UTAH CORE STANDARDS

# UTAH SCIENCE WITH ENGINEERING EDUCATION (SEEd) STANDARDS

UTAH STATE OFFICE OF EDUCATION 250 EAST 500 SOUTH P.O. BOX 144200 SALT LAKE CITY, UTAH 84114-4200 BRAD SMITH, STATE SUPERINTENDENT OF PUBLIC INSTRUCTION

Utah STATE OFFICE of Education

# SCIENCE WITH ENGINEERING EDUCATION (SEEd) STANDARDS

## FOR UTAH

Adopted December 2015
by the
Utah State Board of Education

The Utah State Board of Education, in January of 1984, established policy requiring the identification of specific core standards to be met by all K–12 students in order to graduate from Utah's secondary schools. The Utah State Board of Education regularly updates the Utah Core Standards, while parents, teachers, and local school boards continue to control the curriculum choices that reflect local values.

The Utah Core Standards are aligned to scientifically based content standards. They drive high quality instruction through statewide comprehensive expectations for all students. The standards outline essential knowledge, concepts, and skills to be mastered at each grade level or within a critical content area. The standards provide a foundation for ensuring learning within the classroom.

# UTAH STATE BOARD OF EDUCATION

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8/2015

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## Science Literacy for All Students

Science is a way of knowing, a process for gaining knowledge and understanding of the natural world. Engineering combines the fields of science, technology, and mathematics to provide solutions to real-world problems. The nature and process of developing scientific knowledge and understanding includes constant questioning, testing, and refinement, which must be supported by evidence and has little to do with popular consensus. Since progress in the modern world is tied so closely to this way of knowing, scientific literacy is essential for a society to be competitively engaged in a global economy. Students should be active learners who demonstrate their scientific understanding by using it. It is not enough for students to read about science; they must participate in the three dimensions of science. They should observe, inquire, question, formulate and test hypotheses, analyze data, report, and evaluate findings. The students, as scientists, should have hands-on, active experiences throughout the instruction of the science curriculum. These standards help students find value in developing novel solutions as they engage with complex problems.

## Three Dimensions of Science[1]

Science education includes three dimensions of science understanding: science and engineering practices, crosscutting concepts, and disciplinary core ideas. Every standard includes each of the three dimensions; **Science and Engineering Practices are bolded**, <u>Crosscutting Concepts are underlined</u>, and Disciplinary Core Ideas are in normal font. Standards with *specific engineering expectations are italicized.*

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[1] NRC Framework K–12 Science Education: http://www.nap.edu/catalog.php?record_id=13165

## Organization of Standards

The Utah SEEd standards[2] are organized into **strands**, which represent significant areas of learning within content areas. Within each strand are **standards**. A standard is an articulation of the demonstrated proficiency to be obtained. A standard represents an essential element of the learning that is expected. While some standards within a strand may be more comprehensive than others, all standards are essential for mastery.

## Grade Six | Utah Science With Engineering Education (SEEd) Standards

The sixth grade SEEd standards provide a framework for student understanding of the cycling of matter and the flow of energy through the study of observable phenomena on Earth. Students will explore the role of energy and gravity in the solar system as they compare the scale and properties of objects in the solar system and model the Sun-Earth-Moon system. These strands also emphasize heat energy as it affects some properties of matter, including states of matter and density. The relationship between heat energy and matter is observable in many phenomena on Earth, such as seasons, the water cycle, weather, and climates. Types of ecosystems on Earth are dependent upon the interaction of organisms with each other and with the physical environment. By researching interactions between the living and nonliving components of ecosystems, students will understand how the flow of energy and cycling of matter affects stability and change within their environment.

