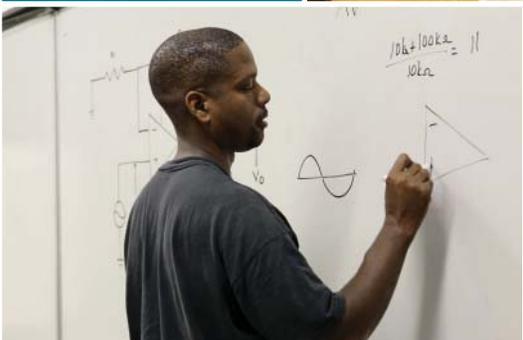


Colorado Academic STANDARDS

Fourth Grade

Science



Colorado Academic Standards Science

"Science is facts; just as houses are made of stone, so is science made of facts; but a pile of stones is not a house, and a collection of facts is not necessarily science." --*Jules Henri Poincaré (1854-1912) French mathematician.*

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High expectations in education are essential for the U.S. to continue as a world leader in the 21<sup>st</sup> century. In order to be successful in postsecondary education, the workforce, and in life, students need a rigorous, age-appropriate set of standards that include finding and gathering information, critical thinking, and reasoning skills to evaluate information, and use information in social and cultural contexts. Students must learn to comprehend and process information, analyze and draw conclusions, and apply the results to everyday life.

A quality science education embodies 21<sup>st</sup> century skills and postsecondary and workforce readiness by teaching students critical skills and thought processes to meet the challenges of today's world. Scientifically literate graduates will help to ensure Colorado's economic vitality by encouraging the development of research and technology, managing and preserving our environmental treasures, and caring for the health and well-being of our citizens.

Science is both a body of knowledge that represents the current understanding of natural systems, and the process whereby that body of knowledge has been established and is continually extended, refined, and revised. Because science is both the knowledge of the natural world and the processes that have established this knowledge, science education must address both of these aspects.

At a time when pseudo-scientific ideas and outright fraud are becoming more common place, developing the skepticism and critical thinking skills of science gives students vital skills needed to make informed decisions about their health, the environment, and other scientific issues facing society. A major aspect of science is the continual interpretation of evidence. All scientific ideas constantly are being challenged by new evidence and are evolving to fit the new evidence. Students must understand the collaborative social processes that guide these changes so they can reason through and think critically about popular scientific information, and draw valid conclusions based on evidence, which often is limited. Imbedded in the cognitive process, students learn and apply the social and cultural skills expected of all citizens in school and in the workplace. For example, during class activities, laboratory exercises, and projects, students learn and practice self-discipline, collaboration, and working in groups.

The Colorado Academic Standards in science represent what all Colorado students should know and be able to do in science as a result of their preschool through twelfth-grade science education. Specific expectations are given for students who complete each grade from preschool through eighth grade and for high school. These standards outline the essential level of science content knowledge and the application of the skills needed by all Colorado citizens to participate productively in our increasingly global, information-driven society.

## Standards Organization and Construction

As the subcommittee began the revision process to improve the existing standards, it became evident that the way the standards information was organized, defined, and constructed needed to change from the existing documents. The new design is intended to provide more clarity and direction for teachers, and to show how 21<sup>st</sup> century skills and the elements of school readiness and postsecondary and workforce readiness indicators give depth and context to essential learning.

The “Continuum of State Standards Definitions” section that follows shows the hierarchical order of the standards components. The “Standards Template” section demonstrates how this continuum is put into practice.

The elements of the revised standards are:

**Prepared Graduate Competencies:** The preschool through twelfth-grade concepts and skills that all students who complete the Colorado education system must master to ensure their success in a postsecondary and workforce setting.

**Standard:** The topical organization of an academic content area.

**High School Expectations:** The articulation of the concepts and skills of a standard that indicates a student is making progress toward being a prepared graduate. *What do students need to know in high school?*

