# Instructional Implications

To meet the goals of *Each Child, Our Future*, Ohio's strategic plan for education, schools and districts will find it essential to have appropriate local curricula supported by high-quality instructional materials. Science is part of providing well-rounded content for students, as well-rounded content is one of the four learning domains listed in the strategic plan.

Science is an essential subject for students in grades K-12. It is important to build a strong foundation in science in early elementary years so students are prepared for understanding more complex material in intermediate and middle grades. It is equally important to continue students' science instruction by offering more advanced courses at the high school level. This allows students to better compete for admission to college or other postsecondary programs, as well as jobs. Advanced science courses in high schools also help produce a more scientifically literate public.

This document outlines the most notable changes from the 2010 standards to the 2018 standards and offers insight into how teachers can best prepare their students using the revised content. **The document is merely an overview; it does not provide a comprehensive treatment of changes or take the place of the model curriculum or instructional resources.**

The document consists of tables containing three columns that show the 2010 standard, the 2018 standard and the implications of any significant shifts from 2010 to 2018. The document addresses only areas in which the focus of instruction has changed. Standards that say "No change to content focus" should continue to be taught with the same goals as the corresponding 2010 standards. For standards in which the instructional focus has shifted, only the changed content is included in the third column of the table. Portions of the standard unaffected by the changes may not appear here but should continue to be taught.

Educators should teach all content in the standards incorporating the science and engineering practices, and they should engage students in scientific thought processes. Where possible, instructors should use real-world data and both problem-based and project-based experiences. *Ohio's Cognitive Demands*, which Ohio initiated in the 2010 standards, are clarified in the 2018 standards, featuring additional *Visions into Practice* examples categorized by cognitive demand. These levels of knowledge relate to current understanding and research about the ways people learn, and they are important aspects of an overall understanding of science concepts. Educators should give their students opportunities to practice all four types of thinking. Please note, the *Visions into Practice* section of the Model Curriculum suggests ways to incorporate these levels into instruction, but the examples are not mandatory; they are simply ideas educators could implement or adapt to suit local curriculum.

Also, educators need to design lessons to incorporate the concepts described in the *Nature of Science* sections. The *Nature of Science* provides a way for increasing students' understanding of science as more than a body of knowledge about how the natural world works. It also is a process for gathering information and gaining deeper knowledge about the world. These concepts of science should not form a standalone unit or be additional course materials. They should be embedded in each area of the science classroom experience, including lessons, laboratory or field studies, and assessments.

# Instructional Implications for Kindergarten

## GRADE BAND THEME: OBSERVATIONS OF THE ENVIRONMENT

This theme focuses on helping students develop the skills for systematic discovery to understand the science of the physical world around them in greater depth by using scientific inquiry.

**Strand Connections:** Living and nonliving things have specific physical properties that can be used to sort and classify. The physical properties of air and water are presented as they apply to weather.

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
|---|---|---|
| **Earth and Space Science (ESS)** | **Earth and Space Science (ESS)** | |
| **Weather changes are long-term and short-term.**<br><br>Weather changes occur throughout the day and from day to day.<br><br>Air is a nonliving substance that surrounds Earth and wind is air that is moving.<br><br>Wind, temperature and precipitation can be used to document short-term weather changes that are observable.<br><br>Yearly weather changes (seasons) are observable patterns in the daily weather changes.<br><br>**Note:** The focus is on observing the weather patterns of seasons. The reason for changing seasons is not appropriate for this grade level; this is found in grade 5. | **K.ESS.1: Weather changes are long-term and short-term.**<br><br>Weather changes occur throughout the day and from day to day.<br><br>Air is a nonliving substance that surrounds Earth and wind is air that is moving.<br><br>Wind, temperature and precipitation can be used to document short-term weather changes that are observable.<br><br>Yearly weather changes (seasons) are observable patterns in the daily weather changes.<br><br>**Note**: *The focus is on observing the weather patterns of seasons. The reason for changing seasons is not appropriate for this grade level; this is found in grade 7.* | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
|---|---|---|
| **The moon, sun and stars can be observed at different times of the day or night.**<br><br>The moon, sun and stars are in different positions at different times of the day or night. Sometimes the moon is visible during the night, sometimes the moon is visible during the day and at other times, the moon is not visible at all. The observable shape of the moon changes in size very slowly throughout each day of every month. The sun is visible only during the day.<br><br>The sun's position in the sky changes in a single day and from season to season. Stars are visible at night, some are visible in the evening or morning and some are brighter than others. | **K.ESS.2: The moon, sun and stars can be observed at different times of the day or night.**<br><br>The moon, sun and stars appear in different positions at different times of the day or night. Sometimes the moon is visible during the night, sometimes the moon is visible during the day and at other times the moon is not visible at all. The observable shape of the moon changes in size very slowly throughout the month. The sun is visible only during the day.<br><br>The sun's position in the sky appears to change in a single day and from season to season. Stars are visible at night, some are visible in the evening or morning and some are brighter than others. | Careful choice of language when describing the "movement" of the sun and stars at this grade level is important for setting the stage for later understanding that it is actually Earth's movement that causes the apparent motion of celestial bodies. Although this concept is not taught explicitly until later grades, care now can set the stage and avoid engraining the misconception that the sun and other stars are orbiting Earth. Use language such as "seem to move," "appears in a new location" or "is now seen to the left" rather than "the sun moved" or "the stars changed their positions."<br><br>The change in language describing the moon's shape is for clarity and has no instructional impact. |
| **Physical Science (PS)** | **Physical Science (PS)** | |
| **Objects and materials can be sorted and described by their properties.**<br><br>Objects can be sorted and described by the properties of the materials from which they are made. Some of the properties can include color, size and texture.<br><br>**Note:** Using the sense of taste should be prohibited in the classroom. Discussions of taste can be limited to experiences outside the classroom. Comparisons of objects are a precursor to measurement. | **K.PS.1: Objects and materials can be sorted and described by their properties.**<br><br>Objects can be sorted and described by the properties of the materials from which they are made. Some of the properties can include color, size and texture. | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| **Some objects and materials can be made to vibrate to produce sound.**<br><br>Sound is produced by touching, blowing or tapping objects. The sounds that are produced vary depending on the properties of objects. Sound is produced when objects vibrate. | **K.PS.2: Some objects and materials can be made to vibrate to produce sound.**<br><br>Sound is produced by touching, blowing or tapping objects. The sounds that are produced vary depending on the properties of objects. Sound is produced when objects vibrate. | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
|---|---|---|
| **Life Science (LS)** | **Life Science (LS)** | |
| **Living things are different from nonliving things.**<br><br>Living things include anything that is alive or has ever been alive. Living things have specific characteristics and traits. Living things grow and reproduce. Living things are found almost everywhere in the world. There are somewhat different kinds in different places.<br><br>**Note 1:** The focus is on the traits and behaviors of living things not on attributes of nonliving things. See Kindergarten Physical Science for nonliving things.<br><br>**Note 2:** Listing the characteristics that distinguish living things from nonliving things is not appropriate at this grade level. Further details will appear in the model curriculum. | **K.LS.1: Living things have specific characteristics and traits.**<br><br>Living things grow and reproduce. Living things are found worldwide. | Kindergarten instruction should emphasize the characteristics and behaviors of living things rather than the distinctions between living and non-living things. Provide many opportunities to directly observe a variety of familiar organisms, including humans. Observe that living things require energy, grow, reproduce and respond to their surroundings. |
| **Living things have physical traits and behaviors, which influence their survival.**<br><br>Living things are made up of a variety of structures. Some of these structures and behaviors influence their survival.<br><br>**Note:** This concept is addressed in PreK, but is included here for districts that do not have a PreK program. Further information for districts is provided in the model curriculum section. | **K.LS.2: Living things have physical traits and behaviors, which influence their survival.**<br><br>Living things are made up of a variety of structures. Some traits can be observable structures. Some of these structures and behaviors influence their survival. | This standard emphasizes that the structures and behaviors of a living thing help it survive in its environment. Naming structures is not as important as understanding what they do and how they are helpful to the organism. *Mice have legs to run so they can escape predators. Bats have wings to fly so they can catch insects. Seedlings have roots to get water from the soil so they do not shrivel and die.* |

# Instructional Implications for Grade 1

## GRADE BAND THEME: OBSERVATIONS OF THE ENVIRONMENT

This theme focuses on helping students develop the skills for systematic discovery to understand the science of the physical world around them in greater depth by using scientific inquiry.

