K-5 Science
Missouri Learning Standards: Grade-Level Expectations

Missouri Department of Elementary and Secondary Education
Spring 2016

	PS1 - Matter and Its Interactions					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
A **Structure and Properties of Matter**	K.PS1.A.1 Make qualitative observations of the physical properties of objects (i.e., size, shape, color, mass).		2. PS1.A.1 Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties. [Clarification Statement: Observations could include color, texture, hardness, and flexibility. Patterns could include the similar properties that different materials share.] 2.PS1.A.2 Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose. [Clarification Statement: Examples of properties could include, strength, flexibility, hardness, texture, and absorbency.]	3.PS1.A.1 Predict and investigate that water can change from a liquid to a solid (freeze), and back again (melt), or from a liquid to a gas (evaporation), and back again (condensation) as the result of temperature changes.		5. PS1.A.1 Develop a model to describe that matter is made of particles too small to be seen. [Clarification Statement: Examples of evidence supporting a model could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.] 5. PS1.A.2 Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved. [Clarification Statement: Examples of reactions or changes could include phase changes, dissolving, and mixing that form new substances.]

	PS1 - Matter and Its Interactions					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
B **Types of Interactions of Matter**				3.PS1.B.1 Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.		5. PS1.B.1 Plan and conduct investigations to separate the components of a mixture/solution by their physical properties (i.e., sorting, filtration, magnets, screening). 5. PS1.B.2 Conduct an investigation to determine whether the combining of two or more substances results in new substances.

	PS2 - Motion and Stability: Forces and Interactions					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
A **Forces and Motion**	K.PS2.A.1 Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object. [Clarification Statement: Examples of pushes or pulls could include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other.] K.PS2.A.2 Describe ways to change the motion of an object (i.e., how to cause an object to go slower, go faster, go farther, change direction, stop).		2.PS2.A.1 Analyze data to determine how the motion of an object changed by an applied force or the mass of an object.		4.PS2.A.1 Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion. 4.PS2.A.2 Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object. [Clarification Statement: Examples could include an unbalanced force on one side of a ball can make it start moving; and, balanced forces pushing on a box from both sides will not produce any motion at all.]	

	PS2 - Motion and Stability: Forces and Interactions					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
B				3.PS2.B.1 Plan and conduct investigations to determine the cause and effect relationship of electric or magnetic interactions between two objects not in contact with each other. [Clarification Statement: Examples of an electric force could include the force on hair from an electrically charged balloon and the electrical forces between a charged rod and pieces of paper; examples of a magnetic force could include the force between two permanent magnets, the force between an electromagnet and steel paperclips, and the force exerted by one magnet versus the force exerted by two magnets. Examples of cause and effect relationships could include how the distance between objects affects strength of the force and how the orientation of magnets affects the direction of the magnetic force.]	4.PS2.B.1 Plan and conduct a fair test to compare and contrast the forces (measured by a spring scale in Newtons) required to overcome friction when an object moves over different surfaces (i.e., rough/smooth). 4.PS2.B.2 Predict how changes in either the amount of force applied to an object or the mass of the object affects the motion (speed and direction) of the object.	5. PS2.B.1 Support an argument that the gravitational force exerted by Earth on objects is directed toward the planet's center. [Clarification Statement: "Down" is a local description of the direction that points toward the center of the spherical Earth.]
Types of Interaction						

	PS3 - Energy					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
A **Definitions of Energy**	K.PS3.A.1 Make observations to determine the effect of sunlight on Earth's surface.	1.PS3.A.1 Identify the source of energy that causes an increase in the temperature of an object (e.g., sun, stove, flame, light bulb).			4.PS3.A.1 Use evidence to construct an explanation relating the speed of an object to the energy of that object.	

	PS3 - Energy					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
B **Conservation of Energy and Energy Transfer**	K.PS3.B.1 With prompting and support, use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area				4.PS3.B.1 Provide evidence to construct an explanation of an energy transformation(e.g. temperature change, light, sound, motion, and magnetic effects) 4.PS3.B.2 Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. [Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device.]	

	PS3 - Energy					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
C **Relationship Between Energy and Forces**					4.PS3.C.1 Use models to explain that simple machines change the amount of effort force and/or direction of force. [Clarification Statement: Memorization of a simple machine is not the focus. This concept builds on the application of force and motion .]	

	PS3 - Energy					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
D						5. PS3.D.1 Use models to describe that energy stored in food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun. [Clarification Statement: Examples of models could include diagrams, and flow charts.]
Energy in Chemical Process and Everyday						

Life

	PS4 - Waves and Their Applications in technologies for Information Transfer					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
A		1.PS4.A.1	2.PS4.A.1		4.PS4.A.1	5. PS4.A.1
Wave Properties		Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate. [Clarification Statement: Examples of vibrating materials that make sound could include tuning forks and plucking a stretched string. Examples of how sound can make matter vibrate could include holding a piece of paper near a speaker making sound and holding an object near a vibrating tuning fork.]	Plan and conduct investigations to provide evidence that changes in vibration create change in sound.		Develop a model of waves to describe patterns in terms of amplitude or wavelength and that waves can cause objects to move. [Clarification Statement: Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves.]	Develop a model to describe that objects can be seen only when light is reflected off them or when they produce their own light.

