Core Content Connectors (CCCs) linked to the
2015 South Dakota Science Standards – High School (Grades 9-12)

How to Read the Grade Level Core Content Connectors

The South Dakota Science Core Content Connectors (CCCs) are intended to promote access to grade-level content standards by pinpointing the big ideas and concepts of the *2015 South Dakota Science Standards*. The CCCs reflect rigorous science expectations and opportunities for students to learn essential science concepts and procedures with deep understanding given guidance from peers and adults, so that all students can engage in sophisticated science and engineering practices.

As shown in the illustration below, each set of CCCs has a title. The title reveals the organization of the CCCs, which is based on the disciplinary core ideas (DCIs) from the *Framework for K-12 Science Education*. Below the title is the corresponding South Dakota Science Standard. Below the standard are the specific CCCs (listed left to right) to address the science and engineering practices (SEPs), disciplinary core ideas, and crosscutting concepts that, when combined, address the "big idea" of the South Dakota science standard above.

Science and Engineering Practices . The blue shaded text on the left includes the CCC for the science and engineering practices used to address the South Dakota science standard listed above. The bold headings are derived from the eight categories detailed in the *Framework for K-12 Science Education*.

Disciplinary Core Ideas. The orange shaded text in the middle includes the CCCs to address the South Dakota science standard listed above. The CCCs are arranged by bold headings representing how the core ideas in the *Framework for K-12 Science Education* are divided into a total of 39 sub-ideas representing the 11 core ideas: four in Life Science, four in Physical Science, and three in Earth and Space Science. The CCCs represent what students should understand about that sub-idea at the end of the grade. The CCCs are bulleted to be certain that each statement is distinct.

Crosscutting Concepts. The green shaded text on the right includes the CCCs to address the South Dakota science standard listed above. The CCCs are arranged by bold headings which are derived from the seven categories detailed in the *Framework for K-12 Science Education*.

<table>
<tr><th colspan="3">Grade. Title</th></tr>
<tr><td colspan="3">South Dakota Science Standard Code. South Dakota science standard descriptor.</td></tr>
<tr><th>Science and Engineering Practices
Core Content Connectors</th><th>Disciplinary Core Ideas
Core Content Connectors</th><th>Crosscutting Concepts
Core Content Connectors</th></tr>
<tr><td>Planning and Carrying Out Investigations
With guidance and support from peers and adults, investigate …</td><td>PS2.A: Forces and Motion
• Recognize that …</td><td>Cause and Effect
With guidance and support from peers and adults, compare the effect …</td></tr>
</table>

Core Content Connectors (CCCs) linked to the *2015 South Dakota Science Standards* – Physical Science (Grades 9-12)

High School Physical Science Conceptual Understanding*:

Matter and Its Interactions is broken down into three sub-ideas: Structure and Properties of Matter, Chemical Reactions, and Nuclear Processes. This includes substructure of atoms, interactions between electric charges, interactions of matter, chemical reactions, nuclear processes, and properties of substances. Chemical reactions, including rates of reactions and energy changes, involve the collisions of molecules and the rearrangements of atoms. Repeating patterns of the periodic table can be used as a tool to explain and predict the properties of elements. A stable molecule has less energy than the same set of atoms separated: one must provide at least this energy to take apart a molecule. Motion and stability focuses on building understanding of forces and interactions and Newton's Second Law. The total momentum of a system of objects is conserved when there is no net force on the system. Newton's Law of Gravitation and Coulomb's Law describe and predict the gravitational and electrostatic forces between objects. Forces at a distance are explained by fields that can transfer energy and can be described in terms of the arrangement and properties of the interacting objects and the distance between them. The forces can be used to describe the relationship between electrical and magnetic fields.

Energy is broken down into four sub-core ideas: Definitions of Energy, Conservation of Energy and Energy Transfer, the Relationship between Energy and Forces, and Energy in Chemical Process and Everyday Life. Energy is understood as a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system, and the total change of energy in any system is always equal to the total energy transferred into or out of the system. Energy at both the macroscopic and the atomic scale can be accounted for as either motions of particles or energy associated with relative position for configuration of particles. Photosynthesis is the primary biological means of capturing radiation from the sun. Fields contain energy that depend on the arrangement of objects in the field.

Waves are broken down into Wave Properties, Electromagnetic Radiation, and Information Technologies and Instrumentation. Wave properties and the interactions of electromagnetic radiation with matter can transfer information across long distances, store information, and investigate nature on many scales. The wavelength and frequency of a wave are related to one another by the speed of the wave, which depends on the type of wave and the medium through which it is passing. Combining waves of different frequencies can make a wide variety of patterns and thereby encode and transmit information. Technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

* As stated in the *2015 South Dakota Science Standards.*

Core Content Connectors (CCCs) linked to the
2015 South Dakota Science Standards – Physical Science (Grades 9-12)

HS-PS1 Matter and Its Interactions		
HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Developing and Using Models Work with peers to construct a model (e.g., a model that shows an atom's nucleus as made of protons and neutrons, and is surrounded by electrons) to describe the relationships between elements in the periodic table and the structure of atoms (e.g., arrangement of the main groups of the periodic table reflects the patterns of outermost electrons).	**PS1.A: Structure and Properties of Matter** • Recognize that that elements are organized in the periodic table horizontally by the number of protons equal to the number of electrons (in a neutral atom) in the atom's nucleus. • Recognize that properties vary in a regular pattern across the rows (periods) and down the columns (families or groups) in the periodic table. • Recognize the importance of the atom's outermost electrons in determining the chemical and physical properties of an element. • Predict the properties of elements using the periodic table.	**Patterns** Work with peers to show how patterns may be observed and can provide evidence for causality in explanations of phenomena (i.e., repeating patterns of the periodic table reflect patterns of outer electron states).

Core Content Connectors (CCCs) linked to the
2015 South Dakota Science Standards – Physical Science (Grades 9-12)

HS-PS1 Matter and Its Interactions		
HS-PS1-2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Constructing Explanations and Designing Solutions Work with peers to construct an explanation for how the patterns of outermost electrons or the electronegativity of elements can be used to predict the number or types of bonds each element forms.	**PS1.A: Structure and Properties of Matter** • Identify an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms. • Identify an explanation for the outcome of a simple chemical reaction based on trends in the periodic table.	**Patterns** Work with peers to construct an explanation for a prediction based on evidence (e.g., knowledge of the chemical properties of the elements involved in a simple chemical reaction can be used to describe and predict chemical reactions).