**Strand Connections:** Energy is observed through movement, heating, cooling and the needs of living organisms.

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
|---|---|---|
| **Earth and Space Science (ESS)** | **Earth and Space Science (ESS)** | |
| **The sun is the principal source of energy.**<br><br>Sunlight warms Earth's land, air and water. The amount of exposure to sunlight affects the amount of warming or cooling of air, water and land. | **1.ESS.1: The sun is the principal source of energy**<br><br>Sunlight warms Earth's land, air and water. The amount of exposure to sunlight affects the amount of warming or cooling of air, water and land. | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| **The physical properties of water can change.**<br><br>These changes occur due to changing energy. Water can change from a liquid to a solid and from a solid to a liquid. Weather observations can be used to examine the property changes of water.<br><br>**Note:** Water as a vapor is not introduced until grade 2; only solid and liquid water should be discussed at this level. A broader coverage of states of matter is found in grade 4. This concept builds on the PS Kindergarten strand pertaining to properties (liquids and solids). | **1.ESS.2: Water on Earth is present in many forms.**<br><br>The physical properties of water can change. These changes occur due to changing energy. Water can change from a liquid to a solid and from a solid to a liquid.<br><br>**Note**: *Water as a vapor is not introduced until grade 2; the water cycle is reserved for later grades.* | The content statement has been revised to better reflect the extent of the existing content elaboration. Although changes in the physical properties of water are an important component of this standard, instruction should also cover other topics related to water. These include the extent to which Earth is covered by water, the various locations of water on Earth and the effects water can have on Earth's surface through erosion and deposition. At this level, observations form the basis of instruction. Provide a variety of opportunities to measure the properties of different forms of water and observe water and its effects on the local environment, as well as through media, maps and globes. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
|---|---|---|
| **Physical Science (PS)** | **Physical Science (PS)** | |
| **Properties of objects and materials can change.**<br><br>Objects and materials change when exposed to various conditions, such as heating or freezing. Not all materials change in the same way.<br><br>**Note1:** Changes in temperature are a result of changes in energy.<br><br>**Note 2:** Water changing from liquid to solid and from solid to liquid is found in ESS grade 1. | **1.PS.1: Properties of objects and materials can change.**<br><br>Objects and materials change when exposed to various conditions, such as heating or cooling. Changes in temperature are a result of changes in energy. Not all materials change in the same way. | The opposite of heating is cooling. This was clarified in the content statement by removing the term frozen. This aligns the standard with the existing elaboration. Introduce the idea that heating a substance is adding energy to it and cooling a substance is subtracting energy. At this level, details of energy transfer are not appropriate. Changes should be observable, but be intentional in pointing out the transfer of energy taking place. *Energy from the sun is entering the candy bar, heating it up and melting it. Energy leaves your skin when holding an ice cube and your fingers get colder.*<br><br>Content relating to parts making up objects was removed. The focus of this standard is on changes in the properties of objects and materials. |
| **Objects can be moved in a variety of ways, such as straight, zigzag, circular and back and forth.**<br><br>The position of an object can be described by locating it relative to another object or to the object's surroundings.<br><br>An object is in motion when its position is changing.<br><br>The motion of an object can be affected by pushing or pulling. A push or pull is a force that can make an object move faster, slower or go in a different direction.<br><br>**Note:** Changes in motion are a result of changes in energy. | **1.PS.2: Objects can be moved in a variety of ways, such as straight, zigzag, circular and back and forth.**<br><br>The position of an object can be described by locating it relative to another object or to the object's surroundings. An object is in motion when its position is changing.<br><br>The motion of an object can be affected by pushing or pulling. A push or pull is a force that can make an object move faster, slower or go in a different direction. Changes in motion are a result of changes in energy. | Introduce the idea that forces between objects can transfer energy. *A ball rolled into another ball passes some of its energy to the second ball. Mom pushing you in the swing transfers energy from mom's arms to the swing.* At this level, students are not expected to distinguish between forces and energy or know formal definitions of these terms. However, the correct application of these terms during instruction helps build a foundation that can improve understanding in later grades. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
|---|---|---|
| **Life Science (LS)** | **Life Science (LS)** | |
| **Living things have basic needs, which are met by obtaining materials from the physical environment.**<br><br>Living things require energy, water, and a particular range of temperatures in their environments.<br><br>Plants get energy from sunlight. Animals get energy from plants and other animals.<br><br>Living things acquire resources from the living and nonliving components of the environment. | **1.LS.1: Living things have basic needs, which are met by obtaining materials from the physical environment.**<br><br>Living things require energy, water, and a particular range of temperatures in their environments. Plants get energy from sunlight. Animals get energy from plants and other animals. Living things acquire resources from the living and nonliving components of the environment. | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| **Living things survive only in environments that meet their needs.**<br><br>Resources are necessary to meet the needs of an individual and populations of individuals. Living things interact with their physical environments as they meet those needs.<br><br>Effects of seasonal changes within the local environment directly impact the availability of resources. | **1.LS.2: Living things survive only in environments that meet their needs.**<br><br>Resources are necessary to meet the needs of an individual and populations of individuals. Living things interact with their physical environments as they meet those needs.<br><br>Effects of seasonal changes within the local environment directly impact the availability of resources. | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

# Instructional Implications for Grade 2

## GRADE BAND THEME: OBSERVATIONS OF THE ENVIRONMENT

This theme focuses on helping students develop the skills for systematic discovery to understand the science of the physical world around them in greater depth by using scientific inquiry.

**Strand Connections:** Living and nonliving things may move. A moving object has energy. Air moving is wind and wind can make a windmill turn. Changes in energy and movement can cause change to organisms and the environments in which they live.

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
|---|---|---|
| **Earth and Space Science (ESS)** | **Earth and Space Science (ESS)** | |
| **The atmosphere is made up of air.**<br><br>Air has properties that can be observed and measured. The transfer of energy in the atmosphere causes air movement, which is felt as wind. Wind speed and direction can be measured.<br><br>**Note:** Air is introduced in ESS Kindergarten and can be linked to PS and LS. | **2.ESS.1: The atmosphere is primarily made up of air.**<br><br>Air has properties that can be observed and measured. The transfer of energy in the atmosphere causes air movement, which is felt as wind. Wind speed and direction can be measured. | The standard still focuses on wind. The insertion of "primarily" was made for increased accuracy to indicate there are things other than air in the atmosphere such as clouds and dust. |
| **Water is present in the air.**<br><br>Water is present in air as clouds, steam, fog, rain, ice, snow, sleet or hail. When water in the air cools (change of energy), it forms small droplets of water that can be seen as clouds. Water can change from liquid to vapor in the air and from vapor to liquid. The water droplets can form into raindrops. Water droplets can change to solid by freezing into snow, sleet or hail. Clouds are moved by flowing air.<br><br>**Note:** This concept builds upon the changing properties of water from ESS grade 1. | **2.ESS.2: Water is present in the atmosphere.**<br><br>Water is present in the atmosphere as water vapor. When water vapor in the atmosphere cools, it forms clouds, fog, rain, ice, snow, sleet or hail.<br><br>**Note**: *The emphasis at this grade level is investigating condensation and evaporation, not memorizing the water cycle itself.*<br><br>**Note**: *The emphasis is not in naming cloud types, but in relating the characteristics of the clouds with weather.* | The emphasis for this standard is understanding phase changes between liquid water and water vapor (condensation and evaporation). This builds on earlier explorations of freezing and melting. Provide opportunities to investigate and observe the condensation and evaporation of water in a variety of situations. Taking advantage of opportunities to point out that energy is transferred during heating and cooling helps build an emerging understanding of energy. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
|---|---|---|
| **Long- and short-term weather changes occur due to changes in energy.**<br><br>Changes in energy affect all aspects of weather, including temperature, precipitation amount and wind.<br><br>**Note:** Discussion of energy at this grade level should be limited to observable changes. | **2.ESS.3: Long- and short-term weather changes occur due to changes in energy.**<br><br>Changes in energy affect all aspects of weather, including temperature, precipitation, and wind. | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| **Physical Science (PS)** | **Physical Science (PS)** | |
| **Forces change the motion of an object.**<br><br>Motion can increase, change direction or stop depending on the force applied.<br><br>The change in motion of an object is related to the size of the force.<br><br>Some forces act without touching, such as using a magnet to move an object or objects falling to the ground.<br><br>**Note:** At this grade level, gravitational and magnetic forces should be introduced through observation and experimentation only. The definitions of these forces should not be the focus of the content statements. | **2.PS.1: Forces change the motion of an object.**<br><br>Motion can increase, change direction or stop depending on the force applied.<br><br>The change in motion of an object is related to the size of the force.<br><br>Some forces act without touching, such as using a magnet to move an object or objects falling to the ground. | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| **Life Science (LS)** | **Life Science (LS)** | |
| **Living things cause changes on Earth**<br><br>Living things function and interact with their physical environments. Living things cause changes in the environments where they live; the changes can be very noticeable or slightly noticeable, fast or slow.<br><br>**Note:** At this grade level, discussion is limited to changes that can be easily observed. | **2.LS.1: Living things cause changes on Earth.**<br><br>Living things function and interact with their physical environments. Living things cause changes in the environments where they live; the changes can be very noticeable or slightly noticeable, fast or slow.<br><br>**Note:** *At this grade level, discussion is limited to changes that can be easily observed.* | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
|---|---|---|
| **Some kinds of individuals that once lived on Earth have completely disappeared, although they were something like others that are alive today.**<br><br>Living things that once lived on Earth no longer exist, their basic needs were no longer met. | **2.LS.2: All organisms alive today result from their ancestors, some of which may be extinct. Not all kinds of organisms that lived in the past are represented by living organisms today.**<br><br>Some kinds of organisms become extinct when their basic needs are no longer met or the environment changes. | The focus of this standard is understanding that all living things are descended from a line of ancestors. Provide opportunities to observe fossils of various types and discuss ways the appearance of fossilized organisms is similar to and different from that of organisms alive today.<br><br>Extinction should be understood as the result of an environment that is unable to meet the basic needs of a particular kind of organism. |

# Instructional Implications for Grade 3

## GRADE BAND THEME: INTERCONNECTIONS WITHIN SYSTEMS

This theme focuses on helping students explore the components of various systems and then investigate dynamic and sustainable relationships within systems using scientific inquiry.

**Strand Connections:** Matter is what makes up all substances on Earth. Matter has specific properties and exists in different states. Earth's resources are made of matter. Matter can be used by living things and can be used for the energy they contain. There are many different forms of energy. Each living component of an ecosystem is composed of matter and uses energy.

