StructureFunction.png** | SC.HSP.6.1.D **Use a model** to illustrate the role of cell signaling and cell communication in producing and maintaining cellular functions within organisms. Emphasis is on conceptual understanding of the types of cell signals, signal reception, signal transduction, and types of cellular responses.  |
|  |  | **C:\Users\sara.cooper.NDE\Desktop\Standards\StructureFunction.png** | 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.  |
|  |  | **C:\Users\sara.cooper.NDE\Desktop\Standards\StructureFunction.png** | 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.  |

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| The performance indicators above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*: |
| **Science and Engineering Practices****Developing and Using Models**Modeling in grade 12 builds on K–11 experiences and progresses to using, synthesizing, and developing models to predict, show, and reflect upon relationships among variables between systems and their components in the natural and designed world.  * Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HSP.6.1.B),(HSP.6.1.D)

**Planning and Carrying Out Investigations**Planning and carrying out in grade 12 builds on K–11 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. * Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HSP.6.1.C)

**Constructing Explanations and Designing Solutions**Constructing explanations and designing solutions in grade 12 builds on K–11 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.* Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HSP.6.1.A)
* Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) (HSP.6.1.E),(HSP.6.1.F)

**---------------------------------------------------------------------------*****Connections to Nature of Science*****Scientific Investigations Use a Variety of Methods*** Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. (HSP.6.1.C)
 | **Disciplinary Core Ideas****LS1.A:  Structure and Function*** Systems of specialized cells within organisms help them perform the essential functions of life. (HSP.6.1.A)
* All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HSP.6.1.A) *(Note: This Disciplinary Core Idea is also addressed by SC.HSP.9.4.B.)*
* Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HSP.6.1.B)
* Feedback mechanisms maintain a living system’s internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HSP.6.1.C)
* Cells communicate by both inter- and intracellular signaling. Signaling cells secrete ligands that bind to target cells and initiate a chain of events within the target cell. The four categories of signaling in multicellular organisms are paracrine signaling, endocrine signaling, autocrine signaling, and direct signaling across gap junctions. (HSP.6.1.D)
* While individual plant species are unique, plants share a common structure; they all transport water, minerals, and sugars through the plant; all plant species reproduce and plant species also respond to environmental factors, such as light, gravity, competition, temperature, and predation. (HSP.6.1.E)
* Animals vary in form and function, which is linked to functioning within their environments. To understand how animals survive within their environments an understanding of animal body structure and organization, body systems, homeostasis, reproduction, and animal behavior is necessary. (HSP.6.1.F)
 |  **Crosscutting Concepts**C:\Users\sara.cooper.NDE\Desktop\Standards\Systems.png**Systems and System Models**Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HSP.6.1.B)**Structure and Function** **C:\Users\sara.cooper.NDE\Desktop\Standards\StructureFunction.png**Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HSP.6.1.A), (HSP.6.1.D) * Explain the function of microscopic and macroscopic structures on organisms. (HSP.6.1.E),(HSP.6.1.F)

C:\Users\sara.cooper.NDE\Desktop\Standards\StabilityChange.png**Stability and Change**Feedback (negative or positive) can stabilize or destabilize a system. (HSP.6.1.C) |

**SC.HSP.7 Interdependent Relationships in Ecosystems**
SC.HSP.7.2 Gather, analyze, and communicate evidence of interdependent relationships in ecosystems.