HS-PS1 Matter and Its Interactions		
HS-PS1-3. Plan and carry out an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Planning and Carrying Out Investigations Work with peers to develop an investigation plan and describe the data to be collected (e.g., melting point and boiling point, volatility, surface tension) that would support inferences about the strength of electrical forces between particles.	**PS1.A: Structure and Properties of Matter** • Identify bulk properties of substances (i.e., melting point, boiling point, and surface tension). • Identify that electrical forces within and between atoms can keep particles close together.	**Patterns** Work with peers to show how patterns can provide evidence of the causal relationships between the strength of the electrical forces between particles and the structure of substances at the bulk scale (e.g., when water is boiled, the molecules are still present but further apart).

HS-PS1 Matter and Its Interactions		
HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Developing and Using Models Work with peers to develop or use models to show the idea that a chemical reaction is a system that affects the energy change (e.g., graphs showing the relative energies of reactants and products, and representations showing energy is conserved).	**PS1.A: Structure and Properties of Matter** • Determine whether energy is released or absorbed in a chemical reaction system using data presented in a table or graph.	**Energy and Matter** Work with peers to illustrate how changes of energy and matter in a system can be described in terms of energy and matter flowing into, out of, and within that system (e.g., breaking bonds requires an input of energy from the system or surroundings, and forming bonds releases energy to the system and the surroundings).

HS-PS1 Matter and Its Interactions		
HS-PS1-5. Construct an explanation based on evidence about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Constructing Explanations and Designing Solutions Work with peers to construct an explanation relating the idea of the kinetic of colliding particles to reaction rate (e.g., evidence of a pattern that increases in temperature usually increase the reaction rate, and vice versa).	**PS1.B: Chemical Reactions** • Identify the effects of changing the temperature of the reacting particles at the rate at which a simple reaction (i.e., two reactants) occurs using a model (e.g., a table of data) of the number and energy of collisions between particles. • Identify the effects of changing the concentration of the reacting particles at the rate at which a simple reaction (i.e., two reactants) occurs using a model (e.g., a table of data) of the number and energy of collisions between particles.	**Patterns** Work with peers to describe evidence (e.g., a table of data) of a pattern that increases in concentration (e.g., a change in one concentration while the other concentration is held constant) increase the reaction rate, and vice versa.

HS-PS1 Matter and Its Interactions		
HS-PS1-6. Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Constructing Explanations and Designing Solutions Work with peers to use Le Chatelier's Principle to describe the relative quantities of a product before and after changes to a given chemical reaction system (e.g., concentration increases, decreases, or stays the same).	**PS1.B: Chemical Reactions** • Identify a change in one variable (i.e., temperature, concentration, pressure) of a chemical equation that would produce increased amounts of products at equilibrium.	**Stability and Change** Work with peers to identify explanations of how things change and how they remain stable (e.g., how, at a molecular level, a stress involving a change to one component of an equilibrium system affects other components).

HS-PS1 Matter and Its Interactions		
HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Using Mathematics and Computational Thinking Work with peers to use a mathematical representation to calculate the mass of any component of a reaction, given any other component.	**PS1.B: Chemical Reactions** • Identify a chemical equation, showing reactants and products of a chemical reaction, which illustrates the claim that matter (i.e., atoms) is neither created nor destroyed during a chemical reaction. • Identify a mathematical representation (e.g., table, graph) or pictorial depictions that illustrates the claim that mass is conserved during a chemical reaction.	**Energy and Matter** Work with peers to develop a model to support the claim that atoms, and therefore mass, are conserved during a chemical reaction in closed systems.

HS-PS1 Matter and Its Interactions		
HS-PS1-8. Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Developing and Using Models Work with peers to develop models to illustrate the relationships between components underlying the nuclear processes of 1) fission, 2) fusion and 3) alpha, beta, or gamma radioactive decays.	**PS1.C: Nuclear Processes** • Recognize that nuclear processes (i.e., fusion, fission, and radioactive decays), involve the release or absorption of energy. • Contrast changes during the processes of alpha, beta, or gamma radioactive decay using graphs or pictorial depictions of the composition of the nucleus of the atom and the energy released.	**Energy and Matter** Work with peers to illustrate that in nuclear processes, the total number of neutrons plus protons is the same both before and after the nuclear process, although the total number of protons and the total number of neutrons may be different before and after.

HS-PS2 Motion and Stability: Forces and Interactions		
HS-PS2-1. Analyze data to support the claim that Newton's Second Law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Analyzing and Interpreting Data Work with peers to determine the relationship between an object's acceleration and the force applied across a range of data, by the formula a = F/m (e.g., double force yields double acceleration, etc.).	**PS2.A: Forces and Motion** • Predict changes in the motion of a macroscopic object, such as a falling object, an object rolling down a ramp, or a moving object being pulled by a constant force using data (e.g., tables or graphs of position or velocity as a function of time for an object subject to a net unbalanced force).	**Cause and Effect** Work with peers to identify and describe cause and effect relationships among the net force on a macroscopic object, its mass, and its acceleration (e.g., a more massive object experiencing the same net force as a less massive object has a smaller acceleration, and a larger net force on a given object produces a correspondingly larger acceleration).

HS-PS2 Motion and Stability: Forces and Interactions		
HS-PS2-2. Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Using Mathematics and Computational Thinking Work with peers to use mathematical representations to model and describe momentum (as defined for a frame of reference) as the mass times the velocity of the object (P = mv).	**PS2.A: Forces and Motion** • Identify an example of the law of momentum conservation (e.g., in a collision, the momentum change of an object is equal to and opposite of the momentum change of the other object) represented using graphical or visual displays (e.g., pictures, pictographs, drawings, written observations, tables, charts).	**Systems and System Models** Work with peers to describe when a system interacts with objects outside itself, the total momentum of the system can change; analyze how that change is balanced by changes in the momentum of objects outside the system (i.e., conservation of momentum).

S-PS2 Motion and Stability: Forces and Interactions		
HS-PS2-3. Design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Constructing Explanations and Designing Solutions Work with peers to evaluate a device based on its ability to minimize the force on the test object during a collision.	**PS2.A: Forces and Motion** • Evaluate a device (e.g., football helmet or a parachute) designed to minimize force by comparing data (i.e., momentum, mass, velocity, force, or time).	**Cause and Effect** Work with peers to test a device that minimizes the force on a macroscopic object during a collision and use the test results to improve the device's performance (e.g., extending the impact time, reducing the device's mass, considering cost-benefit analysis).