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
|---|---|---|
| **Earth and Space Science (ESS)** | **Earth and Space Science (ESS)** | |
| **Earth's nonliving resources have specific properties.**<br><br>Soil is composed of pieces of rock, organic material, water and air and has characteristics that can be measured and observed.<br><br>Rocks have unique characteristics that allow them to be sorted and classified. Rocks form in different ways. Air and water are nonliving resources.<br><br>**Note 1:** Rock classification is not the focus for this grade level; this is found in grade 6. At this grade, the actual characteristics of rocks can be used to sort or compare, rather than formal classification.<br><br>**Note 2:** Properties of air and water have been addressed in PreK. | **3.ESS.1: Earth's nonliving resources have specific properties.**<br><br>Soil is composed of pieces of rock, organic material, water and air and has characteristics that can be measured and observed. Use the term "soil", not "dirt". Dirt and soils are not synonymous.<br><br>Rocks have specific characteristics that allow them to be sorted and compared. Rocks form in different ways. Air and water are also nonliving resources.<br><br>**Note:** *Rock classification is not the focus for this grade level; this is found in grade 6. At this grade, the observable characteristics of rocks can be used to sort or compare, rather than formal classification.* | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| **Earth's resources can be used for energy.**<br><br>Many of Earth's resources can be used for the energy they contain. Renewable energy is an energy resource, such as wind, water or solar energy, that is replenished within a short amount of time by natural processes. Nonrenewable energy is an energy resource, such as coal or oil, that is a finite energy source that cannot be replenished in a short amount of time. | **3.ESS.2: Earth's resources can be used for energy.**<br><br>Renewable energy resources, such as wind, water or solar energy, can be replenished within a short amount of time by natural processes.<br><br>Nonrenewable energy is a finite resource, such as natural gas, coal or oil, which cannot be replenished in a short amount of time. | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
|---|---|---|
| **Some of Earth's resources are limited.**<br><br>Some of Earth's resources become limited due to overuse and/or contamination. Reducing resource use, decreasing waste and/or pollution, recycling and reusing can help conserve these resources. | **3.ESS.3: Some of Earth's resources are limited.**<br><br>Some of Earth's resources become limited due to overuse and/or contamination. Reducing resource use, decreasing waste and/or pollution, recycling and reusing can help conserve these resources. | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| **Physical Science (PS)** | **Physical Science (PS)** | |
| **All objects and substances in the natural world are composed of matter.**<br><br>Matter takes up space and has mass*.<br><br>*While mass is the scientifically correct term to use in this context, the NAEP 2009 Science Framework (page 27) recommends using the more familiar term "weight" in the elementary grades with the distinction between mass and weight being introduced at the middle school level. In Ohio, students will not be assessed on the differences between mass and weight until Grade 6. | **3.PS.1: All objects and substances in the natural world are composed of matter.**<br><br>Matter takes up space and has mass.<br><br>Differentiating between mass and weight is not necessary at this grade level. | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| **Matter exists in different states, each of which has different properties.**<br><br>The most common states of matter are solids, liquids and gases.<br><br>Shape and compressibility are properties that can distinguish between the states of matter.<br><br>One way to change matter from one state to another is by heating or cooling. | **3.PS.2: Matter exists in different states, each of which has different properties.**<br><br>The most recognizable states of matter are solids, liquids and gases.<br><br>Shape and compressibility are properties that can distinguish between the states of matter.<br><br>One way to change matter from one state to another is by heating or cooling. | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| **Heat, electrical energy, light, sound and magnetic energy are forms of energy.**<br><br>There are many different forms of energy. Energy is the ability to cause motion or create change. | **3.PS.3: Heat, electrical energy, light, sound and magnetic energy are forms of energy.**<br><br>There are many different forms of energy. Energy is the ability to cause motion or create change. The different forms of energy that are outlined at this grade level should be limited | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
|---|---|---|
| **Note:** The different forms of energy that are outlined at this grade level should be limited to familiar forms of energy that a student is able to observe. | to familiar forms that a student is able to observe. | |
| **Life Science (LS)** | **Life Science (LS)** | |
| **Offspring resemble their parents and each other.**<br><br>Individual organisms inherit many traits from their parents indicating a reliable way to transfer information from one generation to the next.<br><br>Some behavioral traits are learned through interactions with the environment and are not inherited. | **3.LS.1: Offspring resemble their parents and each other.**<br><br>Individual organisms inherit many traits from their parents indicating a reliable way to transfer information from one generation to the next.<br><br>Some behavioral traits are learned through interactions with the environment and are not inherited. | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| **Individuals of the same kind differ in their traits and sometimes the differences give individuals an advantage in surviving and reproducing.**<br><br>Plants and animals have physical features that are associated with the environments where they live.<br><br>Plants and animals have certain physical or behavioral characteristics that improve their chances of surviving in particular environments.<br><br>Individuals of the same kind have different characteristics that they have inherited. Sometimes these different characteristics give individuals an advantage in surviving and reproducing.<br><br>**Note:** The focus is on the individual, not the population. Adaption is not the focus at this grade level. | **3.LS.2: Individuals of the same kind of organism differ in their inherited traits. These differences give some individuals an advantage in surviving and/or reproducing.**<br><br>Plants and animals have physical features that are associated with the environments where they live.<br><br>Plants and animals have certain physical or behavioral characteristics that influence their chances of surviving in particular environments.<br><br>**Note:** *The focus is on the individual, not the population. Adaption is not the focus at this grade level.* | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
|---|---|---|
| **Plants and animals have life cycles that are part of their adaptations for survival in their natural environments.**<br><br>Over the whole earth, organisms are growing, reproducing, dying and decaying. The details of the life cycle are different for different organisms, which affects their ability to survive and reproduce in their natural environments.<br><br>**Note:** The names of the stages within the life cycles are not the focus.<br><br>**Note:** New organisms are produced by the old ones**.** | **3.LS.3: Plants and animals have life cycles that are part of their adaptations for survival in their natural environments.**<br><br>Worldwide, organisms are growing, reproducing, dying and decaying. The details of the life cycle are different for different organisms, which affects their ability to survive and reproduce in their natural environments.<br><br>**Note:** *The names of the stages within the life cycles are not the focus.* | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

# Instructional Implications for Grade 4

## GRADE BAND THEME: INTERCONNECTIONS WITHIN SYSTEMS

This theme focuses on helping students explore the components of various systems and then investigate dynamic and sustainable relationships within systems using scientific inquiry.

**Strand Connections:** Heat and electrical energy are forms of energy that can be transferred from one location to another. Matter has properties that allow the transfer of heat and electrical energy. Heating and cooling affect the weathering of Earth's surface and Earth's past environments. The processes that shape Earth's surface and the fossil evidence found can help decode Earth's history.

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
|---|---|---|
| **Earth and Space Science (ESS)** | **Earth and Space Science (ESS)** | |
| **Earth's surface has specific characteristics and landforms that can be identified.**<br><br>About 70 percent of the Earth's surface is covered with water and most of that is the ocean. Only a small portion of the Earth's water is freshwater, which is found in rivers, lakes and groundwater.<br><br>Earth's surface can change due to erosion and deposition of soil, rock or sediment. Catastrophic events such as flooding, volcanoes and earthquakes can create landforms. | **4.ESS.1: Earth's surface has specific characteristics and landforms that can be identified.**<br><br>About 70 percent of the Earth's surface is covered with water and most of that is the ocean. Only a small portion of the Earth's water is freshwater, which is found in rivers, lakes, groundwater and glaciers.<br><br>Earth's surface can change due to erosion and deposition of soil, rock or sediment.<br><br>Catastrophic events such as flooding, volcanoes and earthquakes can create landforms. | Glaciers were added as a freshwater location. Glaciers contain the largest portion (nearly 70 percent) of the freshwater on Earth. Students should develop an understanding of the important role glaciers play as an agent of weathering and erosion, specifically emphasizing the creation of the current landforms in and around Ohio. This content can be connected to the role of glaciers in environmental changes, which is covered in 4.LS.1. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
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| **The surface of Earth changes due to weathering.**<br><br>Rocks change shape, size and/or form due to water or ice movement, freeze and thaw, wind, plant growth, gases in the air, pollution and catastrophic events such as earthquakes, mass wasting, flooding and volcanic activity.<br><br>**Note:** The ice movement (above) refers to large bodies of ice, such as glaciers that can break large rocks into small ones. | **4.ESS.2: The surface of Earth changes due to weathering.**<br><br>Rocks change shape, size and/or form due to water or glacial movement, freeze and thaw, wind, plant growth, acid rain, pollution and catastrophic events such as earthquakes, flooding, and volcanic activity.<br><br>**Note:** *Differentiating between chemical and physical weathering is not the focus at this grade level.* | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| **The surface of Earth changes due to erosion and deposition.**<br><br>Water, wind and ice physically remove and carry (erosion) rock, soil and sediment and deposit the material in a new location.<br><br>Gravitational force affects movements of water, rock and soil. | **4.ESS.3: The surface of Earth changes due to erosion and deposition.**<br><br>Liquid water, wind and ice physically remove and carry rock, soil and sediment (erosion) and deposit the material in a new location (deposition).<br><br>Gravitational force affects movements of water, rock and soil. | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| **Physical Science (PS)** | **Physical Science (PS)** | |
| **The total amount of matter is conserved when it undergoes a change.**<br><br>When an object is broken into smaller pieces, when a solid is dissolved in a liquid or when matter changes state (solid, liquid, gas), the total amount of matter remains constant.<br><br>**Note 1:** At this grade, the discussion of conversation of matter should be limited to a macroscopic, observable level.<br><br>**Note 2:** States of matter are found in PS grade 3. Heating and cooling is one way to change the state of matter. | **4.PS.1: When objects break into smaller pieces, dissolve, or change state, the total amount of matter is conserved.**<br><br>When an object is broken into smaller pieces, when a solid is dissolved in a liquid or when matter changes state (solid, liquid, gas), the total amount of matter remains constant.<br><br>**Note:** *Differentiation between mass and weight is not necessary at this grade level.* | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
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| **Energy can be transformed from one form to another or can be transferred from one location to another.**<br><br>Energy transfers from hot objects to cold objects as heat, resulting in a temperature change.<br><br>Electric circuits require a complete loop of conducting materials through which an electrical energy can be transferred.<br><br>Electrical energy in circuits can be transformed to other forms of energy, including light, heat, sound and motion. Electricity and magnetism are closely related. | **4.PS.2: Energy can be transferred from one location to another or can be transformed from one form to another.**<br><br>Energy transfers from hot objects to cold objects as heat, resulting in a temperature change.<br><br>Electric circuits require a complete loop of conducting materials through which electrical energy can be transferred.<br><br>Electrical energy in circuits can be transformed to other forms of energy, including light, heat, sound and motion. Electricity and magnetism are closely related. | This grade level sets the stage for a more complete understanding of energy in later grades. It is important to distinguish between energy changing location (transfer) and energy changing from one type to another (transformation). Provide experiences with a variety of each of these processes.<br><br>Teachers should carefully choose the words they use when teaching to foster an emerging understanding of energy terms. At this level, there is no need to distinguish between heat and thermal energy; however, proper use of these terms provides the foundation for making that distinction explicit in middle school. |
| **Life Science (LS)** | **Life Science (LS)** | |
| **Changes in an organism's environment are sometimes beneficial to its survival and sometimes harmful.**<br><br>Ecosystems can change gradually or dramatically. When the environment changes, some plants and animals survive and reproduce and others die or move to new locations. An animal's patterns of behavior are related to the environment. This includes the kinds and numbers of other organisms present, the availability of food and resources, and the physical attributes of the environment. | **4.LS.1: Changes in an organism's environment are sometimes beneficial to its survival and sometimes harmful.**<br><br>Ecosystems can change gradually or dramatically. When the environment changes, some plants and animals survive and reproduce and others die or move to new locations.<br><br>Ecosystems are based on interrelationships among and between biotic and abiotic factors. These include the diversity of other organisms present, the availability of food and other resources, and the physical attributes of the environment. | The focus of this standard is on the relationships within ecosystems, including how components interact and the effects that changing conditions within an ecosystem have on the components of the ecosystem.<br><br>Provide opportunities for observations of the local environment (schoolyard, parks) and the interactions of biotic and abiotic factors to reinforce this content. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
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| **Fossils can be compared to one another and to present-day organisms according to their similarities and differences.**<br><br>The concept of biodiversity is expanded to include different classification schemes based upon shared internal and external characteristics of organisms.<br><br>Most types of organisms that have lived on Earth no longer exist.<br><br>Fossils provide a point of comparison between the types of organisms that lived long ago and those existing today. | **4.LS.2: Fossils can be compared to one another and to present-day organisms according to their similarities and differences.**<br><br>The concept of biodiversity is expanded to include different classification schemes based upon shared internal and external characteristics of organisms.<br><br>Most species that have lived on Earth are extinct.<br><br>Fossils provide a point of comparison between the types of organisms that lived long ago and those existing today. | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

# Instructional Implications for Grade 5

## GRADE BAND THEME: INTERCONNECTIONS WITHIN SYSTEMS

This theme focuses on helping students explore the components of various systems and then investigate dynamic and sustainable relationships within systems using scientific inquiry.

**Strand Connections:** Cycles on Earth, such as those occurring in ecosystems, in the solar system, and in the movement of light and sound result in describable patterns. Speed is a measurement of movement. Change in speed is related to force and mass*. The transfer of energy drives changes in systems, including ecosystems and physical systems.