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|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\ScaleProportionQuantity.png | 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.**   |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\ScaleProportionQuantity.png | 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.  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\StabilityChange.png | 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.  |
|  | C:\Users\sara.cooper.NDE\Desktop\Standards\EngineeringConnection'.png | C:\Users\sara.cooper.NDE\Desktop\Standards\StabilityChange.png | 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.  |
| **C:\Users\sara.cooper.NDE\Desktop\Standards\ComputerScienceConnection.png** | C:\Users\sara.cooper.NDE\Desktop\Standards\EngineeringConnection'.png | C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.png | SC.HSP.7.2.E **Create or revise a simulation** to test 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.  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.png | 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.  |
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| The performance indicators above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*: |
| **Science and Engineering Practices****Using Mathematics and Computational Thinking**Mathematical and computational thinking in grade 12 builds on K–11 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.* Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (HSP.7.2.A)
* Use mathematical representations of phenomena or design solutions to support and revise explanations. (HSP.7.2.B)
* Create or revise a simulation of a phenomenon, designed device, process, or system. (HSP.7.2.F)

**Constructing Explanations and Designing Solutions**Constructing explanations and designing solutions in grade 12 builds on K–11 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.* Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HSP.7.2.D)

**Engaging in Argument from Evidence**Engaging in argument from evidence in grade 12 builds on K–11 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.* Evaluate the claims, evidence, and reasoningbehind currently accepted explanations or solutions to determine the merits of arguments. (HSP.7.2.C)
* Evaluate the evidencebehind currently accepted explanations or solutions to determine the merits of arguments. (HSP.7.2.E)

**-------------------------------------------------------------------*****Connections to Nature of Science*** **Scientific Knowledge is Open to Revision in Light of New Evidence*** Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HSP.7.2.B)
* Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation. (HSP.7.2.C),(HSP.7.2.E)
 | **Disciplinary Core Ideas****LS2.A:  Interdependent Relationships in Ecosystems*** Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (HSP.7.2.A),(HSP.7.2.B)

**LS2.C:  Ecosystem Dynamics, Functioning, and Resilience*** A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.  (HSP.7.2.B),(HSP.7.2.C)
* Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HSP.7.2.D)

**LS2.D:  Social Interactions and Group Behavior*** Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HSP.7.2.E)

**LS4.C:  Adaptation*** Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometimes the extinction–of some species. (HSP.7.2.F)

**LS4.D: Biodiversity and Humans** * Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). *(secondary to HSP.7.2.D)*
* Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. *(secondary to HSP.7.2.D),* (HSP.7.2.F)

**ETS1.B: Developing Possible Solutions*** When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. *(secondary to HSP.7.2.D),(secondary to HSP.7.2.F)*
* Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. *(secondary to HSP.7.2.F)*
 |  **Crosscutting Concepts**C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.png**Cause and Effect**Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HSP.7.2.E),(HSP.7.2.F)C:\Users\sara.cooper.NDE\Desktop\Standards\ScaleProportionQuantity.png**Scale, Proportion, and Quantity**The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HSP.7.2.A)* Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (HSP.7.2.B)

C:\Users\sara.cooper.NDE\Desktop\Standards\StabilityChange.png**Stability and Change**Much of science deals with constructing explanations of how things change and how they remain stable. (HSP.7.2.C),(HSP.7.2.D) |

**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.

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|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\EnergyMatter.png | 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  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\EnergyMatter.png | 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.  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\EnergyMatter.png | 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.  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\EnergyMatter.png | 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.  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\EnergyMatter.png | 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.**   |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\Systems.png | 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.  |
|  |  | **C:\Users\sara.cooper.NDE\Desktop\Standards\StructureFunction.png** | 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.  |
|  |  | **C:\Users\sara.cooper.NDE\Desktop\Standards\StructureFunction.png** | 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.  |

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| The performance indicators above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*: |
| **Science and Engineering Practices****Developing and Using Models**Modeling in  grade 12 builds on K–11  experiences and progresses to using, synthesizing, and developing models to predict, show, and reflect upon relationships among variables between systems and their components in the natural and designed worlds.  * Use a model based on evidence to illustratethe relationships between systems or between components of a system. (HSP.8.3.A),(HSP.8.3.C)
* Develop a model based on evidence to illustrate the relationships between systems or components of a system. (HSP.8.3.F)
* Develop a model to reflect on science concepts. (HSP.8.3.G)