	PS4 - Waves and Their Applications in technologies for Information Transfer					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
B						
Electromagnetic Radiation						

	PS4 - Waves and Their Applications in technologies for Information Transfer					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
C		1.PS4.C.1 Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance. [Clarification Statement: Examples of devices could include a light source to send signals, paper cup and string "telephones," and a pattern of drum beats.]				
Information Technologies and Instrumentation						

	LS1 - From Molecules to Organisms: Structure and Processes					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
A		1.LS1.A.1 Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs. [Clarification Statement: Examples of human problems that can be solved by mimicking plant or animal solutions could include designing clothing or equipment to protect bicyclists by mimicking turtle shells, acorn shells, and animal scales; stabilizing structures by mimicking animal tails and roots on plants; keeping out intruders by mimicking thorns on branches and animal quills; and, detecting intruders by mimicking eyes and ears.]			4.LS1.A.1 Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and plant reproduction. [Clarification Statement: Examples of structures could include thorns, stems, roots, colored petals, heart, stomach, lung, brain, and skin.]	5. LS1.A.1 Compare and contrast the major organs/organ systems (e.g. support, reproductive, digestive, transport/circulatory, excretory, response) that perform similar functions for animals belonging to different vertebrate classes.
Structure and Function						

	LS1 - From Molecules to Organisms: Structure and Processes					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
B **Growth and Development of Organisms**				3.LS1.B.1 Develop a model to compare and contrast observations on the life cycle of different plants and animals. [Clarification Statement: Changes organisms go through during their life form a pattern.]		

	LS1 - From Molecules to Organisms: Structure and Processes					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
C **Organization for Matter and Energy Flow in Organisms**	K.LS1.C.1 Use observations to describe patterns of what plants and animals (including humans) need to survive. [Clarification Statement: Examples of patterns could include that animals need to take in food but plants do not; the different kinds of food needed by different types of animals; the requirement of plants to have light; and, that all living things need water.]					5. LS1.C.1 Support an argument that plants get the materials (i.e. carbon dioxide, water, sunlight) they need for growth chiefly from air and water. [Clarification Statement: Emphasis is on the idea that plant matter comes mostly from air and water, not from the soil. Clarification Statement: [Do not assess photosynthesis.]

	LS1 - From Molecules to Organisms: Structure and Processes					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
D					4.LS1.D.1 Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways. [Clarification Statement: Emphasis is on systems of information transfer.]	
Information Processing						

	LS2 - Ecosystems: Interactions, Energy, and Dynamics					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
A			2.LS2.A.1 Plan and conduct investigations on the growth of plants when growing conditions are altered (e.g., dark vs. light, water vs. no water). 2.LS2.A.2 Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.			
Interdependent Relationships in Ecosystems						

	LS2 - Ecosystems: Interactions, Energy, and Dynamics					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
B						5. LS2.B.1 Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. [Clarification Statement: Emphasis is on the idea that matter that is not food (air, water, decomposed materials in soil) is changed by plants into matter that is food.

Cycles of matter and Energy Transfer in Ecosystems						Examples of systems could include organisms, ecosystems, and the Earth.]

	LS3 - Heredity: Inheritance and Variation of Traits					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
A **Inheritance of Traits**		1.LS3.A.1 Make observations to construct an evidence based account that young plants and animals are like, but not exactly like, their parents. [Clarification Statement: Examples of patterns could include features plants or animals share. Examples of observations could include leaves from the same kind of plant are the same shape but can differ in size; and, a particular breed of dog looks like its parents but is not exactly the same.]		3.LS3.A.1 Construct scientific arguments to support claims that some characteristics of organisms are inherited from parents and some are influenced by the environment. [Clarification Statement: Examples of the environment affecting a trait could include normally tall plants grown with insufficient water are stunted; and, a pet dog that is given too much food and little exercise may become overweight.]		

	LS3 - Heredity: Inheritance and Variation of Traits					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
B **Natural Selection**				3.LS3.B.1 Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving and finding mates. [Clarification Statement: Examples of cause and effect relationships could be plants that have larger thorns than other plants may be less likely to be eaten by predators; and, animals that have better camouflage coloration than other animals may be more likely to survive and therefore more likely to leave offspring.]		

	LS3 - Heredity: Inheritance and Variation of Traits					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
C **Adaptation**				3.LS3.C.1 Construct an argument with evidence that in a particular ecosystem some organisms -- based on structural adaptations or behaviors -- can survive well, some survive less well, and some cannot. [Clarification Statement: Examples of evidence could include needs and characteristics of the organisms and habitats involved. The organisms and their habitat make up a system in which the parts depend on each other.]		

	LS3 - Heredity: Inheritance and Variation of Traits					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
D **Biodiversity and Humans**				3.LS3.D.1 Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change. [Clarification Statement: Examples of environmental changes could include changes in land characteristics, water distribution, temperature, food, and other organisms.]		

	ESS1 - Earth's Place in the Universe					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
A **The Universe and its Stars**		1.ESS1.A.1 Describe the presence of the sun, moon, and stars in the sky over time. 1.ESS1.A.2 Use observations of the sun, moon, and stars to describe patterns that can be predicted. [Clarification Statement: Examples of patterns could include that the sun and moon appear to rise in one part of the sky, move across the sky, and set; and stars other than our sun are visible at night but not during the day.]				5. ESS1.A.1 Support an argument that relative distances from Earth affects the apparent brightness of the sun compared to other stars.

	ESS1 - Earth's Place in the Universe					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
B **Earth and the Solar System**	K.ESS1.B.1 Make observations during different seasons to relate the amount of daylight to the time of year. [Clarification Statement: Emphasis is on relative comparisons of the amount of daylight in the winter to the amount in the spring or fall.]					5. ESS1.B.1 Make observations during different seasons to relate the amount of daylight to the time of year. [Clarification Statement: Emphasis is on relative comparisons of the amount of daylight in the winter to the amount in the spring or fall.] 5. ESS1.B.2 Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky. [Clarification Statement: Examples of patterns could include the position and motion of Earth with respect to the sun and selected stars that are visible only in particular months.]