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
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| **Earth and Space Science (ESS)** | **Earth and Space Science (ESS)** | |
| **The solar system includes the sun and all celestial bodies that orbit the sun. Each planet in the solar system has unique characteristics.**<br><br>The distance from the sun, size, composition and movement of each planet are unique. Planets revolve around the sun in elliptical orbits. Some of the planets have moons and/or debris that orbit them. Comets, asteroids and meteoroids orbit the sun.<br><br>**Note:** The shape of Earth's orbit is nearly circular (also true for other planets). Many graphics that illustrate the orbit overemphasize the elliptical shape, leading to the misconception regarding seasonal change being related to how close Earth is to the sun. The discussion of planet characteristics should be at an introductory level for this grade. | **5.ESS.1: The solar system includes the sun and all celestial bodies that orbit the sun. Each planet in the solar system has unique characteristics.**<br><br>The distance from the sun, size, composition and movement of each planet are unique. Planets revolve around the sun in elliptical orbits. Some of the planets have moons and/or debris that orbit them. Comets, asteroids and meteoroids orbit the sun. | Content around the solar system, its components and recent projects remains a part of this standard. There is an increased emphasis on understanding the role of gravity in causing celestial bodies to remain in orbit. Students should develop the understanding that gravity is a force between two objects that pulls in both directions. Care should be taken not to further the misconception that only the larger object pulls on the smaller object.<br><br>Provide various opportunities to explore circular motion and observe the result of removing the force toward the center (e.g., whiffle ball swung on a string and released, marble rolled around a paper plate with a wedge removed). At this level, only a conceptual understanding, based on observations, is appropriate. A detailed understanding of the mechanisms of circular motion is not required until high school. |
| **The sun is one of many stars that exist in the universe.**<br><br>The sun appears to be the largest star in the sky because it is the closest star to Earth. Some stars are larger than the sun and some stars are smaller than the sun. | **5.ESS.2: The sun is one of many stars that exist in the universe.**<br><br>The sun appears to be the largest star in the sky because it is the closest star to Earth. Some stars are larger than the sun and some stars are smaller than the sun. | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
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| **Most of the cycles and patterns of motion between the Earth and sun are predictable.**<br><br>Earth's revolution around the sun takes approximately 365 days. Earth completes one rotation on its axis in a 24-hour period, producing day and night. This rotation makes the sun, stars and moon appear to change position in the sky. Earth's axis is tilted at an angle of 23.5°. This tilt, along with Earth's revolution around the sun, affects the amount of direct sunlight that the Earth receives in a single day and throughout the year. The average daily temperature is related to the amount of direct sunlight received. Changes in average temperature throughout the year are identified as seasons.<br><br>**Note 1:** The amount of direct sunlight that Earth receives is related to the altitude of the sun, which affects the angle of the sun's rays and the amount of time the sun is above the horizon each day.<br><br>**Note 2:** Different regions around the world have seasonal changes that are not based solely on average temperature (e.g., rainy season, dry season, monsoon season). | **5.ESS.3: Most of the cycles and patterns of motion between the Earth and sun are predictable.**<br><br>Earth's revolution around the sun takes approximately 365 days. Earth completes one rotation on its axis in a 24-hour period, producing day and night. This rotation makes the sun, stars and moon appear to change position in the sky.<br><br>**Note:** *Moon phases should not be the focus.* | Content about the cause of seasonal changes on Earth has been moved to grade 7. The standard emphasizes understanding the effects of Earth's motion.<br><br>Provide opportunities to explore daily and seasonal differences in the appearance of the sky and to track repetitious patterns in the apparent location of the sun, moon and stars. These patterns should be explicitly linked to the rotation and revolution of Earth.<br><br>The movement of shadows throughout the day should be explored and tied to Earth's rotation. The cause of night should be recognized as the time when a particular portion of Earth's surface is in the shadow created when sunlight is blocked by the planet.<br><br>Rich experiences with models and manipulatives at this level provide a base for development of the three-dimensional thinking that is required to understand seasonal changes and the effects of other interactions within the universe at later grade levels. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
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| **Physical Science (PS)** | **Physical Science (PS** | |
| **The amount of change in movement of an object is based on the mass* of the object and the amount of force exerted.**<br><br>Movement can be measured by speed. The speed of an object is calculated by determining the distance (d) traveled in a period of time (t).<br><br>Earth pulls down on all objects with a gravitational force. Weight is a measure of the gravitational force between an object and the Earth.<br><br>Any change in speed or direction of an object requires a force and is affected by the mass* of the object and the amount of force applied.<br><br>**Note1:** Gravity and magnetism are introduced (through observation) in PS grade 2.<br><br>*While mass is the scientifically correct term to use in this context, the NAEP 2009 Science Framework (page 27) recommends using the more familiar term "weight" in the elementary grades with the distinction between mass and weight being introduced at the middle school level. In Ohio, students will not be assessed on the differences between mass and weight until Grade 6. | **5.PS.1: The amount of change in movement of an object is based on the mass of the object and the amount of force exerted.**<br><br>Movement can be measured by speed. The speed of an object is calculated by determining the distance (d) traveled in a period of time (t).<br><br>Any change in speed or direction of an object requires a force and is affected by the mass of the object and the amount of force applied.<br><br>**Note:** *Differentiating between mass and weight is not necessary at this grade level.* | Forces are described by strength and direction. The study of forces is expanded to the effects of two forces acting on an object simultaneously. Both balanced and unbalanced forces should be observed and discussed.<br><br>Although average speed can be calculated from a mathematical formula, performing this calculation does not provide a conceptual understanding of speed as a measurement of how quickly position changes. To develop this understanding, explore and compare a variety of objects moving at various speeds. Examining the distances traveled in successive units of time as an object moves with constant, increasing and decreasing speed is an important experience at this level. This provides the foundation necessary for the application of mathematical reasoning in later grades. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
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| **Light and sound are forms of energy that behave in predictable ways.**<br><br>Light travels and maintains its direction until it interacts with an object or moves from one medium to another and then it can be reflected, refracted or absorbed.<br><br>Sound is produced by vibrating objects and requires a medium through which to travel. The rate of vibration is related to the pitch of the sound.<br><br>**Note:** At this grade level, the discussion of light and sound should be based on observable behavior. Waves are introduced at the middle school level. | **5.PS.2: Light and sound are forms of energy that behave in predictable ways.**<br><br>Light travels and maintains its direction until it interacts with an object or moves from one medium to another and then it can be reflected, refracted or absorbed.<br><br>Sound is produced by vibrating objects and requires a medium through which to travel. The rate of vibration is related to the pitch of the sound.<br><br>**Note:** *At this grade level, the discussion of light and sound should be based on observable behavior. Waves are introduced at the middle school level.* | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| **Life Science (LS)** | **Life Science (LS** | |
| **Organisms perform a variety of roles in an ecosystem.**<br><br>Populations of organisms can be categorized by how they acquire energy.<br><br>Food webs can be used to identify the relationships among producers, consumers and decomposers in an ecosystem. | **5.LS.1: Organisms perform a variety of roles in an ecosystem.**<br><br>Populations of organisms can be categorized by how they acquire energy.<br><br>Food webs can be used to identify the relationships among producers, consumers and decomposers in an ecosystem. | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

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| **All of the processes that take place within organisms require energy.**<br><br>For ecosystems, the major source of energy is sunlight.<br><br>Energy entering ecosystems as sunlight is transferred and transformed by producers into energy that organisms use through the process of photosynthesis. That energy then passes from organism to organism as illustrated in food webs.<br><br>In most ecosystems, energy derived from the sun is transferred and transformed into energy that organisms use by the process of photosynthesis in plants and other photosynthetic organisms. | **5.LS.2: All of the processes that take place within organisms require energy.**<br><br>For ecosystems, the major source of energy is sunlight. Energy entering ecosystems as sunlight is transferred and transformed by producers into energy that organisms use through the process of photosynthesis. That energy is used or stored by the producer and can be passed from organism to organism as illustrated in food webs. | It is important to foster an understanding that most of the energy entering an organism is transformed by the organism during its daily activities, leaving only a small percentage of energy to move from organism to organism within any ecosystem.<br><br>This emerging understanding of energy continuously being dissipated to the environment leads to understanding the need for a continual input of energy (usually sunlight) into ecosystems. |

# Instructional Implications for Grade 6

## GRADE BAND THEME: ORDE AND ORGANIZATION

This theme focuses on helping students use scientific inquiry to discover patterns, trends, structures and relationships that may be inferred by simple principles. These principles are related to the properties or interactions within and between systems.

**Strand Connections:** All matter is made of small particles called atoms. The properties of matter are based on the order and organization of atoms and molecules. Cells, minerals, rocks and soil are all examples of matter.