**Using Mathematics and Computational Thinking**Mathematical and computational thinking in grade 12 builds on K–11 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.* Use mathematical representations of phenomena or design solutions to support claims. (HSP.8.3.E)

**Constructing Explanations and Designing Solutions**Constructing explanations and designing solutions in  grade 12 builds on K–11 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.* Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HSP.8.3.B),(HSP.8.3.D)
* Construct an explanation by applying scientific reasoning to link observed evidence to the explanation. (HSP.8.3.H)

**--------------------------------------------------------*****Connections to Nature of Science*** **Scientific Knowledge is Open to Revision in Light of New Evidence*** Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HSP.8.3.D)
 | **Disciplinary Core Ideas****LS1.C:  Organization for Matter and Energy Flow in Organisms** * The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HSP.8.3.A)
* The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. (HSP.8.3.B)
* As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HSP.8.3.B),(HSP.8.3.C)
* As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment.(HSP.8.3.C)
* ATP is the “rechargeable battery” of the cell and consist of three molecules: ribose sugar, adenine nitrogen base, and phosphate.  ATP stores energy in the triphosphate group attached to the ribose sugar.
* Chemical reactions within living organisms are regulated by protein catalysis called enzymes. The enzymes unique three-dimensional shape allows it to bind to their specific substrate and catalyze the reaction with lower activation energy and without being consumed during the reaction. Enzyme activity can be affected by conditions such as temperature, pH, concentration, and the presence of inhibitors and activators.

**LS2.B:  Cycles of Matter and Energy Transfer in Ecosystems** * Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (HSP.8.3.D)
* Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (HSP.8.3.E)
* Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. (HSP.8.3.F)

**Chemical Bonding*** There are four types of chemical bonding seen in the compounds found in living organisms, ionic bonding, nonpolar covalent bonding, polar covalent bonding, and hydrogen bonding. (HSP.8.3.G)
* Water molecules contain polar covalent bonds, which allow water to form hydrogen bonds with itself and other polar molecules producing water’s cohesive, adhesive, and other properties important to living systems. (HSP.8.3.H)

**PS3.D:   Energy in Chemical Processes*** The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. *(secondary to HSP.8.3.F)*
 |  **Crosscutting Concepts**C:\Users\sara.cooper.NDE\Desktop\Standards\Systems.png**Systems and System Models**Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HSP.8.3.F), C:\Users\sara.cooper.NDE\Desktop\Standards\EnergyMatter.png**Energy and Matter** Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HSP.8.3.A), (HSP.8.3.B)* Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.(HSP.8.3.C),(HSP.8.3.E)
* Energy drives the cycling of matter within and between systems. (HSP.8.3.D)

**C:\Users\sara.cooper.NDE\Desktop\Standards\StructureFunction.pngStructure and Function** The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. (HSP.8.3.G), (HSP.8.3.H) |

**SC.HSP.9 Inheritance and Variation of Traits**

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

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|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\Systems.png | SC.HSP.9.4.A **Use a model** to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.png | SC.HSP.9.4.B **Ask questions** to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.png | SC.HSP.9.4.C **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.  |
|  | **C:\Users\sara.cooper.NDE\Desktop\Standards\ComputerScienceConnection.png** | C:\Users\sara.cooper.NDE\Desktop\Standards\ScaleProportionQuantity.png | SC.HSP.9.4.D **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  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\Patterns.png | SC.HSP.9.4.E **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.  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\Systems.png | SC.HSP.9.4.F **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  |

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| The performance indicators above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*: |
| **Science and Engineering Practices****Asking Questions and Defining Problems**Asking questions and defining problems in grade 12 builds on K–11 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.* Ask questions that arise from examining models or a theory to clarify relationships. (SC.HSP.9.4.B)

**Developing and Using Models**Modeling in grade 12 builds on K–11 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.  * Use a model based on evidence to illustratethe relationships between systems or between components of a system. (SC.HSP.9.4.A)

**Analyzing and Interpreting Data**Analyzing data in grade 12 builds on K–11 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.* Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.  (SC.HSP.9.4.D)