[2] Most SEEd Standards are based on the Next Generation Science Standards: http://www.nextgenscience.org

## Strand 6.1: STRUCTURE AND MOTION WITHIN THE SOLAR SYSTEM

The solar system consists of the Sun, planets, and other objects within Sun's gravitational influence. Gravity is the force of attraction between masses. The Sun-Earth-Moon system provides an opportunity to study interactions between objects in the solar system that influence phenomena observed from Earth. Scientists use data from many sources to determine the scale and properties of objects in our solar system.

- **Standard 6.1.1** **Develop and use a model** of the Sun-Earth-Moon system to describe the cyclic patterns of lunar phases, eclipses of the Sun and Moon, and seasons. Examples of models could be physical, graphical, or conceptual.

- **Standard 6.1.2** **Develop and use a model** to describe the role of gravity and inertia in orbital motions of objects in our solar system.

- **Standard 6.1.3** **Use computational thinking** to **analyze data** and determine the scale and properties of objects in the solar system. Examples of scale could include size and distance. Examples of properties could include layers, temperature, surface features, and orbital radius. Data sources could include Earth and space-based instruments such as telescopes and satellites. Types of data could include graphs, data tables, drawings, photographs, and models.

## Strand 6.2: ENERGY AFFECTS MATTER

Matter and energy are fundamental components of the universe. Matter is anything that has mass and takes up space. Transfer of energy creates change in matter. Changes between general states of matter can occur through the transfer of energy. Density describes how closely matter is packed together. Substances with a higher density have more matter in a given space than substances with a lower density. Changes in heat energy can alter the density of a material. Insulators resist the transfer of heat energy, while conductors easily transfer heat energy. These differences in energy flow can be used to design products to meet the needs of society.

- **Standard 6.2.1** **Develop models** to show that molecules are made of different kinds, proportions and quantities of atoms. Emphasize understanding that there are differences between atoms and molecules, and that certain combinations of atoms form specific molecules. Examples of simple molecules could include water ($H_2O$), atmospheric oxygen ($O_2$), and carbon dioxide ($CO_2$).

- **Standard 6.2.2** **Develop a model** to predict the effect of heat energy on states of matter and density. Emphasize the arrangement of particles in states of matter (solid, liquid, or gas) and during phase changes (melting, freezing, condensing, and evaporating).

- **Standard 6.2.3** **Plan and carry out an investigation** to determine the relationship between temperature, the amount of heat transferred, and the change of average particle motion in various types or amounts of matter. Emphasize recording and evaluating data, and communicating the results of the investigation.

- **Standard 6.2.4** ***Design*** *an object, tool, or process* that minimizes or maximizes heat energy transfer. *Identify criteria and constraints, develop a prototype for iterative testing, analyze data from testing, and propose modifications for optimizing the* ***design solution***. Emphasize demonstrating how the structure of differing materials allows them to function as either conductors or insulators.

## Strand 6.3: EARTH'S WEATHER PATTERNS AND CLIMATE

All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. Heat energy from the Sun, transmitted by radiation, is the primary source of energy that affects Earth's weather and drives the water cycle. Uneven heating across Earth's surface causes changes in density, which result in convection currents in water and air, creating patterns of atmospheric and oceanic circulation that determine regional and global climates.

- **Standard 6.3.1** **Develop a model** to describe how the cycling of water through Earth's systems is driven by energy from the Sun, gravitational forces, and density.
- **Standard 6.3.2** **Investigate** the interactions between air masses that cause changes in weather conditions. Collect and analyze weather data to provide evidence for how air masses flow from regions of high pressure to low pressure causing a change in weather. Examples of data collection could include field observations, laboratory experiments, weather maps, or diagrams.
- **Standard 6.3.3** **Develop and use a model** to show how unequal heating of the Earth's systems causes patterns of atmospheric and oceanic circulation that determine regional climates. Emphasize how warm water and air move from the equator toward the poles. Examples of models could include Utah regional weather patterns such as lake-effect snow and wintertime temperature inversions.
- **Standard 6.3.4** **Construct an explanation supported by evidence** for the role of the natural greenhouse effect in Earth's energy balance, and how it enables life to exist on Earth. Examples could include comparisons between Earth and other planets such as Venus and Mars.