	ESS1 - Earth's Place in the Universe					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
C			2.ESS1.C.1 Use information from several sources to provide evidence that Earth events can occur quickly or slowly. [Clarification Statement: Examples of events and timescales could include volcanic explosions and earthquakes, which happen quickly and erosion of rocks, which occurs slowly.]		4.ESS1.C.1 Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time. [Clarification Statement: Examples of evidence from patterns could include rock layers with marine shell fossils above rock layers with plant fossils and no shells, indicating a change from land to water over time; and, a canyon with different rock layers in the walls and a river in the bottom, indicating that over time a river cut through the rock.]	
The History of Planet Earth						

	ESS2 - Earth's Systems					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
A			2.ESS2.A.1 Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land. [Clarification Statement: Examples of solutions could include different designs of dikes and windbreaks to hold back wind and water, and different designs for using shrubs, grass, and trees to hold back the land.]		4.ESS2.A.1 Plan and conduct scientific investigations or simulations to provide evidence how natural processes (e.g. weathering and erosion) shape Earth's surfaces.	5. ESS2.A.1 Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. [Clarification Statement: Examples could include the influence of the ocean on ecosystems, landform shape, and climate; the influence of the atmosphere on landforms and ecosystems through weather and climate; and the influence of mountain ranges on winds and clouds in the atmosphere. The geosphere, hydrosphere, atmosphere, and biosphere are each a system.]
Earth Materials and Systems						

	ESS2 - Earth's Systems					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
B **Plate Tectonics and Large-Scale Systems**			2.ESS2.B.1 Develop a model to represent the shapes and kinds of land and bodies of water in an area.		4.ESS2.B.1 Analyze and interpret data from maps to describe patterns of Earth's features. [Clarification Statement: Maps can include topographic maps of Earth's land and ocean floor, as well as maps of the locations of mountains, continental boundaries, volcanoes, and earthquakes.]	

	ESS2 - Earth's Systems					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
C **The Role of Water in Earth's Surface Processes**			2.ESS2.C.1 Obtain information to identify where water is found on Earth and that it can be solid or liquid.			5. ESS2.C.1 Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.

	ESS2 - Earth's Systems					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
D **Weather and Climate**	K.ESS2.D.1 Use and share observations of local weather conditions to describe patterns over time. [Clarification Statement: Examples of qualitative observations could include descriptions of the weather (such as sunny, cloudy, rainy, and warm); examples of quantitative observations could include numbers of sunny, windy, and rainy days in a month. Examples of patterns could include that it is usually cooler in the morning than in the afternoon and the number of sunny days versus cloudy days in different months.]	1.ESS2.D.1 Identify patterns indicating relationships between observed weather data and weather phenomena (e.g., temperature and types of precipitation, clouds and amounts of precipitation).		3.ESS2.D.1 Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season. [Clarification Statement: Examples of data could include average temperature, precipitation, and wind direction.] 3.ESS2.D.2 Obtain and combine information to describe climates in different regions of the world.		

	ESS2 - Earth's Systems					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
E **Biogeology**	K.ESS2.E.1 With prompting and support, construct an argument using evidence for how plants and animals (including but not limited to humans) can change the environment to meet their needs.					

	ESS3 - Earth and Human Activity					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
A **Natural Resources**	K.ESS3.A.1 Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.				4.ESS3.A.1 Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans. [Clarification Statement: Examples of solutions could include designing an earthquake resistant building and improving monitoring of volcanic activity.]	

	ESS3 - Earth and Human Activity					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
B **Natural Hazards**				3.ESS3.B.1 Make a claim about the merit of an existing design solution (e.g. levies, tornado shelters, sea walls, etc.) that reduces the impacts of a weather-related hazard. [Clarification Statement: Examples of design solutions to weather-related hazards could include barriers to prevent flooding, wind resistant roofs, and lightning rods.]		

	ESS3 - Earth and Human Activity					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
C **Human Impacts on Earth's Systems**	K.ESS3.C.1 Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.					5. ESS3.C.1 Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

	ETS1 - Engineering Design					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
A **Defining and Delimiting Engineering Problems**	K.ETS1.A.1 Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.	1.ETS1.A.1 Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.	2.ETS1.A.1 Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.	3.ETS1.A.1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.	4.ETS1.A.1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.	5.ETS1.A.1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

	ETS1 - Engineering Design					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
B **Developing Possible Solutions**	K.ETS1.B.1 Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.	1.ETS1.B.1 Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.	2.ETS1.B.1 Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.	3.ETS1.B.1 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.	4.ETS1.B.1 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.	5.ETS1.B.1 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

	ETS1 - Engineering Design					
	Grade K	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
C **Optimizing the Solution Process**	K.ETS1.C.1 Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.	1.ETS1.C.1 Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.	2.ETS1.C.1 Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.	3.ETS1.C.1 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.	4.ETS1.C.1 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.	5.ETS1.C.1 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