HS-PS2 Motion and Stability: Forces and Interactions		
HS-PS2-4. Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Using Mathematics and Computational Thinking Work with peers to use given mathematical formulas to calculate the gravitational force between objects or predict the electrostatic force between charged objects.	**PS2.B: Types of Interactions** • Use Newton's law of universal gravitation as a mathematical model to qualitatively describe or predict the effects of gravitational forces in systems with two objects. • Use Coulomb's law to qualitatively describe or predict the electrostatic forces in systems with two objects.	**Patterns** Work with peers to describe and predict the effects of forces between distant objects that can be explained by fields using magnets or electric currents.

HS-PS2 Motion and Stability: Forces and Interactions		
HS-PS2-5. Plan and carry out an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Planning and Carrying Out Investigations Work with peers to conduct an investigation which includes the ideas that 1) an electric current produces a magnetic field and 2) a changing magnetic field produces an electric current.	**PS2.B: Types of Interactions** • Compare the relationship between changes in the magnetic field and the amount of electric current created using data.	**Cause and Effect** Work with peers to illustrate the relationship between electric currents and creation of magnetic fields, and changing magnetic fields and inducement of electric currents.

HS-PS2 Motion and Stability: Forces and Interactions		
HS-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Obtaining, Evaluating, and Communicating Information Work with peers to communicate the evidence about how a material's properties make it suitable for use in its designed function.	**PS2.B: Types of Interactions** • Recognize that different materials have different molecular structures and properties which determine different functioning of the material (e.g., flexible, but durable).	**Structure and Function** Work with peers to illustrate that for all materials at the molecular-level, electrostatic forces result in contact forces (e.g., friction, normal forces, stickiness) on the macroscopic scale.

HS-PS3 Energy		
HS-PS3-1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Using Mathematics and Computational Thinking Work with peers to use a computational model to calculate changes in the energy of one component of the system when changes in the energy of the other components and the energy flows are known.	**PS3.A: Definitions of Energy** • Identify a model showing the change in the energy of one component in a system compared to the change in energy of another component in the system.	**Systems and System Models** Work with peers to calculate changes in the energy of one component of the system when changes in the energy of the other components are known (e.g., calculate changes in energy in an energy versus height graph that demonstrates that as an object falls, the potential energy will linearly decrease as the kinetic energy linearly increases).

HS-PS3 Energy		
HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Developing and Using Models Work with peers to use models (e.g., diagrams, drawings, descriptions) to show that the energy at the macroscopic scale is either motions of particles or energy stored in fields using models.	**PS3.A: Definitions of Energy** • Identify that two factors, an object's mass and height above the ground, affect gravity (i.e., energy stored due to position of an object above Earth) at the macroscopic level.	**Energy and Matter** Work with peers to use models to demonstrate that in closed systems, the energy is conserved on both the macroscopic and particle (object) scales so that as one form of energy changes, the total system energy remains constant.

HS-PS3 Energy		
HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Constructing Explanations and Designing Solutions Work with peers to design a device that converts one form of energy into another form of energy and identify how its design can increase benefits for modern civilization while decreasing costs and risk.	**PS3.B: Conservation of Energy and Energy Transfer** • Identify the forms of energy that will be converted by a device that converts one form of energy into another form of energy. • Identify steps in a model of a device showing the transformations of energy that occur (e.g., solar cells, solar ovens, generators, turbines). • Describe constraints to the design of the device which converts one form of energy into another form of energy (e.g., cost or efficiency of energy conversion).	**Energy and Matter** Work with peers to identify losses of energy by the design system to the surrounding environment.

HS-PS3 Energy		
HS-PS3-4. Plan and carry out an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (Second Law of Thermodynamics).		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Planning and Carrying Out Investigations Work with peers to collect and record data that can be used to calculate the change in thermal energy of each of the two components of a system when two components of different temperature are combined within a closed system.	**PS3.B: Conservation of Energy and Energy Transfer** • Identify the temperatures of two liquids of different temperature before and after combining to show uniform energy distribution.	**Systems and System Models** Work with peers to describe uncontrolled systems which evolve toward more stable states (i.e., toward more uniform energy distribution) (e.g., water flows downhill, objects hotter than their surrounding environment cool down).

HS-PS3 Energy		
HS-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Developing and Using Models Work with peers to develop and describe models which illustrate the forces and changes in energy involved when two objects interact (e.g., nature of the interaction, relative magnitude and the direction of the net force on each of the objects) or describe the relationships among components (i.e., change in the energy of the objects).	**PS3.C: Relationship Between Energy and Forces** • Use a model to identify the cause and effect relationships between forces produced by electric or magnetic fields and the change of energy of the objects in the system	**Cause and Effect** Work with peers to use a model to describe the cause and effect relationships on a qualitative level between forces (e.g., what happens when two charges of opposite polarity are near each other).

HS-PS4 Waves and Their Applications in Technologies for Information Transfer		
HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Using Mathematics and Computational Thinking Work with peers to assess claims about frequency, wavelength, and speed of waves using a computational model when two quantities are known for waves traveling in specified media.	**PS4.A: Wave Properties** • Qualitatively describe cause and effect relationships between changes in wave speed and type of media through which the wave travels using mathematical and graphical representations.	**Cause and Effect** Work with peers to illustrate the relationships between frequency, wavelength, and speed of waves traveling in various media.

HS-PS4 Waves and Their Applications in Technologies for Information Transfer		
HS-PS4-2. Evaluate questions about the advantages of using a digital transmission and storage of information.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Asking Questions and Defining Problems Work with peers to discuss answers to questions about the stability and importance of devices that store or transmit digital information (e.g., emailing your homework to a teacher, copying music, using the internet for research).	**PS4.A: Wave Properties** • Use data or qualitative scientific and technical information to evaluate whether features of a digital transmission or storage device are advantages or disadvantages.	**Stability and Change** Work with peers to describe the stability of systems related to the advantages and disadvantages of digital transmission and storage of information.

HS-PS4 Waves and Their Applications in Technologies for Information Transfer		
HS-PS4-3. Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Engaging in Argument from Evidence Work with peers to explain how the wave model is useful for explaining many features of electromagnetic radiation; and how the phenomenon of the photoelectric effect supports the argument that electromagnetic radiation can be described by a particle model.	**PS4.B: Electromagnetic Radiation** • Identify a model or description of electromagnetic radiation (e.g., a radio, microwave, light) as a wave model. • Identify a model or description of electromagnetic radiation (e.g., radiant energy carried by sunlight) as a particle model.	**Systems and System Models** Work with peers to illustrate a wave model as the relationship of the amplitude and frequency of electromagnetic waves, and the particle model of electromagnetic radiation as a way to describe radiant energy.