## Strand 6.4: STABILITY AND CHANGE IN ECOSYSTEMS

The study of ecosystems includes the interaction of organisms with each other and with the physical environment. Consistent interactions occur within and between species in various ecosystems as organisms obtain resources, change the environment, and are affected by the environment. This influences the flow of energy through an ecosystem, resulting in system variations. Additionally, ecosystems benefit humans through processes and resources, such as the production of food, water and air purification, and recreation opportunities. Scientists and engineers investigate interactions among organisms and evaluate design solutions to preserve biodiversity and ecosystem resources.

- **Standard 6.4.1** **Analyze data** to provide evidence for the effects of resource availability on organisms and populations in an ecosystem. **Ask questions** to predict how changes in resource availability affects organisms in those ecosystems. Examples could include water, food, and living space in Utah environments.
- **Standard 6.4.2** **Construct an explanation** that predicts patterns of interactions among organisms across multiple ecosystems. Emphasize consistent interactions in different environments, such as competition, predation, and mutualism.
- **Standard 6.4.3** **Develop a model** to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. Emphasize food webs and the role of producers, consumers, and decomposers in various ecosystems. Examples could include Utah ecosystems such as mountains, Great Salt Lake, wetlands, and deserts.
- **Standard 6.4.4** **Construct an argument supported by evidence** that the stability of populations is affected by changes to an ecosystem. Emphasize how changes to living and nonliving components in an ecosystem affect populations in that ecosystem. Examples could include Utah ecosystems such as mountains, Great Salt Lake, wetlands, and deserts.
- **Standard 6.4.5** *Evaluate competing design solutions* for preserving ecosystem services that protect resources and biodiversity based on how well the solutions maintain stability within the ecosystem. Emphasize **obtaining, evaluating, and communicating** information of differing design solutions. Examples could include policies affecting ecosystems, responding to invasive species or solutions for the preservation of ecosystem resources specific to Utah, such as air and water quality and prevention of soil erosion.

# INTRODUCTION | GRADE 7

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## Grade Seven | Utah Science With Engineering Education (SEEd) Standards

The seventh grade SEEd standards look for relationships of cause and effect which enable students to pinpoint mechanisms of nature and allow them to make predictions. Students will explore how forces can cause changes in motion and are responsible for the transfer of energy and the cycling of matter. This takes place within and between a wide variety of systems, from simple, short-term forces on individual objects to the deep, long- term forces that shape our planet. In turn, Earth's environments provide the conditions for life as we know it. Organisms survive and reproduce only to the extent that their own mechanisms and adaptations allow. Evidence for the evolutionary histories of life on Earth is provided through the fossil record, similarities in the various structures among species, organism development, and genetic similarities across all organisms. Additionally, mechanisms shaping Earth are understood as forces affecting the cycling of Earth's materials. Questions about cause and effect and the ongoing search for evidence in science, or science's ongoing search for evidence, drive this storyline.

[2] Most SEEd Standards are based on the Next Generation Science Standards: http://www.nextgenscience.org

## Strand 7.1: FORCES ARE INTERACTIONS BETWEEN MATTER

Forces are push or pull interactions between two objects. Changes in motion, balance and stability, and transfers of energy are all facilitated by forces on matter. Forces, including electric, magnetic, and gravitational forces, can act on objects that are not in contact with each other. Scientists use data from many sources to examine the cause and effect relationships determined by different forces.

- **Standard 7.1.1** **Carry out an investigation** which provides evidence that a change in an object's motion is dependent on the mass of the object and the sum of the forces acting on it. *Various experimental designs should be evaluated to determine how well the investigation measures an object's motion.* Emphasize conceptual understanding of Newton's First and Second Laws. Calculations will only focus on one-dimensional movement; the use of vectors will be introduced in high school.