6-12 Science Grade-Level Expectations

Missouri Department of Elementary and Secondary Education
Spring 2016

PS1 - Matter and Its Interactions		
Concept	**Middle School**	**High School**
A	6-8.PS1.A.1 Develop models to describe the atomic composition of simple molecules and extended structures. [Clarification Statement: Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or diamonds. Examples of molecular-level models could include drawings, 3D ball and stick structures, or computer representations showing different molecules with different types of atoms. 6-8.PS1.A.2 Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. [Clarification Statement: Examples of reactions could include burning sugar or steel wool, fat reacting with sodium hydroxide, and mixing zinc with hydrogen chloride.] 6-8.PS1.A.3 Gather, analyze, and present information to describe that synthetic materials come from natural resources and how they impact society. [Clarification Statement: Emphasis is on natural resources that undergo a chemical process to form the synthetic material. Examples of new materials could include new medicine, foods, and alternative fuels.] 6-8.PS1.A.4 Develop a model that describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. [Clarification Statement: Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawings and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.]	9-12.PS1.A.1 Use the organization of the periodic table to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. [Clarification Statement: Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.] 9-12.PS1.A.2Construct and revise an explanation for the products 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. [Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, or of oxygen and hydrogen.] 9-12.PS1.A.3 Plan and conduct an investigation to gather evidence to compare physical and chemical properties of substances such as melting point, boiling point, vapor pressure, surface tension, and chemical reactivity to infer the relative strength of attractive forces between particles. [Clarification Statement: Emphasis is on understanding the relative strengths of forces between particles. Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). 9-12.PS1.A.4 Apply the concepts of bonding and crystalline/molecular structure to explain the macroscopic properties of various categories of structural materials, i.e. metals, ionic (ceramics), and polymers. [Clarification Statement: Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.] 9-12.PS1.A.5 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. [Clarification Statement: Emphasis is on the idea that a chemical reaction is a system that affects the energy change. Examples of models could include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved.]
Structure and Properties of Matter		

B **Chemical reactions**	6-8.PS1.B.1 Develop and use a model to describe how the total number of atoms remains the same during a chemical reaction and thus mass is conserved. [Clarification Statement: Emphasis is on law of conservation of matter and on physical models or drawings, including digital forms that represent atoms.] 6-8.PS1.B.2 Construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes. [Clarification Statement: Emphasis is on the design, controlling the transfer of energy to the environment, and modification of a device using factors such as type and concentration of a substance. Examples of designs could involve chemical reactions such as dissolving ammonium chloride or calcium chloride.]	9-12.PS1.B.1 Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. [Clarification Statement: Emphasis is on student reasoning that focuses on the number and energy of collisions between molecules.] 9-12.PS1.B.2 Refine the design of a chemical system by specifying a change in conditions that would alter the amount of products at equilibrium. [Clarification Statement: Emphasis is on the application of Le Chatelier's Principle and on refining designs of chemical reaction systems, including descriptions of the connection between changes made at the macroscopic level and what happens at the molecular level. Examples of designs could include different ways to increase product formation including adding reactants or removing products.] 9-12.PS1.B.3 Use symbolic representations and mathematical calculations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. [Clarification Statement: Emphasis is on conservation of matter and mass through balanced chemical equations, use of the mole concept and proportional relationships.]
C **Nuclear Process**		9-12.PS1.C.1 Use symbolic representations 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. [Clarification Statement: Emphasis is on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations.]

PS2 - Motion and Stability: Forces and Interactions		
Concept	**Middle School**	**High School**
A **Forces and Motion**	6-8.PS2.A.1 Apply physics principles to design a solution that minimizes the force of an object during a collision and develop an evaluation of the solution. 6-8.PS2.A.2 Plan and conduct an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. [Clarification Statement: Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton's Second Law), frame of reference, and specification of units.]	9-12.PS2.A.1 Analyze data to support and verify the concepts expressed by Newton's 2nd law of motion, as it describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. [Clarification Statement: Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object rolling down a ramp, or a moving object being pulled by a constant force.] 9-12.PS2.A.2 Use mathematical representations to support and verify the concepts that the total momentum of a system of objects is conserved when there is no net force on the system. [Clarification Statement: Emphasis is on the quantitative conservation of momentum in interactions and the qualitative meaning of this principle.] 9-12.PS2.A.3 Apply scientific principles of motion and momentum to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. [Clarification Statement: Examples of evaluation and refinement could include determining the success of the device at protecting an object from damage and modifying the design to improve it. Examples of a device could include a football helmet or a parachute.]

B **Types of Interaction**	6-8.PS2.B.1 Analyze diagrams and collect data to determine the factors that affect the strength of electric and magnetic forces. [Clarification Statement: Examples of devices that use electric and magnetic forces could include electromagnets, electric motors, or generators. Examples of data could include the effect of the number of turns of wire on the strength of an electromagnet, or the effect of increasing the number or strength of magnets on the speed of an electric motor.] 6-8.PS2.B.2 Create and analyze a graph to use as evidence to support the claim that gravitational interactions depend on the mass of interacting objects. [Clarification Statement: Examples of evidence for arguments could include data generated from simulations or digital tools; and charts displaying mass, strength of interaction, distance from the sun, and orbital periods of objects within the solar system.] 6-8.PS2.B.3 Conduct an investigation and evaluate the experimental design to provide evidence that electric and magnetic fields exist between objects exerting forces on each other even though the objects are not in contact. . [Clarification Statement: Examples of this phenomenon could include the interactions of magnets, electrically-charged strips of tape, and electrically-charged pith balls. Examples of investigations could include first-hand experiences or simulations.]	9-12.PS2.B.1 Use mathematical representations of Newton's Law of Gravitation to describe and predict the gravitational forces between objects. [Clarification Statement: Emphasis is on both quantitative and conceptual descriptions of gravitational fields.] 9-12.PS2.B.2 Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.