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
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| **Earth and Space Science (ESS)** | **Earth and Space Science (ESS)** | |
| **Minerals have specific, quantifiable properties.**<br><br>Minerals are naturally occurring, inorganic solids that have a defined chemical composition. Minerals have properties that can be observed and measured. Minerals form in specific environments. | **6.ESS.1: Minerals have specific, quantifiable properties.**<br><br>Minerals are naturally occurring, inorganic solids that have a defined chemical composition. Minerals have properties that can be observed and measured. Minerals form in specific environments.<br><br>**Note:** *The emphasis is on learning how to identify the mineral by conducting tests (not through memorization).* | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| **Igneous, metamorphic and sedimentary rocks have unique characteristics that can be used for identification and/or classification.**<br><br>Most rocks are composed of one or more minerals, but there are a few types of sedimentary rocks that contain organic material, such as coal. The composition of the rock, types of mineral present, mineral arrangement, and/or mineral shape and size can be used to identify the rock and to interpret its history of formation, breakdown. | **6.ESS.2: Igneous, metamorphic and sedimentary rocks have unique characteristics that can be used for identification and/or classification.**<br><br>Most rocks are composed of one or more minerals, but there are a few types of sedimentary rocks that contain organic material, such as coal. The composition of the rock, types of mineral present, and/or mineral shape and size can be used to identify the rock and to interpret its history of formation, breakdown (weathering) and transport (erosion). | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
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| **Igneous, metamorphic and sedimentary rocks form in different ways.**<br><br>Magma or lava cools and crystallizes to form igneous rocks. Heat and pressure applied to existing rock forms metamorphic rocks. Sedimentary rock forms as existing rock weathers chemically and/or physically and the weathered material is compressed and then lithifies. Each rock type can provide information about the environment in which it was formed. | **6.ESS.3: Igneous, metamorphic and sedimentary rocks form in different ways.**<br><br>Magma or lava cools and crystallizes to form igneous rocks. Heat and pressure applied to existing rock forms metamorphic rocks. Sedimentary rock forms as existing rock weathers chemically and/or physically and the weathered material is compressed and then lithifies. Each rock type can provide information about the environment in which it was formed. | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| **Soil is unconsolidated material that contains nutrient matter and weathered rock.**<br><br>Soil formation occurs at different rates and is based on environmental conditions, types of existing bedrock and rates of weathering. Soil forms in layers known as horizons. Soil horizons can be distinguished from one another based on properties that can be measured.<br><br>**Note:** The introduction to soil is found in grade 3. | **6.ESS.4: Soil is unconsolidated material that contains organic matter and weathered rock.**<br><br>Soil formation occurs at different rates and is based on environmental conditions, types of existing bedrock and rates of weathering. Soil forms in layers known as horizons. Soil horizons can be distinguished from one another based on properties that can be measured. The terms dirt and soil are not synonymous, use the term "soil".<br><br>**Note:** *The emphasis should be on properties of soil rather than memorization.* | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| **Rocks, minerals and soils have common and practical uses.**<br><br>Nearly all manufactured material requires some kind of geologic resource. Most geologic resources are considered nonrenewable. Rocks, minerals and soil are examples of geologic resources that are nonrenewable.<br><br>**Note:** Nonrenewable energy sources should be included (such as fossil fuels). | **6.ESS.5: Rocks, minerals and soils have common and practical uses.**<br><br>Nearly all manufactured material requires some kind of geologic resource. Most geologic resources are considered nonrenewable. Rocks, minerals and soil are examples of geologic resources that are nonrenewable. | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
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| **Physical Science (PS)** | **Physical Science (PS)** | |
| **All matter is made up of small particles called atoms.**<br><br>Each atom takes up space, has mass and is in constant motion. Mass is the amount of matter in an object.<br><br>Elements are a class of substances composed of a single kind of atom.<br><br>Molecules are the combination of two or more atoms that are joined together chemically.<br><br>Compounds are composed of two or more different elements. Each element and compound has properties, which are independent of the amount of the sample. | **6.PS.1: Matter is made up of small particles called atoms.**<br><br>Matter has mass, volume and density and is made up of particles called atoms.<br><br>Elements are a class of substances composed of a single kind of atom.<br><br>Molecules are the combination of two or more atoms that are joined together chemically. | At grade 6, the focus is a conceptual understanding of density, which can be developed by handling and measuring the mass and volume of a variety of objects and substances. Rocks and minerals could be included in the study to tie instruction to the Earth science content statements.<br><br>Using mass versus volume graphs to find and compare densities by identifying the unit rate is a good way to gain conceptual understanding of density. These graphs can be plotted from experimental data. This material reinforces the understanding of unit rate from the grade 6 mathematics standards.<br><br>A basic understanding of atoms, elements and molecules is included with this standard. However, subatomic particles, the periodic table or details about how molecules form is not necessary at this level. Content dealing with compounds has been moved to grade 7. |
| **Changes of state are explained by a model of matter composed of atoms and/or molecules that are in motion.**<br><br>When substances undergo changes of state, neither atoms nor molecules themselves are changed in structure.<br><br>Thermal energy is a measure of the motion of the atoms and molecules in a substance.<br><br>Mass is conserved when substances undergo changes of state.<br><br>**Note:** Thermal energy can be connected to kinetic energy at this grade level. The rate of vibration is related to the pitch of the sound.<br><br>**Note:** At this grade level, the discussion of light and sound should be based on observable behavior. Waves are introduced at the middle school level. | **6.PS.2: Changes of state are explained by a model of matter composed of particles that are in motion.**<br><br>Temperature is a measure of the average motion of the particles in a substance.<br><br>Heat is a process of energy transfer rather than a type of energy. Energy transfer can result in a change in temperature or a phase change.<br><br>When substances undergo changes of state, atoms change their motion and position.<br><br>**Note:** *It is not the intent of this standard to encourage vocabulary identification (matching definitions with heat, temperature, and thermal energy). Instead, these are provided as conceptual tools for understanding the role of energy in physical, biotic, atmospheric, oceanic, and geologic systems covered in grade 6 and subsequent grades and courses.* | This standard continues to focus on the role of energy in changes of state. At this level, students should begin to understand the relationship between heat, temperature and thermal energy.<br><br>Experiencing that temperature does not change during phase changes can tie into discussions of potential vs. kinetic energy (6.PS.3).<br><br>This content also provides a foundation for understanding the role of energy, as well as how it transfers and transforms, in various systems. These concepts will continue to be developed throughout middle school and high school. |

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| **There are two categories of energy: kinetic and potential.**<br><br>Objects and substances in motion have kinetic energy.<br><br>Objects and substances can have energy as a result of their position (potential energy).<br><br>**Note:** Kinetic and potential energy should be introduced at the macroscopic level for this grade. Chemical and elastic potential energy should not be included at this grade; this is found in PS grade 8. | **6.PS.3: There are two categories of energy: kinetic and potential.**<br><br>Objects and substances in motion have kinetic energy.<br><br>Objects and substances can have energy as a result of their position (potential energy).<br><br>**Note:** *Chemical and elastic potential energy should not be included at this grade; this is found in PS grade 7.* | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| **An object's motion can be described by its speed and the direction in which it is moving.**<br><br>An object's position and speed can be measured and graphed as a function of time.<br><br>**Note 1:** This begins to quantify student observations using appropriate mathematical skills.<br><br>**Note 2:** Velocity and acceleration rates should not be included at this grade level; these terms are introduced in high school. | **6.PS.4: An object's motion can be described by its speed and the direction in which it is moving.**<br><br>An object's position and speed can be measured and graphed as a function of time.<br><br>**Note:** *Velocity and acceleration rates should not be included at this grade level; these terms are introduced in high school.* | Speed versus time graphs have been removed from this grade level and reserved for high school. This is to allow time to develop a deeper conceptual understanding of position versus time graphs by eliminating the confusion of trying to interpret two types of graphs where similar line segments represent different motions.<br><br>Skills at this level include constructing a position versus time graph from data, explaining the motion depicted on a position versus time graph and comparing the motion of two objects using their position versus time graphs. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
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| **Life Science (LS)** | **Life Science (LS)** | |
| **Cells are the fundamental unit of life.**<br>All living things are composed of cells.<br>Different body tissues and organs are made of different kinds of cells. The ways cells function are similar in all living organisms.<br>**Note 1:** Specific information about the organelles that need to be addressed at this grade level will be found in the model curriculum.<br>**Note 2:** Emphasis should be placed on the function and coordination of these components, as well as on their roles in overall cell function. | **6.LS.1: Cells are the fundamental unit of life.**<br>All living things are composed of cells. Different body tissues and organs are made of different kinds of cells. The ways cells function are similar in all living organisms.<br>**Note:** *Emphasis should be placed on the function and coordination of cell organelles as well as their roles in overall cell function. Specific information about the organelles that need to be addressed at this grade level will be found in the model curriculum.* | The standard focuses on understanding the relationship between structure and function. A variety of cell organelles should be examined. Knowing their names or identifying them on a diagram is less important than understanding their general structures and how the structure relates to their functions, as well as the types of cells in which they are found.<br>Knowing the details of cellular processes is above grade level, but a general sense of the cell as a system of organelles with coordinated functions should be developed.<br>Comparing single-celled and multicellular organisms and the relationships between cells, tissues, organs and systems in complex organisms continues to be a part of this standard. |
| **All cells come from pre-existing cells.**<br>Cells repeatedly divide resulting in more cells and growth and repair in multicellular organisms.<br>**Note:** This is not a detailed discussion of the phases of mitosis or meiosis. The focus should be on reproduction as a means of transmitting genetic information from one generation to the next, cellular growth and repair. | **6.LS.2: All cells come from pre-existing cells.**<br>Cells repeatedly divide resulting in more cells and growth and repair in multicellular organisms.<br>**Note:** *This is not a detailed discussion of the phases of mitosis or meiosis. The focus should be on reproduction as a means of transmitting genetic information from one generation to the next, cellular growth and repair.* | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| **Cells carry on specific functions that sustain life.**<br>Many basic functions of organisms occur in cells. Cells take in nutrients and energy to perform work, like making various molecules required by that cell or an organism.<br>Every cell is covered by a membrane that controls what can enter and leave the cell.<br>Within the cell are specialized parts for the transport of materials, energy capture and | **6.LS.3: Cells carry on specific functions that sustain life.**<br>Many basic functions of organisms occur in cells. Cells take in nutrients and energy to perform work, like making various molecules required by that cell or an organism.<br>Every cell is covered by a membrane that controls what can enter and leave the cell.<br>Within the cell are specialized parts for the transport of materials, energy capture and | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

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| release, protein building, waste disposal, information feedback and movement.<br><br>**Note:** Emphasis should be placed on the function and coordination of cell components, as well as on their roles in overall cell function. | release, protein building, waste disposal, information feedback and movement.<br><br>**Note:** *Emphasis should be placed on the function and coordination of cell components, as well as on their roles in overall cell function.* | |
| **Living systems at all levels of organization demonstrate the complementary nature of structure and function.**<br><br>The level of organization within organisms includes cells, tissues, organs, organ systems and whole organisms.<br><br>Whether the organism is single-celled or multicellular, all of its parts function as a whole to perform the tasks necessary for the survival of the organism.<br><br>Organisms have diverse body plans, symmetry and internal structures that contribute to their being able to survive in their environments. | **6.LS.4: Living systems at all levels of organization demonstrate the complementary nature of structure and function.**<br><br>The level of organization within organisms includes cells, tissues, organs, organ systems and whole organisms.<br><br>Whether the organism is single-celled or multicellular, all of its parts function as a whole to perform the tasks necessary for the survival of the organism.<br><br>Organisms have diverse body plans, symmetry and internal structures that contribute to their being able to survive in their environments. | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

# Instructional Implications for Grade 7

## GRADE BAND THEME: ORDE AND ORGANIZATION

This theme focuses on helping students use scientific inquiry to discover patterns, trends, structures and relationships that may be inferred by simple principles. These principles are related to the properties or interactions within and between systems.

**Strand Connections:** Systems can exchange energy and/or matter when interactions occur within systems and between systems. Systems cycle matter and energy in observable and predictable patterns.