**Constructing Explanations and Designing Solutions**Constructing explanations and designing solutions in grade 12 builds on K–11 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.* Construct an explanation by applying scientific reasoning to link observed evidence to the explanation. (SC.HSP.9.4.F)

**Engaging in Argument from Evidence**Engaging in argument from evidence in grade 12 builds on K–11 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s).  Arguments may also come from current scientific or historical episodes in science.* Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence. (SC.HSP.9.4.C)
* Evaluate the claims, evidence, and reasoningbehind currently accepted explanations or solutions to determine the merits of arguments. (SC.HSP.9.4.D)
 | **Disciplinary Core Ideas****LS1.A:  Structure and Function*** All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins. *(secondary to SC.HSP.9.4.B) (Note: This Disciplinary Core Idea is also addressed by SC.HSP.9.4.A.)*

**LS1.B:  Growth and Development of Organisms*** In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow.  The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. (SC.HSP.9.4.A)

**LS3.A:  Inheritance of Traits*** Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species’ characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways.  Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function. (SC.HSP.9.4.B)
* For a cell to function properly, proteins must be synthesized at the proper time. All cells control or regulate the synthesis of proteins from information encoded in their DNA. Gene expression is the process of turning on a gene to produce a specific protein. Contrast gene expression in prokaryotes and eukaryotes. Explain the operon model for gene expression and the three methods of operon regulation: repressors, activators, and inducers. (SC.HSP.9.4.E)

**LS3.B:  Variation of Traits*** In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. (SC.HSP.9.4.C)
* Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. (SC.HSP.9.4.C),(SC.HSP.9.4.D)

**Biotechnology*** Understand the goal of biotechnology, the history of biotechnology, the role that molecular biology has played, the basic techniques used in biotechnology, and the primary application of biotechnology in medicine, agriculture, and bioremediation. (SC.HSP.9.4.F)
 |  **Crosscutting Concepts**C:\Users\sara.cooper.NDE\Desktop\Standards\Patterns.png**Patterns** Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (SC.HSP.9.4.E)C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.png**Cause and Effect**Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (SC.HSP.9.4.B),(SC.HSP.9.4.C)C:\Users\sara.cooper.NDE\Desktop\Standards\ScaleProportionQuantity.png**Scale, Proportion, and Quantity** Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). (SC.HSP.9.4.D)C:\Users\sara.cooper.NDE\Desktop\Standards\Systems.png**Systems and System Models**Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (SC.HSP.9.4.A),(SC.HSP.9.4.F)**---------------------------------------------*****Connections to Nature of Science*** **Science is a Human Endeavor** * Technological advances have influenced the progress of science and science has influenced advances in technology. (SC.HSP.9.4.D)
* Science and engineering are influenced by society and society is influenced by science and engineering. (SC.HSP.9.4.D)
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**SC.HSP.10 Biological Evolution**
SC.HSP.10.5 Gather, analyze, and communicate evidence of biological evolution.

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|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\Patterns.png | 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.  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.png | 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.  |
|  | **C:\Users\sara.cooper.NDE\Desktop\Standards\ComputerScienceConnection.png** | C:\Users\sara.cooper.NDE\Desktop\Standards\Patterns.png | 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  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.png | 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.  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.png | 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.  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\Patterns.png | 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.  |

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| The performance indicators above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*: |
| **Science and Engineering Practices****Developing and Using Models**Modeling in grade 12 builds on K–11 experiences and progresses to using, synthesizing, and developing models to predict, show, and reflect upon relationships among variables between systems and their components in the natural and designed world. * Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations. (SC.HSP.10.5.F)

**Analyzing and Interpreting Data** Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. * Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (SC.HSP.10.5.C)

**Constructing Explanations and Designing Solutions**Constructing explanations and designing solutions in 9–12 builds on K–8  experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.* Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (SC.HSP.10.5.B),(SC.HSP.10.5.D)