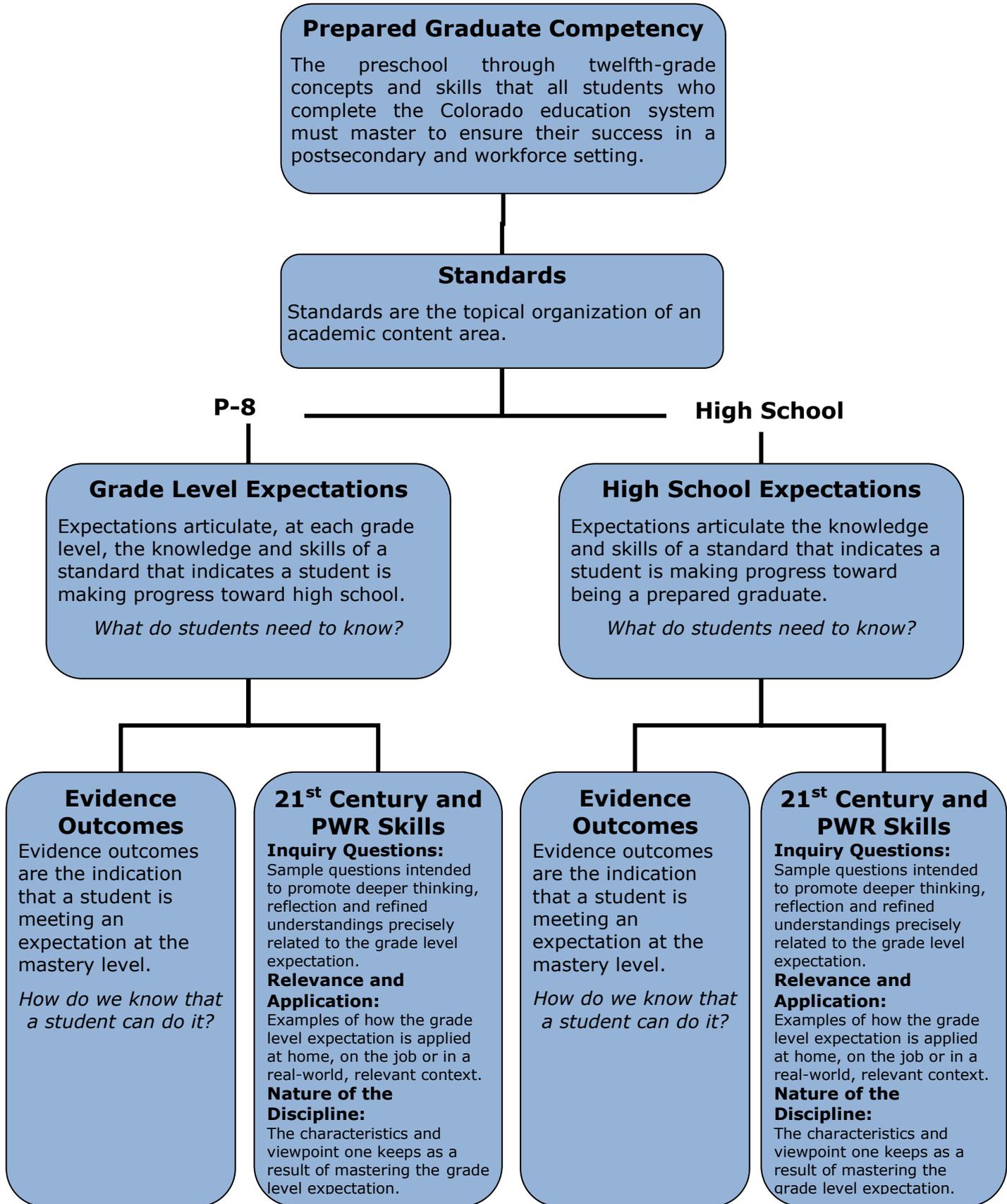
**Grade Level Expectations:** The articulation (at each grade level), concepts, and skills of a standard that indicate a student is making progress toward being ready for high school. *What do students need to know from preschool through eighth grade?*

**Evidence Outcomes:** The indication that a student is meeting an expectation at the mastery level. *How do we know that a student can do it?*

**21<sup>st</sup> Century Skills and Readiness Competencies:** Includes the following:

- ***Inquiry Questions:***  
Sample questions are intended to promote deeper thinking, reflection and refined understandings precisely related to the grade level expectation.
- ***Relevance and Application:***  
Examples of how the grade level expectation is applied at home, on the job or in a real-world, relevant context.
- ***Nature of the Discipline:***  
The characteristics and viewpoint one keeps as a result of mastering the grade level expectation.

# Continuum of State Standards Definitions



## STANDARDS TEMPLATE

**Content Area: NAME OF CONTENT AREA**

**Standard:** The topical organization of an academic content area.

**Prepared Graduates:**

- The preschool through twelfth-grade concepts and skills that all students who complete the Colorado education system must master to ensure their success in a postsecondary and workforce setting.

### High School and Grade Level Expectations

**Concepts and skills students master:**

Grade Level Expectation: High Schools: The articulation of the concepts and skills of a standard that indicates a student is making progress toward being a prepared graduate.