PS3 - Energy		
Concept	**Middle School**	**High School**
A **Definitions of Energy**	6-8.PS3.A.1 Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object. [Clarification Statement: Emphasis is on descriptive relationships between kinetic energy and mass separately from kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different sizes of rocks downhill, and getting hit by a whiffle ball versus a tennis ball.] 6-8.PS3.A.2 Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system. [Clarification Statement: Emphasis is on relative amounts of potential energy, not on calculations of potential energy. Examples of objects within systems interacting at varying distances could include: the Earth and either a roller coaster cart at varying positions on a hill or objects at varying heights on shelves, changing the direction/orientation of a magnet, and a balloon with static electrical charge being brought closer to a classmate's hair. Examples of models could include representations, diagrams, pictures, and written descriptions of systems.] 6-8.PS3.A.3 Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. [Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.] 6-8.PS3.A.4 Plan and conduct an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the temperature of the sample. [Clarification Statement: Examples of experiments could include comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass as they cool or heat in the environment, or the same material with different masses when a specific amount of energy is added.]	9-12.PS3.A.1 Create a computational model to calculate the change in the energy of one component in a system when the changes in energy are known. [Clarification Statement: Emphasis is on explaining the meaning of mathematical expressions used in the model.] 9-12.PS3.A.2 Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects). [Clarification Statement: Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an object above the earth, and the energy stored between two electrically-charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations.] 9-12.PS3.A.3 Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. [Clarification Statement: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency.]

B **Conservation of Energy and Energy Transfer**	6-8.PS3.B.1 Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object. [Clarification Statement: Examples of empirical evidence used in arguments could include an inventory or other representation of the energy before and after the transfer in the form of temperature changes or motion of object.]	9-12.PS3.B.1 Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). [Clarification Statement: Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.]

C **Relationship Between Energy and Forces**		9-12.PS3.C.1 Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. . [Clarification Statement: Examples of models could include drawings, diagrams, and texts, such as drawings of what happens when two charges of opposite polarity are near each other.]
D **Energy in Chemical Process and Everyday Life**		

PS4 - Waves and Their Applications in Technologies for Information Transfer		
Concept	**Middle School**	**High School**
A **Wave Properties**	6-8.PS4.A.1Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave. [Clarification Statement: Emphasis is on describing waves with both qualitative and quantitative thinking.] 6-8.PS4.A.2 Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. [Clarification Statement: Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions.]	9-12.PS4.A.1 Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. [Clarification Statement: Examples of data could include electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the Earth.] 9-12.PS4.A.2 Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other. [Clarification Statement: Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include resonance, interference, diffraction, and photoelectric effect.]
B **Electromagnetic Radiation**		9-12.PS4.B.1 Communicate technical information about how electromagnetic radiation interacts with matter. [Clarification Statement: Examples could include solar cells capturing light and converting it to electricity; medical imaging; and communications technology.] 9-12.PS4.B.2 Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter. [Clarification Statement: Emphasis is on the idea that photons associated with different frequencies of light have different energies, and the damage to living tissue from electromagnetic radiation depends on the energy of the radiation. Examples of published materials could include trade books, magazines, web resources, videos, and other passages that may reflect bias.]

LS1 - From Molecules to Organisms: Structure and Processes		
Concept	**Middle School**	**High School**
A	6-8.LS1.A.1 Provide evidence that organisms (unicellular and multicellular) are made of cells and that a single cell must carry out all of the basic functions of life. [Clarification Statement: Emphasis is on developing evidence that living things are made of cells, distinguishing between living and non-living things, and understanding that living things may be made of one cell or many and varied cells.]	9-12.LS1.A.1 Construct a model of how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells. [Clarification Statement: Genes are the regions in DNA that code for proteins. Basic transcription and translation explain the roles of DNA and RNA in coding the instructions for making polypeptides.]
Structure and Function	6-8.LS1.A.2 Develop and use a model to describe the function of a cell as a whole and ways parts of the cells contribute to that function. [Clarification Statement: Emphasis is on the cell functioning as a whole system and the primary role of identified parts of the cell, specifically the nucleus, chloroplasts, mitochondria, cell membrane, and cell wall.]	9-12.LS1.A.2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. [Clarification Statement: Emphasis is on functions at the organism system level such as nutrient uptake, water delivery, and organism movement in response to stimuli.]
	6-8.LS1.A.3 Develop an argument supported by evidence for how multicellular organisms are organized by varying levels of complexity; cells, tissue, organs, organ systems.	9-12.LS1.A.3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. [Clarification Statement: Examples of investigations could include heart rate response to exercise, stomata response to moisture and temperature, and root development in response to water levels.]
	6-8.LS1.A.4 Present evidence that body systems interact to carry out key body functions, including providing nutrients and oxygen to cells, removing carbon dioxide and waste from cells and the body, controlling body motion/activity and coordination, and protecting the body.	

B **Growth and Development of Organisms**	6-8.LS1.B.1 Construct an explanation for how characteristic animal behaviors as well as specialized plant structures affect the probability of successful reproduction of animals and plants respectively. [Clarification Statement: Examples of animal behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, herding of animals to protect young from predators, and vocalization of animals and colorful plumage to attract mates for breeding. Examples of animal behaviors that affect the probability of plant reproduction could include transferring pollen or seeds; and, creating conditions for seed germination and growth. Examples of plant structures that affect the probability of plant reproduction could include bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.] 6-8.LS1.B.2 Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. [Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.]	9-12.LS1.B.1 Develop and use models to communicate the role of mitosis, cellular division, and differentiation in producing and maintaining complex organisms. [Clarification Statement: Major events of the cell cycle include cell growth, DNA replication, preparation for division, separation of chromosomes, and separation of cell contents.]