- **Standard 7.1.2** Apply Newton's Third Law to ***design a solution*** *to a problem involving the motion of two colliding objects in a system*. Examples could include collisions between two moving objects or between a moving object and a stationary object.

- **Standard 7.1.3** **Construct a model** using observational evidence to describe the nature of fields existing between objects that exert forces on each other even though the objects are not in contact. Emphasize the cause and effect relationship between properties of objects (such as magnets or electrically-charged objects) and the forces they exert.

- **Standard 7.1.4** **Collect and analyze data** to determine the factors that affect the strength of electric and magnetic forces. Examples 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 of increasing the number or strength of magnets on the speed of an electric motor.

- **Standard 7.1.5** **Engage in argument from evidence** to support the claim that gravitational interactions within a system are attractive and dependent upon the masses of interacting objects. Examples of evidence for arguments could include mathematical data generated from various simulations.

## Strand 7.2: CHANGES TO EARTH OVER TIME

Earth's processes are dynamic and interactive, and are the result of energy flowing and matter cycling within and among Earth's systems. Energy from the sun and Earth's internal heat are the main sources driving these processes. Plate tectonics is a unifying theory that explains crustal movements of Earth's surface, how and where different rocks form, the occurrence of earthquakes and volcanoes, and the distribution of fossil plants and animals.

- **Standard 7.2.1** **Develop a model** of the rock cycle to describe the relationship between energy flow and matter cycling that create igneous, sedimentary, and metamorphic rocks. Emphasize the processes of melting, crystallization, weathering, deposition, sedimentation, and deformation, which act together to form minerals and rocks.

- **Standard 7.2.2** **Construct an explanation** based on evidence for how processes have changed Earth's surface at varying time and spatial scales. Examples of processes that occur at varying time scales could include slow plate motions or rapid landslides. Examples of processes that occur at varying spatial scales could include uplift of a mountain range or deposition of fine sediments.

- **Standard 7.2.3** **Ask questions** to *identify constraints* of specific geologic hazards and *evaluate competing design solutions* for maintaining the stability of human-engineered structures, such as homes, roads, and bridges. Examples of geologic hazards could include earthquakes, landslides, or floods.

- **Standard 7.2.4** **Develop and use a scale model** of the matter in the Earth's interior to demonstrate how differences in density and chemical composition (silicon, oxygen, iron, and magnesium) cause the formation of the crust, mantle, and core.

- **Standard 7.2.5** **Ask questions and analyze and interpret data** about the patterns between plate tectonics and:

  **(1)** The occurrence of earthquakes and volcanoes.

  **(2)** Continental and ocean floor features.

  **(3)** The distribution of rocks and fossils.

  Examples could include identifying patterns on maps of earthquakes and volcanoes relative to plate boundaries, the shapes of the continents, the locations of ocean structures (including mountains, volcanoes, faults, and trenches), and similarities of rock and fossil types on different continents.

- **Standard 7.2.6** **Make an argument from evidence** for how the geologic time scale shows the age and history of Earth. Emphasize scientific evidence from rock strata, the fossil record, and the principles of relative dating, such as superposition, uniformitarianism and recognizing unconformities.

## Strand 7.3: STRUCTURE AND FUNCTION OF LIFE

Living things are made of smaller structures, which function to meet the needs of survival. The basic structural unit of all living things is the cell. Parts of a cell work together to function as a system. Cells work together and form tissues, organs, and organ systems. Organ systems interact to meet the needs of the organism.

- **Standard 7.3.1** **Plan and carry out an investigation** that provides evidence that the basic structures of living things are cells. Emphasize that cells can form single-celled or multicellular organisms, and that multicellular organisms are made of different types of cells.
- **Standard 7.3.2** **Develop and use a model** to describe the function of a cell in living systems and the way parts of cells contribute to cell function. Emphasize the cell as a system, including the interrelating roles of the nucleus, chloroplasts, mitochondria, cell membrane, and cell wall.
- **Standard 7.3.3** **Construct an explanation** using evidence to explain how body systems have various levels of organization. Emphasize understanding that cells form tissues, tissues form organs, and organs form systems specialized for particular body functions. Examples could include relationships between the circulatory, excretory, digestive, respiratory, muscular, skeletal, and nervous systems. Specific organ functions will be taught at the high school level.