**Engaging in Argument from Evidence**Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s).  Arguments may also come from current or historical episodes in science.* Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (SC.HSP.10.5.E)
 | **Disciplinary Core Ideas****LS4.A:  Evidence of Common Ancestry and Diversity*** Genetic information provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence. (SC.HSP.10.5.A), (SC.HSP.10.5.F)

**LS4.B:  Natural Selection*** Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. (SC.HSP.10.5.B), (SC.HSP.10.5.C)
* The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (SC.HSP.10.5.C)

**LS4.C:  Adaptation*** Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment’s limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. (SC.HSP.10.5.B)
* Natural selection leads to adaptation that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. (SC.HSP.10.5.C),(SC.HSP.10.5.D)
* Adaptation also means that the distribution of traits in a population can change when conditions change. (SC.HSP.10.5.C)
* Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometimes the extinction–of some species. (SC.HSP.10.5.E)
* Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species’ evolution is lost. (SC.HSP.10.5.E)
 |  **Crosscutting Concepts**C:\Users\sara.cooper.NDE\Desktop\Standards\Patterns.png**Patterns**Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (SC.HSP.10.5.A),(SC.HSP.10.5.C),(SC.HSP.10.5.F)**Cause and Effect**C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.pngEmpirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (SC.HSP.10.5.B),(SC.HSP.10.5.D),(SC.HSP.10.5.E)**---------------------------------------*****Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems*** Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. (SC.HSP.10.5.A),(SC.HSP.10.5.D)
 |

**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.*

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|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\Patterns.png | SC.HSP.6.2.A **Communicate scientific information** that explains the patterns of organization in the integumentary system. Information could be gathered from dissections, models, simulations, and scientific texts.  |
|  |  | **C:\Users\sara.cooper.NDE\Desktop\Standards\StructureFunction.png** | SC.HSP.6.2.B **Ask questions** to clarify the role of various proteins and integumentary system function.  |
|  |  | **C:\Users\sara.cooper.NDE\Desktop\Standards\StructureFunction.png** | 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. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\StabilityChange.png | SC.HSP.6.2.D **Plan and conduct an investigation** to gather evidence that feedback mechanisms in the integumentary system help maintain homeostasis. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.png | SC.HSP.6.2.E **Construct a scientific explanation** based on evidence for the role ofcell division in integumentary system dysfunction. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\Systems.png | SC.HSP.6.2.F **Develop and use a model** to explain the relationship between the integumentary system and other body systems. Emphasis is on the endocrine system.  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\EnergyMatter.png | SC.HSP.6.2.G **Construct and revise an explanation** based on evidence for the role of the integumentary system in the cycling of matter and flow of energy among body systems.  |

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

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|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\Patterns.png | SC.HSP.6.3.A **Communicate scientific information** that explains the patterns of organization in the skeletal system. Information could be gathered from dissections, models, simulations, and scientific texts.  |
|  |  | **C:\Users\sara.cooper.NDE\Desktop\Standards\StructureFunction.png** | 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. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\StabilityChange.png | SC.HSP.6.3.C **Plan and conduct an investigation** to gather evidence that feedback mechanisms in the skeletal system help maintain homeostasis. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.png | SC.HSP.6.3.D **Develop and use a model** to explain the order of events necessary for bone formation. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.png | SC.HSP.6.3.E **Construct and present arguments** using evidence to support claims about the causes of dysfunction in the skeletal system. Evidence could include data obtained from case studies.  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\Systems.png | SC.HSP.6.3.F **Develop and use a model** to explain the relationship between the skeletal system and other body systems. Include the endocrine system.  |