C **Organization for Matter and Energy Flow in Organisms**	6-8.LS1.C.1 Construct a scientific explanation based on evidence for the role of photosynthesis and cellular respiration in the cycling of matter and flow of energy into and out of organisms.	9-12.LS1.C.1 Use a model to demonstrate how photosynthesis transforms light energy into stored chemical energy. [Clarification Statement: Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. Examples of models could include diagrams, chemical equations, and conceptual models.] 9-12.LS1.C.2 Use a model to demonstrate that cellular respiration is a chemical process whereby the bonds of molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy. [Clarification Statement: Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration.] 9-12.LS1.C.3 Construct and revise an explanation based on evidence that organic macromolecules are primarily composed of six elements, where carbon, hydrogen, and oxygen atoms may combine with nitrogen, sulfur, and phosphorus to form large carbon-based molecules. [Clarification Statement: Large carbon-based molecules included are proteins, carbohydrates, nucleic acids, and lipids.]
D **Information Processing**		

LS2 - Ecosystems: Interactions, Energy, and Dynamics		
Concept	**Middle School**	**High School**
A **Interdependent Relationships in Ecosystems**	6-8.LS2.A.1 Analyze and interpret data to provide evidence for the effects of resource availability on individual organisms and populations of organisms in an ecosystem. [Clarification Statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.]. 6-8.LS2.A.2 Construct an explanation that predicts the patterns of interactions among and between the biotic and abiotic factors in a given ecosystem. [Clarification Statement: Relationships may include competition, predation, and symbiosis.]	9-12.LS2.A.1 Explain how various biotic and abiotic factors affect the carrying capacity and biodiversity of an ecosystem using mathematical and/or computational representations. [Clarification Statement: Examples of biotic factors could include relationships among individuals (e.g., feeding relationships, symbioses, competition) and disease. Examples of abiotic factors could include climate and weather conditions, natural disasters, and availability of resources. Genetic diversity includes within a population and species within an ecosystem. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets.]
B **Cycles of matter and Energy Transfer in Ecosystems**	6-8.LS2.B.1 Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. [Clarification Statement: Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, including food chains and food webs.]	9-12.LS2.B.1 Construct and revise an explanation based on evidence that the processes of photosynthesis, chemosynthesis, and aerobic and anaerobic respiration are responsible for the cycling of matter and flow of energy through ecosystems and that environmental conditions restrict which reactions can occur. [Clarification Statement: Examples of environmental conditions can include the availability of sunlight or oxygen.] 9-12.LS2.B.2 Communicate the pattern of the cycling of matter and the flow of energy among trophic levels in an ecosystem. [Clarification Statement: Emphasis is on using a model of stored energy in biomass to describe the transfer of energy from one tropic level to another. Emphasis is on atoms and molecules as they move through an ecosystem.] 9-12.LS2.B.3 Use a model that illustrates the roles of photosynthesis, cellular respiration, decomposition, and combustion to explain the cycling of carbon in its various forms among the biosphere, atmosphere, hydrosphere, and geosphere. [Clarification Statement: The primary forms of carbon include carbon dioxide, hydrocarbons, waste, and biomass. Examples of models could include simulations and mathematical and conceptual models.]

C **Ecosyste6-8 Dynamics, Functioning and Resilience**	6-8.LS2.C.1Construct an argument supported by empirical evidence that explains how changes to physical or biological components of an ecosystem affect populations. [Clarification Statement: Emphasis is on recognizing patterns in data and making inferences about changes in populations, defining the boundaries of the system, and on evaluating empirical evidence supporting arguments about changes to ecosystems.] 6-8.LS2.C.2. Evaluate benefits and limitations of differing design solutions for maintaining an ecosystem. [Clarification Statement: Examples of design solutions could include water, land, and species protection, and the prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.]	9-12.LS2.C.1 Evaluate the claims, evidence, and reasoning that the interactions in ecosystems maintain relatively consistent populations of species while conditions remain stable, but changing conditions may result in new ecosystem dynamics. [Clarification Statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.] 9-12.LS2.C.2 Design, evaluate, and/or refine solutions that positively impact the environment and biodiversity. [Clarification Statement: Examples of solutions may include captive breeding programs, habitat restoration, pollution mitigation, energy conservation, agriculture and mining programs, and ecotourism.]
D **Social Interactions and Group Behavior**		

LS3 - Heredity: Inheritance and Variation of Traits		
Concept	**Middle School**	**High School**
A **Inheritance of Traits**		9-12.LS3.A.1 Develop and use models to clarify relationships about how DNA in the form of chromosomes is passed from parents to offspring through the processes of meiosis and fertilization in sexual reproduction.
B **Variation of Traits**		9-12.LS3.B.1 Compare and contrast asexual and sexual reproduction with regard to genetic information and variation in offspring 9-12.LS3.B.2 Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism. [Clarification Statement: Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins.] 9-12.LS3.B.3 Make and defend a claim that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) mutations occurring during replication, and/or (3) mutations caused by environmental factors. [Clarification Statement: Emphasis is on using data to support arguments for the way variation occurs.] 9-12.LS3.B.4 Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population. [Clarification Statement: Emphasis is on the use of mathematics (Punnett Squares) to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits.]