HS-PS4 Waves and Their Applications in Technologies for Information Transfer		
HS-PS4-4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Obtaining, Evaluating, and Communicating Information Work with peers to describe and communicate a particle model of electromagnetic radiation as energy carried by packets of electromagnetic energy called photons.	**PS4.B: Electromagnetic Radiation** • Recognize the relationship between the damage to living tissue from electromagnetic radiation and the energy of the radiation.	**Cause and Effect** Work with peers to describe the cause and effect reasoning for the claim that the energies of the photons involved are related to the degree of damage on living tissue caused by electromagnetic radiation.

HS-PS4 Waves and Their Applications in Technologies for Information Transfer		
HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Obtaining, Evaluating, and Communicating Information Work with peers to communicate technical information about technological devices that use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.	**PS4.C: Information Technologies and Instrumentation** • Identify examples of large amounts of information that can be stored and transmitted as a result of being digitized (e.g., a picture stored as the values of an array of pixels).	**Cause and Effect** Work with peers to discuss a device used to solve a real-world problem, and how people depend on the device (e.g., a computer which can store a picture as an array of pixels and send it over long distances as a series of wave pulses).

Core Content Connectors (CCCs) linked to the *2015 South Dakota Science Standards* – Life Science (Grades 9-12)

High School Life Science Conceptual Understanding*:

Cells are the basic unit of organization of all living things. Deoxyribonucleic acid (DNA) determines the structure of proteins which in turn determines the structures of specialized cells. Systems of cells function together to support critical life processes such as maintenance, growth, and reproduction. The energy for these processes comes from photosynthesis and cellular respiration. Photosynthesis transforms light energy into stored chemical energy. Cellular respiration, both aerobic and anaerobic, breaks the chemical bonds of food resulting in new compounds and a net transfer of energy. As carbon, hydrogen, and oxygen from sugar molecules break down, they combine with other elements to form amino acids and/or other carbon-based macromolecules.

Ecosystems are complex interactions between biotic and abiotic factors. When stable, ecosystems will support relatively consistent numbers of organisms; however, when subjected to extreme changes, new ecosystems or reduced biodiversity may occur. Plants form the lowest level of the food web, and as they are consumed, only a small portion of the matter is transferred upward. Matter and energy are conserved at each food web link as some matter is used for growth, some matter is used to release energy for life processes, and some is discarded. Photosynthesis and cellular respiration are key components of the global carbon cycle as matter and energy flow between the biosphere, atmosphere, hydrosphere, and geosphere. The carrying capacity of a particular ecosystem limits the amount and type of organisms it can support. The more biodiversity an ecosystem can support the more resilient it is to environmental changes.

Heredity is the passing of characteristics from one generation to the next via genes. Chromosomes are single long DNA molecules which carry the instructions for forming particular species characteristics. Genes are a segment on the DNA that code for a particular trait. An alternative form of a gene found at the same place on a chromosome is called an allele. Genetic variations may result from new genetic combinations through meiosis, replication errors, or mutations. Environmental factors may cause mutations in genes or affect the expression of traits. The interactions of genes with their environment and the relative presence or absence of different alleles determines the distribution of traits within a population.

The ideas of common ancestry and biological unity and diversity are supported by extensive scientific evidence and form the foundation of modern biological studies. This evidence includes the fossil record, similar DNA sequences, comparative anatomy, and embryological evidence. Evolution is driven by the potential of a species to increase in number, the genetic variation of individuals, competition for resources, and propagation of organisms that are better able to survive and reproduce in the environment. Changes to an environment could see individual species increase in number, new species emerge, or the extinction of some species. Human activity can have an adverse effect on the biodiversity of an ecosystem.

* As stated in the *2015 South Dakota Science Standards.*

HS-LS1 From Molecules to Organisms: Structures and Processes		
HS-LS1-1. Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Constructing Explanations and Designing Solutions Work with peers to follow the chain of reasoning which explains that because all cells contain DNA, all cells contain genes that can code for the formation of proteins, and protein molecules have important functions which are necessary for the proper functioning of the cells.	**LS1.A: Structure and Function** • Relate DNA molecules to the way cells store and use information to guide their functions. • Relate groups of specialized cells (e.g., heart cells, nerve cells, muscle cells, epithelial cells, fat cells, blood cells) within organisms to the performance of essential functions of life.	**Structure and Function** Work with peers to describe the basic life processes of all cells which includes the building of specific proteins using the instructions carried by genes within DNA.

HS-LS1 From Molecules to Organisms: Structures and Processes		
HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Planning and Carrying Out Investigations Work with peers to investigate how the functions of major body systems contribute to the overall function of an organism.	**LS1.A: Structure and Function** • Identify a model of the levels of organization for structure and function in organisms which includes cells, tissues, organs, and organ systems.	**Stability and Change** Work with peers to describe a model which illustrates how the interaction between systems provides specific functions in multicellular organisms.

HS-LS1 From Molecules to Organisms: Structures and Processes		
HS-LS1-3. Plan and carry out an investigation to provide evidence that feedback mechanisms maintain homeostasis.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Planning and Carrying Out Investigations Work with peers to collect and record changes in the external environment and organisms' responses as a function of time.	**LS1.A: Structure and Function** • Identify how different organisms react (e.g., heart rate, body temperature) to changes in their external environment.	**Stability and Change** Work with peers to relate changes in a living organism's external environment to feedback mechanisms (positive and negative) which allow the organism to remain alive and functional.

HS-LS1 From Molecules to Organisms: Structures and Processes		
HS-LS1-4. Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Developing and Using Models Work with peers to develop a model which illustrates that when a cell divides in two, it passes identical genetic material to two daughter cells, and successive divisions produce many cells which can differentiate to create different cell types to maintain a complex organism.	**LS1.B: Growth and Development of Organisms** • Identify how growth occurs when cells multiply (i.e., mitosis) using a model.	**Systems and System Models** Work with peers to identify and describe the components of the model relevant for illustrating the role of mitosis and differentiation in producing and maintaining complex organisms.

HS-LS1 From Molecules to Organisms: Structures and Processes		
HS-LS1-5. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Developing and Using Models Work with peers to develop a model which illustrates that photosynthesis transforms light energy into stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.	**LS1.C: Organization for Matter and Energy Flow in Organisms** • Recognize that photosynthesis results in the conversion of light energy to stored chemical energy.	**Energy and Matter** Work with peers to use the model to describe that plants, algae (including phytoplankton), and other energy fixing microorganisms use sunlight, water, and carbon dioxide to facilitate photosynthesis, which stores energy, forms plant matter, releases oxygen, and maintains plants' activities.