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
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| **Earth and Space Science (ESS)** | **Earth and Space Science (ESS)** | |
| **The hydrologic cycle illustrates the changing states of water as it moves through the lithosphere, biosphere, hydrosphere and atmosphere.**<br><br>Thermal energy is transferred as water changes state throughout the cycle. The cycling of water in the atmosphere is an important part of weather patterns on Earth. The rate at which water flows through soil and rock is dependent upon the porosity and permeability of the soil or rock.<br><br>Note: Contamination can occur within any step of the hydrologic cycle. Ground water is easily contaminated as pollution present in the soil or spilled on the ground surface moves into the ground water and impacts numerous water sources. | **7.ESS.1: The hydrologic cycle illustrates the changing states of water as it moves through the lithosphere, biosphere, hydrosphere and atmosphere.**<br><br>Thermal energy is transferred as water changes state throughout the cycle. The cycling of water in the atmosphere is an important part of weather patterns on Earth. The rate at which water flows through soil and rock is dependent upon the porosity and permeability of the soil or rock. | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| **Thermal-energy transfers in the ocean and the atmosphere contribute to the formation of currents, which influence global climate patterns.**<br><br>The sun is the major source of energy for wind, air and ocean currents and the hydrologic cycle. As thermal energy transfers occur in the atmosphere and ocean, currents form. Large bodies of water can influence weather and climate. The jet stream is an | **7.ESS.2: Thermal-energy transfers in the ocean and the atmosphere contribute to the formation of currents, which influence global climate patterns.**<br><br>The sun is the major source of energy for wind, air and ocean currents and the hydrologic cycle. As thermal energy transfers occur in the atmosphere and ocean, currents form. Large bodies of water can influence | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
|---|---|---|
| example of an atmospheric current and the Gulf Stream is an example of an oceanic current. Ocean currents are influenced by factors other than thermal energy, such as water density, mineral content (such as salinity), ocean floor topography and Earth's rotation. All of these factors delineate global climate patterns on Earth.<br><br>**Note:** This content statement is related to LS grade 7 (biomes). Regional temperature and precipitation contribute to the identification of climatic zones. | weather and climate. The jet stream is an example of an atmospheric current and the Gulf Stream is an example of an oceanic current. Ocean currents are influenced by factors other than thermal energy, such as water density, mineral content (such as salinity), ocean floor topography and Earth's rotation. All of these factors delineate global climate patterns on Earth. | |
| The atmosphere has different properties at different elevations and contains a mixture of gases that cycle through the lithosphere, biosphere, hydrosphere and atmosphere.<br><br>The atmosphere is held to the Earth by the force of gravity. There are defined layers of the atmosphere that have specific properties, such as temperature, chemical composition and physical characteristics. Gases in the atmosphere include nitrogen, oxygen, water vapor, carbon dioxide and other trace gases.<br><br>Biogeochemical cycles illustrate the movement of specific elements or molecules (such as carbon or nitrogen) through the lithosphere, biosphere, hydrosphere and atmosphere.<br><br>Note: The emphasis is on why the atmosphere has defined layers, not on naming the layers. | 7.ESS.3: The atmosphere has different properties at different elevations and contains a mixture of gases that cycle through the lithosphere, biosphere, hydrosphere and atmosphere.<br><br>The atmosphere is held to the Earth by the force of gravity. There are defined layers of the atmosphere that have specific properties, such as temperature, chemical composition and physical characteristics. Gases in the atmosphere include nitrogen, oxygen, water vapor, carbon dioxide and other trace gases. Biogeochemical cycles illustrate the movement of specific elements or molecules (such as carbon or nitrogen) through the lithosphere, biosphere, hydrosphere and atmosphere.<br><br>Note: *The emphasis is on why the atmosphere has defined layers, not on naming the layers.* | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
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| **The relative patterns of motion and positions of Earth, moon and sun cause solar and lunar eclipses, tides and phases of the moon.**<br>The moon's orbit and its change of position relative to Earth and sun result in different parts of the moon being visible from Earth (phases of the moon).<br>A solar eclipse is when Earth moves into the shadow of the moon (during a new moon). A lunar eclipse is when the moon moves into the shadow of Earth (during a full moon).<br>Gravitational force between Earth and the moon causes daily oceanic tides. When the gravitational forces from the sun and moon align (at new and full moons) spring tides occur. When the gravitational forces of the sun and moon are perpendicular (at first and last quarter moons), neap tides occur. | **7.ESS.4: The relative patterns of motion and positions of Earth, moon and sun cause solar and lunar eclipses, tides and phases of the moon.**<br>The moon's orbit and its change of position relative to Earth and sun result in different parts of the moon being visible from Earth (phases of the moon).<br>A solar eclipse is when Earth moves into the shadow of the moon (during a new moon). A lunar eclipse is when the moon moves into the shadow of Earth (during a full moon).<br>Gravitational force between Earth and the moon causes daily oceanic tides. When the gravitational forces from the sun and moon align (at new and full moons) spring tides occur. When the gravitational forces of the sun and moon are perpendicular (at first and last quarter moons), neap tides occur. | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
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| **New content** | **7.ESS.5: The relative positions of Earth and the sun cause patterns we call seasons.**<br>Earth's axis is tilted at an angle of 23.5°. This tilt along with Earth's revolution around the sun, affects the amount of direct sunlight that the earth receives in a single day and throughout the year. The average daily temperature is related to the amount of direct sunlight received. | The focus of this new content statement is on the causes of seasonal changes. This content previously was in grade 5. Students entering grade 7 prior to fall 2022 already should have been taught this content but may need it reinforced or deepened.<br>Students should develop an understanding about the role Earth's axial tilt has on both the changing number of hours of daylight during different seasons and the angle at which the light strikes the ground in various locations. Comparing different locations across the globe allows for deeper conceptual understanding of the length of day and the angle of sunlight, as well as their roles in temperature ranges.<br>Exploring light striking a curved surface can foster an understanding of the relationship between a region's location on Earth's surface and the amount of energy the sun provides to the area each day.<br>Specific seasonal weather patterns can be tied to content about global currents in 7.ESS.2. Global currents work in conjunction with the effects of Earth's revolution to cause these patterns. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
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| **Physical Science (PS)** | **Physical Science (PS)** | |
| **The properties of matter are determined by the arrangement of atoms.**<br><br>Elements can be organized into families with similar properties, such as highly reactive metals, less-reactive metals, highly reactive nonmetals and some gases that are almost completely nonreactive.<br><br>Substances are classified according to their properties, such as metals and acids.<br><br>When substances interact to form new substances, the properties of the new substances may be very different from those of the old, but the amount of mass does not change.<br><br>**Note 1:** This is the conceptual introduction of the Periodic table of Elements.<br><br>**Note 2:** Acids and bases are included in this topic; further detail will be provided in the Model Curriculum.<br><br>**Note 3:** It is important to emphasize that most changes in the properties of matter have some combination of chemical and physical change (at different levels). | **7.PS.1: Elements can be organized by properties.**<br><br>Elements can be classified as metals, non-metals and metalloids, and can be organized by similar properties such as color, solubility, hardness, density, conductivity, melting point and boiling point, viscosity, and malleability.<br><br>Note 1: *This is the conceptual introduction of the Periodic Table of Elements and should be limited to classifications based on observable properties; it should not include the names of the families.* | **The content from the first physical science standard in the 2010 standards was divided between this standard and 7.PS.2.**<br><br>Content related to acids and bases was moved to high school. Subatomic particles also are reserved for high school; therefore, it is no longer necessary to cover content related to protons, neutrons, electrons, atomic number or mass number. Likewise, ions, isotopes and mechanisms of chemical bonding are above grade level.<br><br>Study of the periodic table at this level should focus on the trends in properties of elements. Students should explore properties (listed in the descriptor) of various elements, either in the laboratory, virtually or through research.<br><br>Identifying trends and patterns on the periodic table based on these properties will lay the foundation for a more complete understanding of bonding patterns and other chemistry concepts at the high school level.<br><br>Identifying patterns from data rather than simply memorizing the location and properties of particular groups on the periodic table provides the richest learning experience. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
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| **New content statement** | **7.PS.2: Matter can be separated or changed, but in a closed system, the number and types of atoms remains constant.**<br><br>When substances interact and form new substances the properties of the new substances may be very different from those of the original substances, but the amount of mass does not change.<br><br>Physically combining two or more substances forms a mixture, which can be separated through physical processes.<br><br>**Note:** *Under these standards, classifying specific changes as chemical or physical is not appropriate*. | This standard focuses on the conservation of matter at the microscopic level.<br><br>Distinguishing among elements, molecules, compounds and mixtures (previously in grades 6 and 7) continues to be a part of this standard. However, the instructional focus should be the conservation of matter as mixtures or compounds are formed or separated.<br><br>Simple balanced chemical equations can be used to visualize the conservation of atoms during chemical reactions. Basic photosynthesis and cellular respiration equations can be used to tie this content to 7.LS.1.<br><br>An introduction to the idea that energy is required to break bonds, and that energy is released when bonds are formed, is appropriate, but the mechanisms of bonding are reserved for high school. Understanding that energy can be taken in from, or released to, the environment during chemical changes should be tied to the conceptual idea of conservation of energy in the overall system. |
| **Energy can be transformed or transferred but is never lost.**<br>When energy is transferred from one system to another, the quantity of energy before transfer equals the quantity of energy after transfer. When energy is transformed from one form to another, the total amount of energy remains the same. | **7.PS.3: Energy can be transformed or transferred but is never lost.**<br><br>When energy is transferred from one system to another, the quantity of energy before transfer equals the quantity of energy after transfer. When energy is transformed from one form to another, the total amount of energy remains the same. | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

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| **Energy can be transferred through a variety of ways.**<br>Mechanical energy can be transferred when objects push or pull on each other over a distance.<br><br>Electromagnetic waves transfer energy when they interact with matter.<br><br>Thermal energy can be transferred through radiation, convection and conduction.<br><br>Electrical energy transfers when an electrical source is connected in a complete electrical circuit to an electrical device.<br><br>**Note 1:** Energy transfers should be experiential and observable. This builds upon PS grade 4 and is directly connected to ESS grade 7 (thermal energy transfers in the hydrologic cycle.)<br><br>**Note 2:** Electricity can be measured through current, voltage and resistance. In addition, renewable energy systems should be included (such as wind, geothermal, water or solar).<br><br>**Note 3:** The types of waves used within this topic include seismic, oceanic, sound and light. Seismic waves also are found in ESS grade 8. | **7.PS.4: Energy can be transferred through a variety of ways.**<br><br>Mechanical energy can be transferred when objects push or pull on each other over a distance.<br><br>Mechanical and electromagnetic waves transfer energy when they interact with matter.<br><br>Thermal energy can be transferred through radiation, convection and conduction.<br><br>An electrical circuit transfers energy from a source to a device.<br><br>**Note:** *Energy transfers should be experiential and observable at this grade level.* | The existing content remains in place and still should be covered at the previous depth. In addition, forms of potential energy, motors and generators have been incorporated into this standard. This material previously was in the grade 8 standards.<br><br>This standard lays the foundation for deeper understanding of the mechanisms of energy transfer in high school. It is important to build a strong conceptual understanding of the ways energy moves.<br><br>Much of the material in this energy transfer standard relates to other content in grade 7 and should be a focus throughout the curriculum. Introducing this content early in the year allows students to apply their knowledge to understanding other systems (hydrologic cycle, global currents, ecosystems) studied at this level. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
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| **Life Science (LS)** | **Life Science (LS)** | |
| **Matter is transferred continuously between one organism to another and between organisms and their physical environments.**<br><br>Plants use the energy in light to make sugars out of carbon dioxide and water (photosynthesis). These materials can be used and immediately stored for later use.<br><br>Organisms that eat plants break down plant structures to produce the materials and energy they need to survive. Then they are consumed by other organisms.<br><br>Energy can transform from one form to another in living things. Animals get energy from oxidizing food, releasing some of its energy as heat.<br><br>The total amount of matter and energy remains constant, even though its form and location change.<br><br>**Note 1:** Chemical reactions are resented as the rearrangement of atoms in molecules.<br><br>**Note 2:** Chemical reactions in terms of subatomic structures of atoms are not appropriate. | **7.LS.1: Energy flows and matter is transferred continuously from one organism to another and between organisms and their physical environments.**<br><br>Plants use the energy in light to make sugars out of carbon dioxide and water (photosynthesis). These materials can be used or stored for later use. Organisms that eat plants break down plant structures to release the energy and produce the materials they need to survive. The organism may then be consumed by other organisms for materials and energy.<br><br>Energy can transform from one form to another in living things. Animals get energy from oxidizing food, releasing some of its energy as heat.<br><br>The total amount of matter and energy remains constant, even though its form and location change.<br><br>**Note:** *Chemical reactions in terms of subatomic structures of atoms are not appropriate at this grade level. Chemical reactions are presented as the rearrangement of atoms in molecules.* | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
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| **In any particular biome, the number, growth and survival of organisms and populations depend on biotic and abiotic factors.**<br><br>Biomes are regional ecosystems characterized by distinct types of organisms that have developed under specific soil and climatic conditions.<br><br>The variety of physical (abiotic) conditions that exists on Earth gives rise to diverse environments (biomes) and allows for the existence of a wide variety of organisms (biodiversity).<br><br>Ecosystems are dynamic in nature; the number and types of species fluctuate over time. Disruptions, deliberate or inadvertent, to the physical (abiotic) or biological (biotic) components of an ecosystem impact the composition of an ecosystem.<br><br>**Note:** Predator-prey and producer consumer relations are addressed in grade 5. | **7.LS.2: In any particular biome, the number, growth and survival of organisms and populations depend on biotic and abiotic factors.**<br><br>The variety of physical (abiotic) conditions that exists on Earth gives rise to diverse environments (biomes) and allows for the existence of a wide variety of organisms (biodiversity).<br><br>Biomes are regional ecosystems characterized by distinct types of organisms that have developed under specific soil and climatic conditions.<br><br>Ecosystems are dynamic in nature; the number and types of species fluctuate over time. Disruptions, deliberate or inadvertent, to the physical (abiotic) or biological (biotic) components of an ecosystem impact the composition of an ecosystem. | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