LS4 - Biological Evolution; Unity and Diversity		
Concept	**Middle School**	**High School**
A **Evidence of Common Ancestry and Diversity**	6-8.LS4.A.1 Analyze and interpret evidence from the fossil record to infer patterns of environmental change resulting in extinction and changes to life forms throughout the history of the Earth. [Clarification Statement: Examples of evidence include sets of fossils that indicate an environment, anatomical structures that indicate the function of an organism in the environment, and fossilized tracks that indicate behavior of organisms.]	9-12.LS4.A.1 Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. (Clarification statement: Emphasis is on a conceptual understanding of the role each line of evidence has relating to common ancestry and biological evolution. Examples of evidence could include similarities in DNA sequences, anatomical structures, and order of appearance of structures in embryological development. Communicate could mean written report, oral discussion, etc.) 9-12.LS4.A.2 Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy. [Clarification Statement: Emphasis is on inferring general patterns of relatedness among embryos of different organisms by comparing the macroscopic appearance of diagrams or pictures.]
B	6-8.LS4.B.1 Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment. [Clarification Statement: Emphasis is on using simple probability statements and proportional reasoning to construct explanations.] 6-8.LS4.B.2 Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. [Clarification Statement: Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, and farming practices).]	9-12.LS4.B.1 Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment. (Clarification Statement: Emphasis is on using evidence to explain the influence each of the four factors has on number of organisms, behaviors, morphology, or physiology in terms of ability to compete for limited resources and subsequent survival of individuals and adaptation of species. Examples of evidence could include mathematical models such as simple distribution graphs and proportional reasoning.)

Natural Selection		9-12.LS4.B.2 Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait. [Clarification Statement: Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations.]

C	6-8.LS4.C.1 Interpret graphical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.	9-12.LS4.C.1 Construct an explanation based on evidence for how natural selection leads to adaptation of populations. [Clarification Statement: Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations.] 9-12.LS4.C.2 Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species. [Clarification statement: Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, fishing, and application of fertilizers, droughts, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.] 9-12.LS4.C.3 Create or revise a model to test a solution to mitigate adverse impacts of human activity on biodiversity. [Clarification Statement: Emphasis is on designing solutions for a proposed problem related to threatened or endangered species, or to genetic variation of organisms for multiple species.]
Adaptation		

D		
Biodiversity and Humans		

ESS1 - Earth's Place in the Universe		
Concept	**Middle School**	**High School**
A **The Universe and its Stars**	6-8.ESS1.A.1 Develop and use a model of the Earth-sun-moon system to explain the cyclic patterns of lunar phases and eclipses of the sun and moon. [Clarification Statement: Examples of models can be physical, graphical, or conceptual and should emphasize relative positions and distances.] 6-8.ESS1.A.2 Develop and use a model of the Earth-sun system to explain the cyclical pattern of seasons, which includes the Earth's tilt and directional angle of sunlight on different areas of Earth across the year. [Clarification Statement: Examples of models can be physical, graphical, or conceptual.] 6-8.ESS1.A.3 Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system. [Clarification Statement: Emphasis for the model is on gravity as the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. Examples of models can be physical or conceptual.]	9-12.ESS1.A.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 in the form of radiation. [Clarification Statement: Emphasis is on the energy transfer mechanisms that allow energy from nuclear fusion in the Sun's core to reach Earth. Examples of evidence for the model include observations of the masses and lifetimes of other stars, as well as the ways that the Sun's radiation varies due to sudden solar flares ("space weather").] 9-12.ESS1.A.2 Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe. [Clarification Statement: Emphasis is on the astronomical evidence of the red shift of light from galaxies as an indication that the universe is currently expanding, the cosmic microwave background as the remnant radiation from the Big Bang, and the observed composition of ordinary matter of the universe, primarily found in stars and interstellar gases (from the spectra of electromagnetic radiation from stars), which matches that predicted by the Big Bang theory (3/4 hydrogen and 1/4 helium).] 9-12.ESS1.A.3 Communicate scientific ideas about the way stars, over their life cycle, produce elements. [Clarification Statement: Emphasis is on the way nucleosynthesis, and therefore the different elements created, varies as a function of the mass of a star and the stage of its lifetime.]
B **Earth and the Solar System**	6-8.ESS1.B.1 Analyze and interpret data to determine scale properties of objects in the solar system. [Clarification Statement: Examples of scale properties include the sizes of an object's layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data include statistical information, drawings and photographs, and models.]	9-12.ESS1.B.1 Use Kepler's Law to predict the motion of orbiting objects in the solar system. [Clarification Statement: Emphasis is on Newtonian gravitational laws governing orbital motions, which apply to human-made satellites as well as planets and moons.]

C **The History of Planet Earth**	6-8.ESS1.C.1 Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's history. [Clarification Statement: Emphasis is on how analyses of rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history. Examples of Earth's major events could range from being very recent (such as the last Ice Age or the earliest fossils of homo sapiens) to very old (such as the formation of Earth or the earliest evidence of life). Examples can include the formation of mountain chains and ocean basins, the evolution or extinction of particular living organisms, or significant volcanic eruptions.]	9-12.ESS1.C.1 Evaluate evidence of the past and current movements of continental and oceanic crust, the theory of plate tectonics, and relative densities of oceanic and continental rocks to explain why continental rocks are generally much older than rocks of the ocean floor. [Clarification Statement: Examples include the ages of oceanic crust increasing with distance from mid-ocean ridges (a result of plate spreading) and the ages of North American continental crust increasing with distance away from a central ancient core (a result of past plate interactions).] 9-12.ESS1.C.2 Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history. [Clarification Statement: Emphasis is on using available evidence within the solar system to reconstruct the early history of Earth, which formed along with the rest of the solar system 4.6 billion years ago. Examples of evidence include the absolute ages of ancient materials (obtained by radiometric dating of meteorites, moon rocks, and Earth's oldest minerals), the sizes and compositions of solar system objects, and the impact cratering record of planetary surfaces.]