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

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|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\Patterns.png | SC.HSP.6.4.A **Communicate scientific information** that explains the patterns of organization in the muscular system. Information could be gathered from dissections, models, simulations, and scientific texts.  |
|  |  | **C:\Users\sara.cooper.NDE\Desktop\Standards\StructureFunction.png** | 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. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\StabilityChange.png | SC.HSP.6.4.C **Construct an argument** based on evidence that muscle contraction is the result of biochemical reactions. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\StabilityChange.png | SC.HSP.6.4.D **Plan and conduct an investigation** to gather evidence that feedback mechanisms in the muscular system help maintain homeostasis. Investigations could include micro stimulation of muscle tissues. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.png | SC.HSP.6.4.E **Construct and present arguments** using evidence to support claims about the causes of dysfunction in the muscular system. Evidence could include data obtained from case studies.  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\Systems.png | SC.HSP.6.4.F **Develop and use a model** to explain the relationship between the muscular system and other body systems. Include the endocrine system.  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\EnergyMatter.png | SC.HSP.6.4.G **Construct and revise an explanation** based on evidence for the role of the muscular system in the cycling of matter and flow of energy among body systems.  |

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

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|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\Patterns.png | SC.HSP.6.5.A **Communicate scientific information** that explains the patterns of organization in the nervous system. Information could be gathered from dissections, models, simulations, and scientific texts.  |
|  |  | **C:\Users\sara.cooper.NDE\Desktop\Standards\StructureFunction.png** | 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. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\StabilityChange.png | SC.HSP.6.5.C **Construct an argument** based on evidence that production of a nerve impulse is the result of biochemical reactions. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\StabilityChange.png | SC.HSP.6.5.D **Plan and conduct an investigation** to gather evidence that feedback mechanisms in the nervous system help maintain homeostasis.  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.png | SC.HSP.6.5.E **Construct and present arguments** using evidence to support claims about the causes of dysfunction in the nervous system. Evidence could include data obtained from case studies. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\Systems.png | SC.HSP.6.5.F **Develop and use a model** to explain the relationship between the nervous system and other body systems. Include the endocrine system.  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\EnergyMatter.png | SC.HSP.6.5.G **Construct and revise an explanation** based on evidence for the role of the nervous system in the cycling of matter and flow of energy among body systems.  |

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

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|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\Patterns.png | SC.HSP.6.6.A **Communicate scientific information** that explains the patterns of organization in the cardiovascular/respiratory systems. Information could be gathered from dissections, models, simulations, and scientific texts.  |
|  |  | **C:\Users\sara.cooper.NDE\Desktop\Standards\StructureFunction.png** | 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. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\StabilityChange.png | SC.HSP.6.6.C **Plan and conduct an investigation** to gather evidence that feedback mechanisms in the cardiovascular/respiratory systems help maintain homeostasis.  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.png | SC.HSP.6.6.D **Construct and present arguments** using evidence to support claims about the causes of dysfunction in the cardiovascular/respiratory systems. Evidence could include data obtained from case studies. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\Systems.png | SC.HSP.6.6.E **Develop and use a model** to explain the relationship between the cardiovascular/respiratory systems and other body systems. Include the endocrine and lymphatic systems.  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\EnergyMatter.png | SC.HSP.6.6.F **Construct and revise an explanation** based on evidence for the role of the cardiovascular/respiratory systems in the cycling of matter and flow of energy among body systems.  |

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

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|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\Patterns.png | SC.HSP.6.7.A **Communicate scientific information** that explains the patterns of organization in the digestive system. Information could be gathered from dissections, models, simulations, and scientific texts.  |
|  |  | **C:\Users\sara.cooper.NDE\Desktop\Standards\StructureFunction.png** | 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. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\StabilityChange.png | SC.HSP.6.7.C **Plan and conduct an investigation** to gather evidence that feedback mechanisms in the digestive system help maintain homeostasis.  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.png | SC.HSP.6.7.D **Construct and present arguments** using evidence to support claims about the causes of dysfunction in the digestive system. Evidence could include data obtained from case studies. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\Systems.png | SC.HSP.6.7.E **Develop and use a model** to explain the relationship between the digestive system and other body systems. Include the endocrine and lymphatic systems.  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\EnergyMatter.png | SC.HSP.6.7.F **Construct and revise an explanation** based on evidence for the role of the digestive system in the cycling of matter and flow of energy among body systems.  |