# Instructional Implications for Grade 8

## GRADE BAND THEME: ORDE AND ORGANIZATION

This theme focuses on helping students use scientific inquiry to discover patterns, trends, structures and relationships that may be inferred by simple principles. These principles are related to the properties or interactions within and between systems.

**Strand Connections:** Systems can be described and understood by analysis of the interaction of their components. Energy, forces and motion combine to change the physical features of Earth. The changes of the physical Earth and the species that have lived on Earth are found in the rock record. For species to continue, reproduction must be successful.

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
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| **Earth and Space Science (ESS)** | **Earth and Space Science (ESS)** | |
| **The composition and properties of Earth's interior are identified by the behavior of seismic waves.**<br><br>The refraction and reflection of seismic waves as they move through one type of material to another is used to differentiate the layers of Earth's interior. Earth has an inner and outer core, an upper and lower mantle, and a crust.<br><br>The formation of the planet generated heat from gravitational energy and the decay of radioactive elements, which are still present today. Heat released from Earth's core drives convection currents throughout the mantle and the crust.<br><br>**Note:** The thicknesses of each layer of Earth can vary and be transitional, rather than uniform and distinct as often depicted in textbooks. | **8.ESS.1: The composition and properties of Earth's interior are identified by the behavior of seismic waves.**<br><br>The refraction and reflection of seismic waves as they move through one type of material to another is used to differentiate the layers of Earth's interior. Earth has a core, a mantle, and a crust. Impacts during planetary formation generated heat.<br><br>These impacts converted gravitational potential energy to heat. Earth's core is also able to generate its own thermal energy because of decaying atoms. This continuously releases thermal energy. Thermal energy generated from Earth's core drives convection currents in the asthenosphere.<br><br>**Note 1:** *Radioactive decay is not the focus; this will be discussed in Physical Science and Chemistry.*<br><br>**Note 2:** *At this grade level, analyzing seismograms (e.g., amplitude and lag time) and reading a travel time curve are not the focus. At this grade the properties of seismic waves should be addressed.* | The focus and content of this standard has not changed. However, there are significant wording changes to clarify content. The new language clarifies the processes involved and the terms used with reference to the interior dynamics of Earth. It reflects current understanding of the locations, sources and roles of thermal energy and heat in the Earth's interior. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
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| **Earth's crust consists of major and minor tectonic plates that move relative to each other.**<br><br>Historical data and observations such as fossil distribution, paleomagnetism, continental drift and sea-floor spreading contributed to the theory of plate tectonics. The rigid tectonic plates move with the molten rock and magma beneath them in the upper mantle.<br><br>Convection currents in the crust and upper mantle-cause the movement of the plates. The energy that forms convection currents comes from deep within the Earth.<br><br>There are three main types of plate boundaries: divergent, convergent and transform. Each type of boundary results in specific motion and causes events (such as earthquakes or volcanic activity) or features (such as mountains or trenches) that are indicative of the type of boundary. | **8.ESS.2: Earth's lithosphere consists of major and minor tectonic plates that move relative to each other.**<br><br>Historical data and observations such as fossil distribution, paleomagnetism, continental drift and sea-floor spreading contributed to the theory of plate tectonics. The rigid tectonic plates move with the molten rock and magma beneath them in the upper mantle.<br><br>Convection currents in the asthenosphere cause movements of the lithospheric plates. The energy that forms convection currents comes from deep within the Earth.<br><br>There are three main types of plate boundaries: divergent, convergent and transform. Each type of boundary results in specific motion and causes events (such as earthquakes or volcanic activity) or features (such as mountains or trenches) that are indicative of the type of boundary. | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| **A combination of constructive and destructive geologic processes formed Earth's surface.**<br><br>Earth's surface is formed from a variety of different geologic processes, including but not limited to plate tectonics.<br><br>**Note:** The introduction of Earth's surface is found in ESS grade 4. | **8.ESS.3: A combination of constructive and destructive geologic processes formed Earth's surface.**<br><br>Earth's surface is formed from a variety of different geologic processes, including but not limited to plate tectonics. | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
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| **Evidence of the dynamic changes of Earth's surface through time is found in the geologic record.**<br><br>Earth is approximately 4.6 billion years old. Earth history is based on observations of the geologic record and the understanding that processes observed at present day are similar to those that occurred in the past (uniformitarianism). There are different methods to determine relative and absolute age of some rock layers in the geologic record. Within a sequence of undisturbed sedimentary rocks, the oldest rocks are at the bottom (superposition). The geologic record can help identify past environmental and climate conditions.<br><br>**Note:** Environmental and climate conditions also can be documented through the cryosphere as seen through ice cores. | **8.ESS.4: Evidence of the dynamic changes of Earth's surface through time is found in the geologic record.**<br><br>Earth is approximately 4.6 billion years old. Earth history is based on observations of the geologic record and the understanding that processes observed at present day are similar to those that occurred in the past (uniformitarianism). There are different methods to determine relative and absolute age of some rock layers in the geologic record. Within a sequence of undisturbed sedimentary rocks, the oldest rocks are at the bottom (superposition). The geologic record can help identify past environmental and climate conditions. | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| **Physical Science (PS)** | **Physical Science (PS)** | |
| **Forces between objects act when the objects are in direct contact or when they are not touching.**<br><br>Magnetic, electrical and gravitational forces can act at a distance.<br><br>**Note:** Direct contact forces were addressed in the elementary grades. | **8.PS.1: Objects can experience a force due to an external field such as magnetic, electrostatic, or gravitational fields.**<br><br>Magnetic, electrical and gravitational forces can act at a distance. | This standard focuses on using a field model to understand interactions between objects that are not touching. Investigating the effects of external fields on various objects supports this understanding. Take care to foster understanding of fields as scientific models rather than physical materials (for example, field lines are conceptual modeling tools, not actual lines consisting of matter or energy).<br><br>Content relating to motors and generators was moved to grade 7, but the general relationship between electricity and magnetism, including electromagnets, continues to be grade 8 content. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
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| **Forces have magnitude and direction.**<br><br>The motion of an object is always measured with respect to a reference point.<br><br>Forces can be added. The net force on an object is the sum of all of the forces acting on the object. The net force acting on an object can change the object's direction and/or speed.<br><br>When the net force is greater than zero, the object's speed and/or direction will change. When the net force is zero, the object remains at rest or continues to move at a constant speed in a straight line. | **8.PS.2: Forces can act to change the motion of objects.**<br><br>The motion of an object is always measured with respect to a reference point.<br><br>Forces can be added. The new force on an object is the sum of all of the forces acting on the object.<br><br>If there is a nonzero net force acting on an object, its speed and/or direction will change.<br><br>Kinetic friction and drag are forces that act in a direction opposite the relative motion of objects. | Forces due to kinetic friction and drag were emphasized by adding them to the standard descriptor, although the content already was in the elaboration.<br><br>Balanced and unbalanced forces now are being introduced in grade 5. The content on forces for this standard is unchanged, but the depth of coverage should increase. Be aware that there will be several years before students entering grade 8 will have had this additional instruction in grade 5.<br><br>The relative nature of motion should continue to be an emphasis. |
| **There are different types of potential energy.**<br><br>Gravitational potential energy changes in a system as the masses or relative positions of objects are changed.<br><br>Objects can have elastic potential energy due to their compression or chemical potential energy due to the nature and arrangement of the atoms that make up the object. | | This content was moved from grade 8 and now can be found in grade 7. It is important to plan for a transition year, so that a cohort of students does not entirely miss this content. If both grades move entirely to the new standards during one school year, students who are in grade 8 during the first year of implementation will not cover this content in either grade. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
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| **Life Science (LS)** | **Life Science (LS)** | |
| **Diversity of species occurs through gradual processes over many generations. Fossil records provide evidence that changes have occurred in number and types of species.**<br><br>Fossils provide important evidence of how life and environmental conditions have changed.<br><br>Changes in environmental conditions can affect how beneficial a trait will be for the survival and reproductive success of an organism or an entire species.<br><br>Throughout Earth's history, extinction of a species has occurred when the environment changes and the individual organisms of that species do not have the traits necessary to survive and reproduce in the changed environment. Most species (approximately 99 percent) that have lived on Earth are now extinct.<br><br>**Note:** Population genetics and the ability to use statistic mathematics to predict changes in a gene pool are reserved for grade 10. | **8.LS.1: Diversity of species, a result of variation of traits, occurs through the process of evolution and extinction over many generations. The fossil records provide evidence that changes have occurred in number and types of species.**<br><br>Fossils provide important evidence of how life and environmental conditions have changed.<br><br>Changes in environmental conditions can affect how beneficial a trait will be for the survival and reproductive success of an organism or an entire species.<br><br>Throughout Earth's history, extinction of a species has occurred when the environment changes and the individual organisms of that species do not have the traits necessary to survive and reproduce in the changed environment. Most species (approximately 99 percent) that have lived on Earth are now extinct.<br><br>**Note:** *Population genetics and the ability to use statistic mathematics to predict changes in a gene pool are reserved for high school Biology.* | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| **Reproduction is necessary for the continuation of every species.**<br><br>Every organism alive today comes from a long line of ancestors who reproduced successfully every generation. Reproduction is the transfer of genetic information from one generation to the next. It can occur with mixing of genes from two individuals (sexual reproduction). It can occur with the transfer of genes from one individual to the next generation (asexual reproduction). The ability to reproduce defines living things. | **8.LS.2: Every organism alive today comes from a long line of ancestors who reproduced successfully every generation.**<br><br>Reproduction is the transfer of genetic information from one generation to the next. It can occur with mixing of genes from two individuals (sexual reproduction). It can occur with the transfer of genes from one individual to the next generation (asexual reproduction). The ability to reproduce defines living things. | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
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| **The characteristics of an organism are a result of inherited traits received from parent(s).**<br><br>Expression of all traits is determined by genes and environmental factors to varying degrees. Many genes influence more than one trait, and many traits are influenced by more than one gene.<br><br>During reproduction, genetic information (DNA) is transmitted between parent and offspring. In asexual reproduction, the lone parent contributes DNA to the offspring. In sexual reproduction, both parents contribute DNA to the offspring.<br><br>**Note 1:** The focus should be the link between DNA and traits without being explicit about the mechanisms involved.<br><br>**Note 2:** The ways in which bacteria reproduce is beyond the scope of this content statement.<br><br>**Note 3:** The molecular structure of DNA is not appropriate at this grade level. | **8.LS.3: The characteristics of an organism are a result of inherited traits received from parent(s).**<br><br>Expression of all traits is determined by genes and environmental factors to varying degrees. Many genes influence more than one trait, and many traits are influenced by more than one gene.<br><br>During reproduction, genetic information (DNA) is transmitted between parent and offspring. In asexual reproduction, the lone parent contributes DNA to the offspring. In sexual reproduction, both parents contribute DNA to the offspring.<br><br>**Note 1:** *The focus should be the link between DNA and traits without being explicit about the mechanisms involved.*<br><br>**Note 2:** *The ways in which bacteria reproduce is beyond the scope of this content statement.*<br><br>**Note 3:** *The molecular structure of DNA is not appropriate at this grade level.* | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