## Strand 7.4: REPRODUCTION AND INHERITANCE

The great diversity of species on Earth is a result of genetic variation. Genetic traits are passed from parent to offspring. These traits affect the structure and behavior of organisms, which affect the organism's ability to survive and reproduce. Mutations can cause changes in traits that may affect an organism. As technology has developed, humans have been able to change the inherited traits in organisms, which may have an impact on society.

- **Standard 7.4.1** **Develop and use a model** to explain the effects that different types of reproduction have on genetic variation, including asexual and sexual reproduction.

- **Standard 7.4.2** **Obtain, evaluate, and communicate** information about specific animal and plant adaptations and structures that affect the probability of successful reproduction. Examples of adaptations could include nest building to protect young from the cold, herding of animals to protect young from predators, vocalization of animals and colorful plumage to attract mates for breeding, 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.

- **Standard 7.4.3** **Develop and use a model** to describe why genetic mutations may result in harmful, beneficial, or neutral effects to the structure and function of the organism. Emphasize the conceptual idea that changes to traits can happen because of genetic mutations. Specific changes of genes at the molecular level, mechanisms for protein synthesis, and specific types of mutations will be introduced at the high school level.

- **Standard 7.4.4** **Obtain, evaluate, and communicate** information about the technologies that have changed the way humans affect the inheritance of desired traits in organisms. *Analyze data from tests or simulations to determine the best solution to achieve success* in cultivating selected desired traits in organisms. Examples could include artificial selection, genetic modification, animal husbandry, and gene therapy.

## Strand 7.5: CHANGES IN SPECIES OVER TIME

Genetic variation and the proportion of traits within a population can change over time. These changes can result in evolution through natural selection. Additional evidence of change over time can be found in the fossil record, anatomical similarities and differences between modern and ancient organisms, and embryological development.

- **Standard 7.5.1** **Construct an explanation** that describes how the genetic variation of traits in a population can affect some individuals' probability of surviving and reproducing in a specific environment. Over time, specific traits may increase or decrease in populations. Emphasize the use of proportional reasoning to support explanations of trends in changes to populations over time. Examples could include camouflage, variation of body shape, speed and agility, or drought tolerance.

- **Standard 7.5.2** **Analyze and interpret data** for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth, under the assumption that natural laws operate today as in the past.

- **Standard 7.5.3** **Construct explanations** that describe the patterns of body structure similarities and differences between modern organisms, and between ancient and modern organisms, to infer possible evolutionary relationships.

- **Standard 7.5.4** **Analyze data** to compare patterns in the embryological development across multiple species to identify similarities and differences not evident in the fully formed anatomy.

# INTRODUCTION | GRADE 8

## Science Literacy for All Students

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## Grade Eight | Utah Science with Engineering Education (SEEd) Standards

The eighth grade SEEd standards describe the constant interaction of matter and energy in nature. Students will explore how matter is arranged into either simple or complex substances. The strands emphasize how substances store and transfer energy, which can cause them to interact physically and chemically, provide energy to living organisms, or be harnessed and used by humans. Matter and energy cycle and change in ecosystems through processes that occur during photosynthesis and cellular respiration. Additionally, substances that provide a benefit to organisms, including humans, are unevenly distributed on Earth due to geologic and atmospheric systems. Some resources form quickly, allowing them to be renewable, while other resources are nonrenewable. Evidence reveals that Earth systems change and affect ecosystems and organisms in positive and negative ways.