HS-LS1 From Molecules to Organisms: Structures and Processes		
HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Constructing Explanations and Designing Solutions Work with peers to use a model to explain the relationship between the carbon, hydrogen, and oxygen atoms from sugar molecules ingested by an organism and those same atoms found in amino acids and other large carbon-based molecules.	**LS1.C: Organization for Matter and Energy Flow in Organisms** • Identify a model which demonstrates how organisms take in matter (allowing growth and maintenance) and rearrange the atoms in chemical reactions to form different products.	**Energy and Matter** Work with peers to describe how matter and energy flow through different organizational levels of living systems through chemical reactions between sugars and other substances to form different products (i.e., amino acids and other complex carbon-based molecules).

HS-LS1 From Molecules to Organisms: Structures and Processes		
HS-LS1-7. Use a model of the major inputs and outputs of cellular respiration (aerobic and anaerobic) to exemplify the chemical process in which the bonds of food molecules are broken, the bonds of new compounds are formed, and a net transfer of energy results.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Developing and Using Models Work with peers to develop a model which illustrates that cellular respiration is a chemical reaction of oxygen and food molecules that releases energy as the matter is rearranged.	**LS1.C: Organization for Matter and Energy Flow in Organisms** • Identify respiration as the transfer of stored energy to the cell to sustain life's processes (i.e., energy to muscles or energy for maintaining body temperature).	**Energy and Matter** Work with peers to use the model to describe that during cellular respiration the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to cells to sustain life's processes.

HS-LS2 Ecosystems: Interactions, Energy, and Dynamics		
HS-LS2-1. Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Using Mathematics and Computational Thinking Work with peers to use a given mathematical and/or computational representation to identify the factors that have the largest effect on the carrying capacity of an ecosystem for a given population.	**LS2.A: Interdependent Relationships in Ecosystems** • Recognize that the carrying capacities of ecosystems are related to the availability of living and nonliving resources and challenges (e.g., predation, competition, disease). • Use a graphical representation to identify carrying capacities in ecosystems as limits to the numbers of organisms or populations they can support.	**Scale, Proportion, and Quantity** Work with peers to use a given mathematical and/or computational representation to show the significance of a factor (e.g., resources, climate, and competition) is dependent on the scale (e.g., a pond vs. an ocean) at which it occurs.

HS-LS2 Ecosystems: Interactions, Energy, and Dynamics		
HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Using Mathematics and Computational Thinking Work with peers to use a given mathematical and/or computational representation to identify the most important factors that determine biodiversity or population numbers of an ecosystem.	**LS2.A: Interdependent Relationships in Ecosystems** • Use mathematical representations (trends, averages, or graphs) to identify dependencies of an animal population on other organisms for food and their environment for shelter.	**Scale, Proportion, and Quantity** Work with peers to illustrate how ecosystems can exist in the same location on a variety of scales (e.g., plants and animals vs. microbes).

HS-LS2 Ecosystems: Interactions, Energy, and Dynamics		
HS-LS2-3. Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Constructing Explanations and Designing Solutions Work with peers to explain how energy from photosynthesis and respiration drives the cycling of matter and flow of energy under aerobic or anaerobic conditions within an ecosystem.	**LS2.B: Cycle of Matter and Energy Transfer in Ecosystems** • Recognize a model of the flow of matter or energy in aerobic respiration. • Recognize a model of the flow of matter or energy in anaerobic respiration.	**Energy and Matter** Work with peers to make the connections across the concepts that energy inputs to cells occur either by photosynthesis or by taking in food and that 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.

HS-LS2 Ecosystems: Interactions, Energy, and Dynamics		
HS-LS2-4. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Using Mathematical and Computational Thinking Work with peers to use a mathematical representation of a food web to identify the relative proportion of organisms at each trophic level (i.e., identifying producers as the lowest trophic level having the greatest biomass and energy and consumers decreasing in numbers at higher trophic levels).	**LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** • Use a graphical representation to identify the changes in the amount of matter as it travels through a food web. • Use a graphical representation to identify the changes in the amount of energy as it travels through a food web.	**Energy and Matter** Work with peers to use a mathematical representation of a food web to identify the transfer of energy and matter between tropic levels.

HS-LS2 Ecosystems: Interactions, Energy, and Dynamics		
HS-LS2-5. Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Developing and Using Models Work with peers to develop a model of the components of an ecosystem to identify the inputs and outputs of photosynthesis; the inputs and outputs of cellular respiration; and the biosphere, atmosphere, hydrosphere, and geosphere.	**LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** • Use a model of photosynthesis to identify that carbon is exchanged between living and nonliving systems. • Use a model of cellular respiration to identify that carbon is exchanged between living and nonliving systems.	**Systems and System Models** Work with peers to describe the contribution of photosynthesis and cellular respiration to the exchange of carbon within and among the biosphere, atmosphere, hydrosphere, and geosphere in the model.

HS-LS2 Ecosystems: Interactions, Energy, and Dynamics		
HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms under stable conditions; however, moderate to extreme fluctuations in conditions may result in new ecosystems.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Engaging in Argument from Evidence Work with peers to use evidence (e.g., data) to support the argument that resiliency of an ecosystem is subject to the degree of change in the biological and physical environment of that ecosystem.	**LS2.C: Ecosystem Dynamics, Functioning, and Resilience** • Use evidence to identify how modest biological or physical changes versus extreme changes affect stability and change (e.g., number and types of organisms) in ecosystems.	**Stability and Change** Work with peers to describe evidence (in the form of data, information, or other appropriate forms) of factors that affect biodiversity; the relationships between species and the physical environment in an ecosystem; and the changes in the numbers of species and organisms in an ecosystem that have been subject to a modest or extreme change in ecosystem conditions.

HS-LS2 Ecosystems: Interactions, Energy, and Dynamics		
HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Constructing Explanations and Designing Solutions Work with peers to design a solution that involves reducing the negative effects of human activities on the environment and biodiversity.	**LS2.C: Ecosystem Dynamics, Functioning, and Resilience** • Describe how people can help protect the Earth's environment and biodiversity (e.g., preserving ecosystems) and how a human activity would threaten Earth's environment and biodiversity (e.g., pollution, damaging habitats, over hunting).	**Stability and Change** Work with peers to evaluate the proposed solution for its impact on overall environmental stability and changes.

HS-LS2 Ecosystems: Interactions, Energy, and Dynamics		
HS-LS2-8. Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Engaging in Argument from Evidence Work with peers to evaluate evidence to support the claim that group behavior can increase the chances for an individual and a species to survive and reproduce.	**LS2.D: Social Interactions and Group Behavior** • Evaluate evidence supporting the outcome of group behavior (e.g., life expectancy, species' chances to survive and reproduce).	**Cause and Effect** Work with peers to evaluate evidence for causal relationships between specific group behaviors (e.g., flocking, schooling, herding, cooperative hunting, migrating, swarming) and individual survival and reproduction rates.