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

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|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\Patterns.png | SC.HSP.6.8.A **Communicate scientific information** that explains the patterns of organization in the urinary system. Information could be gathered from dissections, models, simulations, and scientific texts.  |
|  |  | **C:\Users\sara.cooper.NDE\Desktop\Standards\StructureFunction.png** | 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. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\StabilityChange.png | SC.HSP.6.8.C **Plan and conduct an investigation** to gather evidence that feedback mechanisms in the urinary system help maintain homeostasis.  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.png | SC.HSP.6.8.D **Construct and present arguments** using evidence to support claims about the causes of dysfunction in the urinary system. Evidence could include data obtained from case studies. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\Systems.png | SC.HSP.6.8.E **Develop and use a model** to explain the relationship between the urinary system and other body systems. Include the endocrine and reproductive systems.  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\EnergyMatter.png | SC.HSP.6.8.F **Construct and revise an explanation** based on evidence for the role of the urinary system in the cycling of matter and flow of energy among body systems.  |

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

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|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\Patterns.png | SC.HSP.6.9.A **Communicate scientific information** that explains the patterns of organization in the reproductive system. Information could be gathered from dissections, models, simulations, and scientific texts.  |
|  |  | **C:\Users\sara.cooper.NDE\Desktop\Standards\StructureFunction.png** | 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. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\StabilityChange.png | SC.HSP.6.9.C **Plan and conduct an investigation** to gather evidence that feedback mechanisms in the reproductive system help maintain homeostasis.  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.png | SC.HSP.6.9.D **Construct and present arguments** using evidence to support claims about the causes of dysfunction in the reproductive system. Evidence could include data obtained from case studies. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\Systems.png | SC.HSP.6.9.E **Develop and use a model** to explain the relationship between the reproductive system and other body systems. Include the endocrine and nervous systems.  |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\EnergyMatter.png | SC.HSP.6.9.F **Construct and revise an explanation** based on evidence for the role of the reproductive system in the cycling of matter and flow of energy among body systems.  |

**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*.*

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|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\EngineeringConnection'.png | SC.HSP.17.1.A **Obtain, evaluate, and communicate information** related to health science careers. Examples include researcher, bio-medical engineer, medical professional, technician, manufacturer and distributor, administrator, and data storage and security professional. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\EngineeringConnection'.png | 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. |
|  |  | C:\Users\sara.cooper.NDE\Desktop\Standards\EngineeringConnection'.png | SC.HSP.17.1.C **Evaluate a solution** to a complex real-world human health problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts**.** Solutions could include the effects on the human body or solutions for environmental public health issues. |