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## Strand 8.1: MATTER AND ENERGY INTERACT IN THE PHYSICAL WORLD

The physical world is made of atoms and molecules. Even large objects can be viewed as a combination of small particles. Energy causes particles to move and interact physically or chemically. Those interactions create a variety of substances. As molecules undergo a chemical or physical change, the number of atoms in that system remains constant. Humans use energy to refine natural resources into synthetic materials.

- **Standard 8.1.1** **Develop a model** to describe the scale and proportion of atoms and molecules. Emphasize developing atomic models of elements and their numbers of protons, neutrons, and electrons, as well as models of simple molecules. Topics like valence electrons, bond energy, ionic complexes, ions, and isotopes will be introduced at the high school level.

- **Standard 8.1.2** **Obtain** information about various properties of matter, **evaluate** how different materials' properties allow them to be used for particular functions in society, and **communicate** your findings. Emphasize general properties of matter. Examples could include color, density, flammability, hardness, malleability, odor, ability to rust, solubility, state, or the ability to react with water.

- **Standard 8.1.3** **Plan and conduct an investigation** and then **analyze and interpret the data** to identify patterns in changes in a substance's properties to determine whether a chemical reaction has occurred. Examples could include changes in properties such as color, density, flammability, odor, solubility, or state.

- **Standard 8.1.4** **Obtain and evaluate information** to describe how synthetic materials come from natural resources, what their functions are, and how society uses these new materials. Examples of synthetic materials could include medicine, foods, building materials, plastics, and alternative fuels.

- **Standard 8.1.5** **Develop a model** that uses **computational thinking** to illustrate cause and effect relationships in particle motion, temperature, density, and state of a pure substance when heat energy is added or removed. Emphasize molecular-level models of solids, liquids, and gases to show how adding or removing heat energy can result in phase changes, and focus on calculating the density of a substance's state.

- **Standard 8.1.6** **Develop a model** to describe how the total number of atoms does not change in a chemical reaction, indicating that matter is conserved. Emphasize demonstrations of an understanding of the law of conservation of matter. Balancing equations and stoichiometry will be learned at the high school level.

- **Standard 8.1.7** **Design, construct,** and **test** a device that can affect the rate of a phase change. *Compare and identify the best characteristics of competing devices and modify them based on* ***data analysis*** *to improve the device to better meet the criteria for success.*

## Strand 8.2: ENERGY IS STORED AND TRANSFERRED IN PHYSICAL SYSTEMS

Objects can store and transfer energy within systems. Energy can be transferred between objects, which involves changes in the object's energy. There is a direct relationship between an object's energy, mass, and velocity. Energy can travel in waves and may be harnessed to transmit information.

- **Standard 8.2.1** **Use computational thinking** to **analyze data** about the relationship between the mass and speed of objects and the relative amount of kinetic energy of the objects. Emphasis should be on the quantity of mass and relative speed to the observable effects of the kinetic energy. Examples could include a full cart vs. an empty cart or rolling spheres with different masses down a ramp to measure the effects on stationary masses. Calculations of kinetic and potential energy will be learned at the high school level.

- **Standard 8.2.2** **Ask questions** about how the amount of potential energy varies as distance within the system changes. **Plan and conduct an investigation** to answer a question about potential energy. Emphasize comparing relative amounts of energy. Examples could include a cart at varying positions on a hill or an object being dropped from different heights. Calculations of kinetic and potential energy will be learned at the high school level.

- **Standard 8.2.3** **Engage in argument** to identify the strongest evidence that supports the claim that the kinetic energy of an object changes as energy is transferred to or from the object. Examples could include observing temperature changes as a result of friction, applying force to an object, or releasing potential energy from an object.

- **Standard 8.2.4** **Use computational thinking** to describe a simple model for waves that shows the pattern of wave amplitude being related to wave energy. Emphasize describing waves with both quantitative and qualitative thinking. Examples could include using graphs, charts, computer simulations, or physical models to demonstrate amplitude and energy correlation.