HS-LS3 Heredity: Inheritance and Variation of Traits		
HS-LS3-1. Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Asking Questions and Defining Problems Work with peers to ask questions to understand that the genetic instructions for forming species' characteristics are carried in the chromosomes; each chromosome consists of a single DNA molecule; and that genes are the regions in the DNA that contain the instructions that code for the formation of proteins.	**LS3.A: Inheritance of Traits** • Recognize that DNA molecules in all cells contain the instructions for traits passed from parents to offspring.	**Cause and Effect** Work with peers to describe the cause and effect relationships between DNA, the proteins it codes for, and the resulting traits observed in an organism.

HS-LS3 Heredity: Inheritance and Variation of Traits		
HS-LS3-2. 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.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Engaging in Argument from Evidence Work with peers to describe evidence that supports the claim that inheritable genetic variations may result from environmental factors.	**LS3.B: Variation of Traits** • Identify a model showing evidence that parents and offspring may have different traits. • Recognize that meiosis is a process which distributes genetic material among the new cells (i.e., gametes) produced, which results in genetic variation. • Recognize that when DNA makes a copy of itself, sometimes errors occur that may lead to genetic variations. • Identify examples of mutations in DNA caused by environmental factors.	**Cause and Effect** Work with peers to illustrate the cause and effect relationship of how chromosomes can sometimes swap sections during the process of meiosis (cell division), which creates gametes that contain new combinations of genes, which helps maximize the genetic diversity of any offspring (e.g., physical characteristics such as eye color).

HS-LS3 Heredity: Inheritance and Variation of Traits		
HS-LS3-3. Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Analyzing and Interpreting Data Work with peers to use appropriate statistical analyses of data, including probability measures, to show how variation and distribution of observed traits depend on both genetic and environmental factors.	**LS3.B: Variation of Traits** • Calculate the probability (e.g., two out of four) of a particular trait in an offspring based on a completed Punnett square. • Identify examples, using data, of environmental factors which affect the expression of traits, and so then affect the probability of occurrences of traits in a population.	**Scale, Proportion, and Quantity** Work with peers to identify and use patterns in a statistical analysis to predict changes in trait distribution within a population if environmental variables change.

HS-LS4 Biological Evolution: Unity and Diversity		
HS-LS4-1. Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Obtaining, Evaluating, and Communicating Information Work with peers to identify and communicate evidence for common ancestry and biological evolution (i.e., patterns in the fossil record; DNA sequences).	**LS4.A: Evidence of Common Ancestry and Diversity** • Identify patterns (e.g., DNA sequences, fossil records) as evidence to a claim of common ancestry.	**Patterns** Work with peers to identify that patterns observed (i.e., DNA sequences, fossil records) provide evidence for relationships relating to biological evolution and common ancestry.

HS-LS4 Biological Evolution: Unity and Diversity		
HS-LS4-2. Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Constructing Explanations and Designing Solutions Work with peers to explain how traits that positively affect survival are more likely to be reproduced and thus are more common in the population.	**LS4.A: Evidence of Common Ancestry and Diversity** • Recognize that as a species grows in number, competition for limited resources also increases. • Recognize that different individuals have specific traits that give advantages (e.g., survive and reproduce at higher rates) over other individuals in the species. • Identify how evolution may be a result of genetic variation through mutations and sexual reproduction in a species that is passed on to their offspring.	**Cause and Effect** Work with peers to describe the cause and effect relationship of how competition for resources and mates, and conditions in the environment can affect which individuals survive, reproduce, and pass their traits on to future generations.

HS-LS4 Biological Evolution: Unity and Diversity		
HS-LS4-3. Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Analyzing and Interpreting Data Work with peers to use basic statistical and graphical analysis to interpret the distribution of genetic traits over time.	**LS4.B: Natural Selection** • Use patterns in data to identify how heritable variations in a trait may lead to an increasing proportion of individuals within a population with that trait (i.e., an advantageous characteristic).	**Patterns** Work with peers to use basic statistical and graphical analysis to interpret the distribution of genetic traits over time.

HS-LS4 Biological Evolution: Unity and Diversity		
HS-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Constructing Explanations and Designing Solutions Work with peers to explain how natural selection provides a mechanism for species to adapt to changes in their environment, which leads to a population that is adapted to a particular environment.	**LS4.C: Adaptation** • Use data to provide evidence for how specific biotic or abiotic differences in ecosystems (e.g., ranges of seasonal temperature, acidity, light, geographic barriers) support the claim that organisms with an advantageous heritable trait are better able to survive over time.	**Cause and Effect** Work with peers to identify the cause and effect relationship between natural selection and adaptation (e.g., changes in a population when some feature of the environment changes).

HS-LS4 Biological Evolution: Unity and Diversity		
HS-LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Engaging in Argument from Evidence Work with peers to identify and evaluate evidence (e.g., in the form of data, information, models, or other appropriate forms) 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, or (3) the extinction of other species.	**LS4.C: Adaptation** • Recognize that species become extinct because they can no longer survive and reproduce given changes in the environment. • Recognize the relationship between naturally occurring or human-induced changes in the environment (e.g., drought, flood, deforestation, fishing, application of fertilizers) and the expression of traits in a species (e.g., peppered moth studies).	**Cause and Effect** Work with peers to identify relationships between environmental changes and 1) the changes in the number of individuals in each species, 2) the number of species in an environment, or 3) the emergence or extinction of species.

HS-LS4 Biological Evolution: Unity and Diversity		
HS-LS4-6. Use a simulation to research and analyze possible solutions for the adverse impacts of human activity on biodiversity.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Using Mathematics and Computational Thinking Work with peers to use a mathematical representation to model the effects of a human activity (e.g., overpopulation, overexploitation, adverse habitat alterations, pollution, invasive species, changes in climate) on a threatened or endangered species.	**LS4.D: Biodiversity and Humans** • Identify long or short term goals of a solution meant to minimize adverse impacts of a human activity on biodiversity.	**Cause and Effect** Work with peers to develop solutions related to the threatened or endangered species, and predict the effects of the specific design solutions on biodiversity.

HS-LS4 Biological Evolution: Unity and Diversity		
HS-LS4-7. Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Analyzing and Interpreting Data Work with peers to identify evidence (i.e., pattern of anatomical and embryological similarities) to develop an explanation of common ancestry.	**LS4.A: Evidence of Common Ancestry and Diversity** • Identify patterns (i.e., pictorial displays, representations, data) as evidence of relationships among species.	**Patterns** Work with peers to use patterns of similarities in embryo development to support an explanation of relatedness among species which appear unrelated.