# Instructional Implications for Physical Science

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
|---|---|---|
| **Study of Matter** | **Study of Matter (PS.M)** | |
| Classification of matter<br>Heterogeneous vs. homogeneous<br>Properties of matter<br>States of matter and its changes | **PS.M.1: Classification of matter**<br>Heterogeneous vs. homogeneous<br>Properties of matter<br>States of matter and its changes | Content previously covered in grade 7 pertaining to pH has been moved to this standard. Discussions and experiments involving the determination of acids, bases and neutrals are pertinent to this standard. However, details of the pH scale and how it is determined by hydrogen and hydroxide concentrations will be covered in the chemistry course. |
| Atoms<br>Models of the atom (components)<br>Ions (cations and anions)<br>Isotopes | **PS.M.2: Atoms**<br>Models of the atom (components)<br>Ions (cations and anions)<br>Isotopes | An introduction to subatomic particles has been removed from the grade 7 physical science curriculum. This will be the first time students are introduced to this concept. Care must be given to present this material to students to ensure their understanding of the concepts, so they may build upon them when discussing ions and isotopes. |
| Periodic trends of the elements<br>Periodic law<br>Representative groups | **PS.M.3: Periodic trends of the elements**<br>Periodic law<br>Representative groups | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| Bonding and compounds<br>Bonding (ionic and covalent)<br>Nomenclature | **PS.M.4: Bonding and compounds**<br>Bonding (ionic and covalent)<br>Nomenclature | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| Reactions of matter<br>Chemical reactions<br>Nuclear reactions | **PS.M.5: Reactions of matter**<br>Chemical reactions<br>Nuclear reactions | Content about types of nuclear reactions and the use of nuclear reactions as an energy resource is now included in this content statement. This content previously had been covered in the chemistry course. |
| **Energy and Waves** | **Energy and Waves (PS.EW)** | |
| Conservation of energy<br>Quantifying kinetic energy<br>Quantifying gravitational potential energy<br>Energy is relative | **PS.EW.1: Conservation of energy**<br>Quantifying kinetic energy<br>Quantifying gravitational potential energy | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| Transfer and transformation of energy (including work) | **PS.EW.2: Transfer and transformation of energy** (including work) | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
|---|---|---|
| Waves<br>Refraction, reflection, diffraction, absorption, superposition<br>Radiant energy and the electromagnetic spectrum<br>Doppler shift | **PS.EW.2: Transfer and transformation of energy** (including work) | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| Waves<br>Refraction, reflection, diffraction, absorption, superposition<br>Radiant energy and the electromagnetic spectrum<br>Doppler shift | **PS.EW.3: Waves**<br>Refraction, reflection, diffraction, absorption, superposition<br>Radiant energy and the electromagnetic spectrum<br>Doppler shift | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| Thermal energy | **PS.EW.4: Thermal energy** | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| Electricity<br>Movement of electrons<br>Current<br>Electric potential (voltage)<br>Resistors and transfer of energy | **PS.EW.5: Electricity**<br>Movement of electrons<br>Current<br>Electric potential (voltage)<br>Resistors and transfer of energy | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| **Forces and Motion** | **Forces and Motion (PS.FM)** | |
| Motion<br>Introduction to one-dimensional vectors<br>Displacement, velocity (constant, average and instantaneous) and acceleration<br>Interpreting position vs. time and velocity vs. time graphs | **PS.FM.1: Motion**<br>Introduction to one-dimensional vectors<br>Displacement, velocity (constant, average and instantaneous) and acceleration<br>Interpreting position vs. time and velocity vs. time graphs | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| Forces<br>Force diagrams<br>Types of forces (gravity, friction, normal, tension)<br>Field model for forces at a distance | **PS.FM.2: Forces**<br>Force diagrams<br>Types of forces (gravity, friction, normal, tension)<br>Field model for forces at a distance | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| Dynamics (how forces affect motion)<br>Objects at rest<br>Objects moving with constant velocity<br>Accelerating objects | **PS.FM.3: Dynamics** (how forces affect motion)<br>Objects at rest<br>Objects moving with constant velocity<br>Accelerating objects | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

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|---|---|---|
| **Universe** | **Universe (PS.U)** | |
| History of the universe | **PS.U.1: History of the universe** | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| Galaxy formation | **PS.U.2: Galaxies** | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| Stars<br>Formation; stages of evolution<br>Fusion in stars | **PS.U.3: Stars**<br>Formation; stages of evolution<br>Fusion in stars | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

# Instructional Implications for Biology

| 2010 Content Statement | 2018 Content Statement | Instructional implications of revisions |
|---|---|---|
| **Heredity** | **Heredity (B.H)** | |
| Cellular genetics | **B.H.1: Cellular genetics** | No change in the content<br><br>Cellular heredity instruction should acknowledge epigenetics as the final arbiter of individual gene expression and the basis for cellular differentiation. Instruction also should explore the complete process, including the role of RNA in gene expression and function within the cell. |
| Structure and function of DNA in cells | **B.H.2: Structure and function of DNA in cells** | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| Genetic mechanisms and inheritance | **B.H.3: Genetic mechanisms and inheritance** | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| Mutations | **B.H.4: Mutations** | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| Modern genetics | **B.H.5: Modern genetics** | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |

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|---|---|---|
| **Evolution** | **Evolution (B.E)** | |
| Mechanisms<br>Natural selection<br>Mutation<br>Genetic drift<br>Gene flow (immigration,<br>Emigration<br>Sexual selection<br>History of Life on Earth | **B.E.1: Mechanisms**<br>Natural selection<br>Mutation<br>Genetic drift<br>Gene flow (immigration, emigration)<br>Sexual selection | *History of Life on Earth* is no longer listed as a separate subtopic in the syllabus. However, the standards address this content throughout the study of the evolution.<br><br>Mutations do not form a mechanism for macroevolutionary progress. Instead, they form the basis of thousands of human diseases and cancer. Instructors should distinguish between microevolutionary adaptation of changes within kinds that are readily observable and macroevolutionary change from single cell creatures to higher complexity — changes that are never directly observed but must be inferred. |
| Diversity of Life<br>Speciation and biological classification based on molecular evidence<br>Variation of organisms within a species due to population genetics and gene frequency | **B.E.2: Speciation**<br>Biological classification expanded to molecular evidence<br><br>Variation of organisms within a species due to population genetics and gene frequency | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| **Diversity and Interdependence of Life** | **Diversity and Interdependence of Life (B.DI)** | |
| Classification Systems<br>Classification systems are frameworks created by scientists for describing the vast diversity of organisms indicating the degree of relatedness between organisms. | **B.DI.1: Biodiversity**<br>Genetic diversity<br>Species diversity | This standard focuses on the study of diversity and similarity at the molecular level of organisms. Examples of diversity at both the macro and micro levels should be observed and discussed. Standards encourage using cladograms to visualize the relatedness of species. |
| Ecosystems<br>Homeostasis<br>Carrying capacity<br>Equilibrium and disequilibrium | **B.DI.2: Ecosystems**<br>Equilibrium and disequilibrium<br>Carrying capacity | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| | **B.DI.3: Loss of diversity**<br>Climate change<br>Anthropocene effects<br>Extinction<br>Invasive species | This is an additional focus for the biology course. Students should examine factors that contribute to the accelerated extinction rates observed today and the implications of declining biodiversity. Instructors should address misconceptions about population growth capacity, interspecies and intraspecies competition for resources and what occurs when members of a species immigrate to or emigrate from ecosystems. Using technology to access real-time data on population changes and growth in specific locations can help relate concepts to current events. |

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|---|---|---|
| **Cells** | **Cells (B.C)** | |
| Cell structure and function<br>Structure, function and interrelatedness of cell organelles<br>Eukaryotic cells and prokaryotic cells | **B.C.1: Cell structure and function**<br>Structure, function and interrelatedness of cell organelles<br>Eukaryotic cells and prokaryotic cells | No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards. |
| Cellular processes<br>Characteristics of life regulated by cellular processes<br>Photosynthesis, chemosynthesis, cellular respiration, cell division and differentiation | **B.C.2: Cellular processes**<br>Characteristics of life regulated by cellular processes<br>Photosynthesis, chemosynthesis, cellular respiration, biosynthesis of macromolecules | Cell division and differentiation have been removed as a topic. This content was introduced in grade 8 and should be built upon in this course.<br>Focus on the biosynthesis of macromolecules, cellular reactions and the external conditions necessary for those reactions to take place. |