**HS Crosscutting Concept Elements**

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| **C:\Users\sara.cooper.NDE\Desktop\Standards\Patterns.pngPatterns – Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.**  |
| **9-12 Crosscutting Statements** * Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
* Classifications or explanations used at one scale may fail or need revision when information from smaller or larger scales is introduced; thus requiring improved investigations and experiments.
 | * Patterns of performance of designed systems can be analyzed and interpreted to reengineer and improve the system.
* Mathematical representations are needed to identify some patterns.
* Empirical evidence is needed to identify patterns.
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| C:\Users\sara.cooper.NDE\Desktop\Standards\CauseEffect.png**Cause and Effect: Mechanism and Prediction** – Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.  |
| **9-12 Crosscutting Statements** * Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
* Systems can be designed to cause a desired effect.
 | * Changes in systems may have various causes that may not have equal effects.
* Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.
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| C:\Users\sara.cooper.NDE\Desktop\Standards\ScaleProportionQuantity.png**Scale, Proportion, and Quantity** – In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.  |
| **9-12 Crosscutting Statements** * The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.
* Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly.
* Patterns observable at one scale may not be observable or exist at other scales.
 | * Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale.
* Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).
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| C:\Users\sara.cooper.NDE\Desktop\Standards\Systems.png**Systems and System Models –** A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.  |
| **9-12 Crosscutting Statements** * When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.
* Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.
 | * Systems can be designed to do specific tasks.
* Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.
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| C:\Users\sara.cooper.NDE\Desktop\Standards\EnergyMatter.png**Energy and Matter: Flows, Cycles, and Conservation** – Tracking energy and matter flows, into, out of, and within systems helps one understand their system’s behavior.  |
| **9-12 Crosscutting Statements** * The total amount of energy and matter in closed systems is conserved.
* Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.
 | * Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.
* Energy drives the cycling of matter within and between systems.
* In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.
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| C:\Users\sara.cooper.NDE\Desktop\Standards\StructureFunction.png**Structure and Function** – The way an object is shaped or structured determines many of its properties and functions.  |
| **9-12 Crosscutting Statements** * Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.
 | * The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.
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| C:\Users\sara.cooper.NDE\Desktop\Standards\StabilityChange.png**Stability and Change** – For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.  |
| **9-12 Crosscutting Statements** * Much of science deals with constructing explanations of how things change and how they remain stable.
* Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.
 | * Feedback (negative or positive) can stabilize or destabilize a system.
* Systems can be designed for greater or lesser stability.
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\* Adapted from: National Research Council (2011). A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. Committee on a Conceptual Framework for New K-12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academy Press. Chapter 4: Crosscutting Concepts.

**HS Science and Engineering Practice Elements**

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| **Asking questions and defining problems** in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.* Ask questions
	+ that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.
	+ that arise from examining models or a theory, to clarify and/or seek additional information and relationships.
	+ to determine relationships, including quantitative relationships, between independent and dependent variables.
	+ to clarify and refine a model, an explanation, or an engineering problem.
* Evaluate a question to determine if it is testable and relevant.
* Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.
* Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.
* Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical, and/or environmental considerations.
 |

 | **Constructing explanations and designing solutions** in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.* Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.
* Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.
* Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.
* Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.
* Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
 |
| **Modeling** in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.* Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism or system in order to select or revise a model that best fits the evidence or design criteria.
* Design a test of a model to ascertain its reliability.
* Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.
* Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.
* Develop a complex model that allows for manipulation and testing of a proposed process or system.
* Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
 | **Mathematical and computational thinking** in 9- 12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.* Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system.
* Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.
* Apply techniques of algebra and functions to represent and solve scientific and engineering problems.
* Use simple limit cases to test mathematical expressions, computer programs, algorithms, or simulations of a process or system to see if a model “makes sense” by comparing the outcomes with what is known about the real world.
* Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3, acre-feet, etc.).
 |
| **Planning and carrying out investigations** to answer questions or test solutions to problems in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.* Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigation’s design to ensure variables are controlled.
* Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.
* Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts.
* Select appropriate tools to collect, record, analyze, and evaluate data.
* Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated.
* Manipulate variables and collect data about a complex model of a proposed process or system to identify failure points or improve performance relative to criteria for success or other variables.
 | **Engaging in argument from evidence** in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.* Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues.
* Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.
* Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence, challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining additional information required to resolve contradictions.
* Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.
* Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.
* Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations).
 |
| **Analyzing data** in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.* Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.
* Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.
* Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.
* Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.
* Evaluate the impact of new data on a working explanation and/or model of a proposed process or system.
* Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success.
 | **Obtaining, evaluating, and communicating information** in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.* Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
* Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.
* Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.
* Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible.
* Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).
 |

\* Adapted from: National Research Council (2011). A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. Committee on a Conceptual Framework for New K-12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academy Press. Chapter 3: Science and Engineering Practices.

**Topic Progression Chart**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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.6.6**  |  |  | **SC.HS.6** |
| **7** Inter-dependent Relationships in Ecosystems  | **SC.K.7**  |  | **SC.2.7**  | **SC.3.7**  |  |  |  | **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** |