Core Content Connectors (CCCs) linked to the *2015 South Dakota Science Standards* – Earth and Space Science (Grades 9-12)

High School Earth and Space Science Conceptual Understanding*:

Light spectra from stars are used to determine their characteristics, processes, and lifecycles. Solar activity creates the elements through nuclear fusion. The development of technologies has provided the astronomical data that provide the empirical evidence for the Big Bang Theory. Kepler's Laws describe common features of the motions of orbiting objects. Observations from astronomy and space probes provide evidence for explanations of solar system formation. The rock record resulting from tectonic and other geoscience processes as well as objects from the solar system can provide evidence of Earth's early history and the relative ages of major geologic formations. Feedback effects exist within and among Earth's systems. Radioactive decay within Earth's interior contributes to thermal convection in the mantle. The planet's dynamics are greatly influenced by water's unique chemical and physical properties.

The role of radiation from the sun and its interactions with the atmosphere, ocean, and land are the foundation for the global climate system. Global climate models are used to predict future changes, including changes influenced by human behavior and natural factors. The role of radiation from the sun and its interactions with the atmosphere, ocean, and land are the foundation for the global climate system. Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits. Natural hazards and other geological events have shaped the course of human history at local, regional, and global scales. Sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources, including the development of technologies. Global climate models used to predict changes continue to be improved, although discoveries about the global climate system are continually needed.

South Dakota is a rich source of geologic resources unique to the Great Plains. Grasslands, the Badlands, Black Hills, and Missouri River Basin all provide unique opportunities for students to investigate the Earth and its many interacting systems. In South Dakota, the use, management, and protection of natural resources have an economic, social, environmental, and geopolitical impact. Natural hazard mitigation (severe weather, flooding, and drought) has a direct impact on the people and environment of our state. Human activities in agriculture, industry, and everyday life have major impacts on the soil, air, and water of South Dakota.

* As stated in the *2015 South Dakota Science Standards.*

HS-ESS1 Earth's Place in the Universe		
HS-ESS1-1. Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Developing and Using Models Work with peers to develop a model and use it to identify relationships between the components, including a description of the process of radiation, the life span of the sun, and how energy released by the sun reaches Earth's system.	**ESS1.A: The Universe and Its Stars** • Describe components of a model illustrating that the sun shines because of nuclear fusion reactions which release light and heat energy which make life on Earth possible.	**Scale and Proportion** Work with peers to use the model to qualitatively describe the scale of the energy released by the fusion process as being much larger than the scale of the energy released by chemical processes.

HS-ESS1 Earth's Place in the Universe		
HS-ESS1-2. Construct an explanation of the Big Bang Theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Constructing Explanations and Designing Solutions Work with peers to construct an explanation that includes a description of how astronomical evidence from numerous sources (i.e., light spectra, motion of distant galaxies, and composition of matter in the universe) is used collectively to support the Big Bang theory.	**ESS1.A: The Universe and Its Stars** • Identify that the universe is expanding and must have been smaller in the past based on astronomical evidence (i.e., light spectra, motion of distant galaxies, and composition of matter in the universe).	**Energy and Matter** Work with peers to explain that the light which reaches Earth from distant galaxies is millions of years old.

HS-ESS1 Earth's Place in the Universe		
HS-ESS1-3. Communicate scientific ideas about the way stars, over their life cycle, produce elements.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Obtaining, Evaluating, and Communicating Information Work with peers to identify and communicate the relationships showing how most elements are formed as a result of natural astronomical processes, either in the Big Bang itself or in the natural evolution of stars.	**ESS1.A: The Universe and Its Stars** • Recognize that solar activity creates elements through nuclear fusion.	**Energy and Matter** Work with peers to use graphical or pictorial representations to identify that atoms are not conserved in nuclear fusion, but the total number of protons plus neutrons is conserved.

HS-ESS1 Earth's Place in the Universe		
HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Using Mathematical and Computational Thinking Work with peers using mathematical modeling to recognize the proportional relationship between a revolving body's period of revolution and its distance to a gravitational center.	**ESS1.B: Earth and the Solar System** • Recognize that objects in the solar system orbit the sun and have an orderly motion (e.g., elliptical paths around the sun). • Relate Earth's orbital characteristics to other bodies in the solar system.	**Scale, Proportion, and Quantity** Work with peers to explain how gravity influences the motion of bodies in the universe and use that information to make predictions about the orbits of planets in the solar system.

HS-ESS1 Earth's Place in the Universe		
HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Engaging in Argument from Evidence Work with peers to identify evidence to support the claim that continental and oceanic rock differ in overall composition, density, and age.	**ESS1.C: The History of Planet Earth** • Explain the relationship between the motion of continental plates and how materials of different ages are arranged on Earth's surface.	**Patterns** Work with peers to describe how patterns observed from the evidence support the explanation about the ages of crustal rocks (i.e., the ages of oceanic crust are greatest nearest to the continents and decrease in age with proximity to the mid-ocean ridges).

HS-ESS1 Earth's Place in the Universe		
HS-ESS1-6. Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Constructing Explanations and Designing Solutions Work with peers to connect the evidence to construct the explanation of Earth's formation and early history (i.e., age and composition of Earth's oldest rocks, lunar rocks, and meteorites).	**ESS1.C: The History of Planet Earth** • Identify ancient Earth materials, lunar rocks, asteroids, and meteorites as sources of evidence scientists use to understand Earth's early history.	**Stability and Change** Work with peers to base an argument that although Earth was bombarded by impacts, just as other objects in the solar system, evidence of erosion and plate tectonics on Earth is the reason that the evidence of this bombardment is not seen today.

Core Content Connectors (CCCs) linked to the
2015 South Dakota Science Standards – Earth and Space Science (Grades 9-12)

HS-ESS2 Earth's Systems		
HS-ESS2-1. Analyze geoscience data to make the claim that one change to Earth's surface can create feedback that cause changes to other Earth systems.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Analyzing and Interpreting Data Work with peers to analyze data and explain the relationships between the changes in one system and changes in another Earth system (e.g., how the loss of ground vegetation causes an increase in water runoff and soil erosion).	**ESS2.A: Earth Materials and Systems** • Identify relationships, using a model, of how the Earth's surface is a complex and dynamic set of interconnected systems (i.e., geosphere, hydrosphere, atmosphere, and biosphere).	**Stability and Change** Work with peers to use the analyzed data to describe a mechanism for the feedback between two of Earth's systems and whether the feedback is increasing (destabilizing) or decreasing (stabilizing) the original changes.