ESS2 - Earth's Systems		
Concept	**Middle School**	**High School**
A **Earth Materials and Systems**	6-8.ESS2.A.1 Develop and use a model to illustrate that energy from the Earth's interior drives convection which cycles Earth's crust leading to melting, crystallization, weathering and deformation of large rock formations, including generation of ocean sea floor at ridges, submergence of ocean sea floor at trenches, mountain building and active volcanic chains. [Clarification Statement: The emphasis is on large-scale cycling resulting from plate tectonics that includes changes in rock types through erosion, heat and pressure.] 6-8.ESS2.A.2 Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. [Clarification Statement: Emphasis is on how processes change Earth's surface at time and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges) or small (such as rapid landslides or microscopic geochemical reactions), and how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events. Examples of geoscience processes include surface weathering and deposition by the movements of water, ice, and wind. Emphasis is on geoscience processes that shape local geographic features, where appropriate.]	9-12.ESS2.A.1 Develop a model to illustrate how Earth's interior and surface processes (constructive and destructive) operate at different spatial and temporal scales to form continental and ocean-floor features. [Clarification Statement: Emphasis is on how the appearance of land features (such as mountains, valleys, and plateaus) and sea-floor features (such as trenches, ridges, and seamounts) are a result of both constructive forces (such as volcanism, tectonic uplift, and orogeny) and destructive mechanisms (such as weathering, mass wasting, and coastal erosion).] 9-12.ESS2.A.2 Analyze geoscientific data to make the claim that one change to Earth's surface can create changes to other Earth systems. 9-12.ESS2.A.3 Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection. [Clarification Statement: Emphasis is on both a one-dimensional model of Earth, with radial layers determined by density, and a three-dimensional model, which is controlled by mantle convection and the resulting plate tectonics. Examples of evidence include maps of Earth's three-dimensional structure obtained from seismic waves, records of the rate of change of Earth's magnetic field (as constraints on convection in the outer core), and identification of the composition of Earth's layers from high-pressure laboratory experiments. 9-12.ESS2.A.4 Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
B **Plate Tectonics and Large-Scale Systems**	6-8.ESS2.B.1 Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions. [Clarification Statement: Examples of data include similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, and trenches).]	[

C **The Role of Water in Earth's Surface Processes**	6-8.ESS2.C.1 Design and develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. [Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.] 6-8.ESS2.C.2 Research, collect, and analyze data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions. [Clarification Statement: Emphasis is on how air masses flow from regions of high pressure to low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time, and how sudden changes in weather can result when different air masses collide. Emphasis is on how weather can be predicted within possible ranges. Examples of data can be provided to students (such as weather maps, diagrams, and visualizations) or obtained through laboratory experiments (such as with condensation).] 6-8.ESS2.C.3 Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. [Clarification Statement: Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. Examples of models can be diagrams, maps and globes, or digital representations.]	9-12.ESS2.C.1 Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. Clarification Statement: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or ice wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids).]

D **Weather and Climate**		9-12.ESS2.D.1 Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. [Clarification Statement: Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.]

E **Biogeology**		9-12.ESS2.E.1 Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. [Clarification Statement: Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth's other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples of coevolution include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for new life.]

ESS3 - Earth and Human Activity		
Concept	**Middle School**	**High School**
A **Natural Resources**	6-8.ESS3.A.1 Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes and human activity. [Clarification Statement: Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).]	9-12.ESS3.A.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. [Clarification Statement: Examples of key natural resources include access to fresh water, regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather. Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.] 9-12.ESS3.A.2 Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on economic, social, and environmental cost-benefit ratios. [Clarification Statement: Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining (for coal, tar sands, and oil shale), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems—not what should happen.]

B **Natural Hazards**	6-8.ESS3.B.1 Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. [Clarification Statement: Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods). Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).]	
C **Human Impacts on Earth's Systems**	6-8.ESS3.C.1 Analyze data to define the relationship for how increases in human population and per-capita consumption of natural resources impact Earth's systems. [Clarification Statement: Examples of data include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change.] 6-8.ESS3.C.2 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. [Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).]	9-12.ESS3.C.1 Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. [Clarification Statement: Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning.] 9-12.ESS3.C.2 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems in order to restore stability and or biodiversity of the ecosystem as well as prevent their reoccurrences. [Clarification Statement: Examples of human activities could include forest fires, acid rain, flooding, urban development, pollution, deforestation, and introduction of an invasive species.]

D **Global Climate Change**	6-8.ESS3.D.1 Analyze evidence of the factors that have caused the change in global temperatures over the past century. [Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities.]	9-12.ESS3.D.1 Analyze geoscientific data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems. [Clarification Statement: Examples of evidence, for both data and climate model outputs, are for climate changes (such as precipitation and temperature) and their associated impacts (such as on sea level, glacial ice volumes, or atmosphere and ocean composition).] 9-12.ESS3.D.2 Predict how human activity affects the relationships between Earth systems in both positive and negative ways. [Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere.]

ETS1 - Engineering Design		
Concept	**Middle School**	**High School**
A **Defining and Delimiting Engineering Problems**	6-8.ETS1.A.1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions**.**	9-12.ETS1.A.1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. 9-12.ETS1.A.2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
B **Developing Possible Solutions**	6-8.ETS1.B.1 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. 6-8.ETS1.B.2 Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. 6-8.ETS1.B.3 Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	9-12.ETS1.B.1 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. 9-12.ETS1.B.2 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.
C **Optimizing the Solution Process**		