Grade Level Expectations: The articulation, at each grade level, the concepts and skills of a standard that indicates a student is making progress toward being ready for high school.

*What do students need to know?*

**Evidence Outcomes**

**Students can:**

Evidence outcomes are the indication that a student is meeting an expectation at the mastery level.

*How do we know that a student can do it?*

**21<sup>st</sup> Century Skills and Readiness Competencies**

**Inquiry Questions:**

Sample questions intended to promote deeper thinking, reflection and refined understandings precisely related to the grade level expectation.

**Relevance and Application:**

Examples of how the grade level expectation is applied at home, on the job or in a real-world, relevant context.

**Nature of the Discipline:**

The characteristics and viewpoint one keeps as a result of mastering the grade level expectation.

## Prepared Graduate Competencies in Science

The preschool through twelfth-grade concepts and skills that all students who complete the Colorado education system must master to ensure their success in a postsecondary and workforce setting.

Prepared Graduates:

- Observe, explain, and predict natural phenomena governed by Newton's laws of motion, acknowledging the limitations of their application to very small or very fast objects
- Apply an understanding of atomic and molecular structure to explain the properties of matter, and predict outcomes of chemical and nuclear reactions
- Apply an understanding that energy exists in various forms, and its transformation and conservation occur in processes that are predictable and measurable
- Analyze the relationship between structure and function in living systems at a variety of organizational levels, and recognize living systems' dependence on natural selection
- Explain and illustrate with examples how living systems interact with the biotic and abiotic environment
- Analyze how various organisms grow, develop, and differentiate during their lifetimes based on an interplay between genetics and their environment
- Explain how biological evolution accounts for the unity and diversity of living organisms
- Describe and interpret how Earth's geologic history and place in space are relevant to our understanding of the processes that have shaped our planet
- Evaluate evidence that Earth's geosphere, atmosphere, hydrosphere, and biosphere interact as a complex system
- Describe how humans are dependent on the diversity of resources provided by Earth and Sun

## Standards in Science

Standards are the topical organization of an academic content area. The three standards of science are:

**1. Physical Science**

Students know and understand common properties, forms, and changes in matter and energy.

**2. Life Science**

Students know and understand the characteristics and structure of living things, the processes of life, and how living things interact with each other and their environment.

**3. Earth Systems Science**

Students know and understand the processes and interactions of Earth's systems and the structure and dynamics of Earth and other objects in space.

## Science Grade Level Expectations at a Glance

| Standard                 | Grade Level Expectation                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Fourth Grade</b>      |                                                                                                                                                                                                                                                                                                                                                                                              |
| 1. Physical Science      | 1. Energy comes in many forms such as light, heat, sound, magnetic, chemical, and electrical                                                                                                                                                                                                                                                                                                 |
| 2. Life Science          | 1. All living things share similar characteristics, but they also have differences that can be described and classified<br>2. Comparing fossils to each other or to living organisms reveals features of prehistoric environments and provides information about organisms today<br>3. There is interaction and interdependence between and among living and nonliving components of systems |
| 3. Earth Systems Science | 1. Earth is part of the solar system, which includes the Sun, Moon, and other bodies that orbit the Sun in predictable patterns that lead to observable paths of objects in the sky as seen from Earth                                                                                                                                                                                       |

## **21<sup>st</sup> Century Skills and Readiness Competencies in Science**

### **Colorado's Description of 21st Century Skills**

Colorado's description of 21st century skills is a synthesis of the essential abilities students must apply in our rapidly changing world. Today's students need a repertoire of knowledge and skills that are more diverse, complex, and integrated than any previous generation. These skills do not stand alone in the standards, but are woven into the evidence outcomes, inquiry questions, and application and are within the nature of science. Science inherently demonstrates each of Colorado's 21<sup>st</sup> century skills, as follows:

#### Critical Thinking and Reasoning

Science requires students to analyze evidence and draw conclusions based on that evidence. Scientific investigation involves defining problems and designing studies to test hypotheses related to those problems. In science, students must justify and defend scientific explanations and distinguish between correlation and causation.

#### Information Literacy

Understanding science requires students to research current ideas about the natural world. Students must be able to distinguish fact from opinion and truth from fantasy. Science requires a degree of skepticism because the ideas of science are subject to change. Science students must be able to understand what constitutes reliable sources of information and how to validate those sources. One key to science is understanding that converging different lines of evidence from multiple sources strengthens a scientific conclusion.

#### Collaboration

Science students must be able to listen to others' ideas, and engage in scientific dialogs that are based on evidence – not opinion. These types of conversations allow them to compare and evaluate the merit of different ideas. The peer review process helps to ensure the validity of scientific explanations.