HS-ESS2 Earth's Systems		
HS-ESS2-2. Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Developing and Using Models Work with peers to develop a model of Earth's interior (i.e., a hot, but solid inner core, a liquid outer core, a solid mantle, and crust) to illustrate convection (i.e., causes hot matter to rise (move away from Earth's center) and cool matter to fall (move toward Earth's center)).	**ESS2.A: Earth Materials and Systems** • Use a model of Earth to identify that the motion of the mantle and its plates occurs primarily through thermal convection, which is primarily driven by radioactive decay within Earth's interior.	**Energy and Matter** Work with peers to describe the relationships between components in a model to describe the cycling of matter (i.e., energy released by radioactive decay in the Earth's crust provides energy that drives the flow of matter in the mantle; thermal energy is released at the surface of the Earth as new crust is formed and cooled; and the flow of matter in the mantle causes crustal plates to move).

HS-ESS2 Earth's Systems		
HS-ESS2-3. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Developing and Using Models Work with peers to develop and use a model of the relationship between energy flow in Earth's systems (e.g., heat energy stored in the oceans and transferred by currents, influence climate) and describe how uneven heating of Earth's components (i.e., water, land, air) produce local and global atmospheric and oceanic movement using models, charts, diagrams, or simple investigations.	**ESS2.A: Earth Materials and Systems** • Use a model to identify different causes of climate change and results of those changes with respect to the Earth's surface temperatures, precipitation patterns, or sea levels over a wide range of temporal and spatial scales. **ESS2.D: Weather and Climate** • Identify different causes of climate change and results of those changes with respect to the Earth's surface temperatures, precipitation patterns, or sea levels over a wide range of temporal and spatial scales using a model.	**Cause and Effect** Work with peers to use a given model to identify specific cause and effect relationships between the factors and the effect on energy flow into and out of Earth's systems.

HS-ESS2 Earth's Systems		
HS-ESS2-4. Plan and carry out an investigation of the properties of water and its effects on Earth materials and surface processes.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Planning and Carrying Out Investigations Work with peers to describe the connection between the properties of water and its effects on Earth materials and surface processes (e.g., heat energy stored in the oceans and transferred by currents, influence climate) and describe how uneven heating of Earth's components (i.e., water, land, air) produce local and global atmospheric and oceanic movement using models, charts, diagrams, or simple investigations (e.g., mechanical effects such as stream transportation and deposition using a stream table, which can be used to infer the ability of water to transport and deposit materials or chemical effects such as solubility of different materials in water, which can be used to infer chemical weathering).	**ESS2.C: The Roles of Water in Earth's Surface Processes** • Identify a connection between the properties of water and its effects on Earth materials.	**Structure and Function** Work with peers to identify and describe the mechanical effects of water on Earth materials (e.g., the expansion of water as it freezes, which can be used to infer the ability of water to break rocks into smaller pieces).

HS-ESS3 Earth and Human Activity		
HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Constructing Explanations and Designing Solutions Work with peers to identify evidence to explain the effects of natural hazards, changes in climate, or the availability of natural resources on features of human societies, including population size and migration patterns.	**ESS3.A: Natural Resources** • Explain the relationship between human activity (e.g., population size, where humans live, types of crops grown) and changes in the amounts of natural resources using evidence. **ESS3.B: Natural Hazards** • Explain the relationship between human activity (e.g., population size, where humans live, types of crops grown) and changes in the occurrence of natural hazards using evidence.	**Cause and Effect** Work with peers to explain cause and effect relationships between environmental factors (natural hazards, changes in climate, and the availability of natural resources) and features of human societies including population size and migration patterns.

HS-ESS3 Earth and Human Activity		
HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Engaging in Argument from Evidence Work with peers to identify evidence of the claim that there is a need for a design solution (e.g., environmental costs) and describe how the solution minimizes impacts (i.e., conservation, recycling, and reuse of resources).	**ESS3.A: Natural Resources** • Identify the solution that demonstrates the most preferred cost-benefit ratios for developing, managing, and utilizing energy and mineral resources (i.e., conservation, recycling, and reuse of resources).	**Influence of Science, Engineering, and Technology on Society and the Natural World** Work with peers to evaluate the strength of a design solution (i.e., economic, environmental, and geopolitical costs, risks, and benefits).

HS-ESS3 Earth and Human Activity		
HS-ESS3-3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Using Mathematics and Computational Thinking Work with peers to identify components of a mathematical model representing relationships among management of natural resources, the sustainability of human populations, and biodiversity.	**ESS3.C: Human Impacts on Earth Systems** • Use numerical data to determine the effects of a conservation strategy to manage natural resources and to sustain human society and plant and animal life.	**Stability and Change** Work with peers to describe simplified relationships between variables that affect the management of natural resources, human sustainability, and biodiversity (e.g., the effect on one component by altering other components in the system).

HS-ESS3 Earth and Human Activity		
HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Constructing Explanations and Designing Solutions Work with peers to evaluate technological solutions that reduce human impacts on natural systems.	**ESS3.C: Human Impacts on Earth Systems** • Connect a technological solution (e.g., wet scrubber; baghouse) to its outcome (e.g., clean air) and to which human activity impact (e.g., air pollution) it is reducing.	**Stability and Change** Work with peers to describe how the technological solutions will reduce human impacts on natural systems.

HS-ESS3 Earth and Human Activity		
HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Analyzing and Interpreting Data Work with peers to organize data (e.g., with graphs) from global climate models (e.g., computational simulations) and identify what each data set represents (e.g., temperature, precipitation, sea level).	**ESS3.D: Global Climate Change** • Use geoscience data to determine the relationship between a change in climate (e.g., precipitation, temperature) and its impact in a region.	**Stability and Change** Work with peers to use data to predict the future effect of a selected aspect of climate change on the physical parameters (e.g., temperature, precipitation, sea level) or chemical composition (e.g., ocean pH) of the atmosphere, geosphere, or hydrosphere.

HS-ESS3 Earth and Human Activity		
HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.		
Science and Engineering Practices **Core Content Connectors**	**Disciplinary Core Ideas** **Core Content Connectors**	**Crosscutting Concepts** **Core Content Connectors**
Using Mathematics and Computational Thinking Work with peers to use a representation of Earth systems to describe relationships among two of Earth's systems.	**ESS3.D: Global Climate Change** • Use representations to describe the relationships among Earth systems and how those relationships are being modified due to human activity (e.g., increase in atmospheric carbon dioxide, increase in ocean acidification, effects on organisms in the ocean (coral reef), carbon cycle of the ocean, possible effects on marine populations).	**Systems and System Models** Work with peers to use a representation of Earth systems to identify how human activity could affect the relationships between the Earth's systems under consideration.