- **Standard 8.2.5** **Develop and use a model** to describe the structure of waves and how they are reflected, absorbed, or transmitted through various materials. Emphasize both light and mechanical waves. Examples could include drawings, simulations, and written descriptions of light waves through a prism; mechanical waves through gas vs. liquids vs. solids; or sound waves through different mediums.

- **Standard 8.2.6** **Obtain and evaluate information to communicate** the claim that the structure of digital signals are a more reliable way to store or transmit information than analog signals. Emphasize the basic understanding that waves can be used for communication purposes. Examples could include using vinyl record vs. digital song files, film cameras vs. digital cameras, or alcohol thermometers vs. digital thermometers.

## Strand 8.3: LIFE SYSTEMS STORE AND TRANSFER MATTER AND ENERGY

Living things use energy from their environment to rearrange matter to sustain life. Photosynthetic organisms are able to transfer light energy to chemical energy. Consumers can break down complex food molecules to utilize the stored energy and use the particles to form new, life-sustaining molecules. Ecosystems are examples of how energy can flow while matter cycles through the living and nonliving components of systems.

- **Standard 8.3.1** **Plan and conduct an investigation** and **use the evidence to construct an explanation** of how photosynthetic organisms use energy to transform matter. Emphasize molecular and energy transformations during photosynthesis.
- **Standard 8.3.2** **Develop a model** to describe how food is changed through chemical reactions to form new molecules that support growth and/or release energy as matter cycles through an organism. Emphasis is on describing that during cellular respiration molecules are broken apart and rearranged into new molecules, and that this process releases energy.
- **Standard 8.3.3** **Ask questions** to **obtain, evaluate, and communicate information** about how changes to an ecosystem affect the stability of cycling matter and the flow of energy among living and nonliving parts of an ecosystem. Emphasize describing the cycling of matter and flow of energy through the carbon cycle.

## Strand 8.4: INTERACTIONS WITH NATURAL SYSTEMS AND RESOURCES

Interactions of matter and energy through geologic processes have led to the uneven distribution of natural resources. Many of these resources are nonrenewable, and per-capita use can cause positive or negative consequences. Global temperatures change due to various factors, and can cause a change in regional climates. As energy flows through the physical world, natural disasters can occur that affect human life. Humans can study patterns in natural systems to anticipate and forecast some future disasters and work to mitigate the outcomes.

- **Standard 8.4.1** **Construct a scientific explanation** based on evidence that shows that the uneven distribution of Earth's mineral, energy, and groundwater resources is caused by geological processes. Examples of uneven distribution of resources could include Utah's unique geologic history that led to the formation and irregular distribution of natural resources like copper, gold, natural gas, oil shale, silver, and uranium.

- **Standard 8.4.2** **Engage in argument supported by evidence** about the effect of per-capita consumption of natural resources on Earth's systems. Emphasize that these resources are limited and may be non-renewable. Examples of evidence include rates of consumption of food and natural resources such as freshwater, minerals, and energy sources.

- **Standard 8.4.3** **Design a solution** to monitor or mitigate the potential effects of the use of natural resources. **Evaluate** competing design solutions *using a systematic process to determine how well each solution meets the criteria and constraints of the problem*. Examples of uses of the natural environment could include agriculture, conservation efforts, recreation, solar energy, and water management.

- **Standard 8.4.4** **Analyze and interpret data** on the factors that change global temperatures and their effects on regional climates. Examples of factors could include agricultural activity, changes in solar radiation, fossil fuel use, and volcanic activity. Examples of data could include graphs of the atmospheric levels of gases, seawater levels, ice cap coverage, human activities, and maps of global and regional temperatures.

- **Standard 8.4.5** **Analyze and interpret** patterns of the occurrence of natural hazards to forecast future catastrophic events, and investigate how data are used to develop technologies to mitigate their effects. Emphasize how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow prediction, but others, such as earthquakes, may occur without warning.

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