#### Self-Direction

Students in science must have persistence and perseverance when exploring scientific concepts. Students must generate their own questions, and design investigations to find the answers. Students must be open to revising and redefining their thinking based on evidence.

#### Invention

Designing investigations and engineering new products involves a large degree of invention. Scientists and engineers often have to think "outside the box" as they push the limits of our current knowledge. They must learn from their failures to take the next steps in understanding. Science students also must integrate ideas from multiple disciplines to formulate an understanding of the natural world. In addition to using invention to design investigations, scientists also use findings from investigations to help them to invent new products.

## **Colorado’s Description for School Readiness**

*(Adopted by the State Board of Education, December 2008)*

School readiness describes both the preparedness of a child to engage in and benefit from learning experiences, and the ability of a school to meet the needs of all students enrolled in publicly funded preschools or kindergartens. School readiness is enhanced when schools, families, and community service providers work collaboratively to ensure that every child is ready for higher levels of learning in academic content.

## **Colorado’s Description of Postsecondary and Workforce Readiness**

*(Adopted by the State Board of Education, June 2009)*

Postsecondary and workforce readiness describes the knowledge, skills, and behaviors essential for high school graduates to be prepared to enter college and the workforce and to compete in the global economy. The description assumes students have developed consistent intellectual growth throughout their high school career as a result of academic work that is increasingly challenging, engaging, and coherent. Postsecondary education and workforce readiness assumes that students are ready and able to demonstrate the following without the need for remediation: Critical thinking and problem-solving; finding and using information/information technology; creativity and innovation; global and cultural awareness; civic responsibility; work ethic; personal responsibility; communication; and collaboration.

## **How These Skills and Competencies are Embedded in the Revised Standards**

Three themes are used to describe these important skills and competencies and are interwoven throughout the standards: *inquiry questions; relevance and application; and the nature of each discipline*. These competencies should not be thought of stand-alone concepts, but should be integrated throughout the curriculum in all grade levels. Just as it is impossible to teach thinking skills to students without the content to think about, it is equally impossible for students to understand the content of a discipline without grappling with complex questions and the investigation of topics.

**Inquiry Questions** – Inquiry is a multifaceted process requiring students to think and pursue understanding. Inquiry demands that students (a) engage in an active observation and questioning process; (b) investigate to gather evidence; (c) formulate explanations based on evidence; (d) communicate and justify explanations, and; (e) reflect and refine ideas. Inquiry is more than hands-on activities; it requires students to cognitively wrestle with core concepts as they make sense of new ideas.

**Relevance and Application** – The hallmark of learning a discipline is the ability to apply the knowledge, skills, and concepts in real-world, relevant contexts. Components of this include solving problems, developing, adapting, and refining solutions for the betterment of society. The application of a discipline, including how technology assists or accelerates the work, enables students to more fully appreciate how the mastery of the grade level expectation matters after formal schooling is complete.

**Nature of Discipline** – The unique advantage of a discipline is the perspective it gives the mind to see the world and situations differently. The characteristics and viewpoint one keeps as a result of mastering the grade level expectation is the nature of the discipline retained in the mind’s eye.

# 1. Physical Science

Students know and understand common properties, forms and changes in matter and energy.

## **Prepared Graduates**

The preschool through twelfth-grade concepts and skills that all students who complete the Colorado education system must master to ensure their success in a postsecondary and workforce setting.

### **Prepared Graduate Competencies in the Physical Science standard:**

- Observe, explain, and predict natural phenomena governed by Newton's laws of motion, acknowledging the limitations of their application to very small or very fast objects
- Apply an understanding of atomic and molecular structure to explain the properties of matter, and predict outcomes of chemical and nuclear reactions
- Apply an understanding that energy exists in various forms, and its transformation and conservation occur in processes that are predictable and measurable

**Content Area: Science**

**Standard: 1. Physical Science**

**Prepared Graduates:**

- Apply an understanding that energy exists in various forms, and its transformation and conservation occur in processes that are predictable and measurable

**Grade Level Expectation: Fourth Grade**

**Concepts and skills students master:**

1. Energy comes in many forms such as light, heat, sound, magnetic, chemical, and electrical

**Evidence Outcomes**

**Students can:**

- a. Identify and describe the variety of energy sources (DOK 1)
- b. Show that electricity in circuits requires a complete loop through which current can pass (DOK 1)
- c. Describe the energy transformation that takes place in electrical circuits where light, heat, sound, and magnetic effects are produced (DOK 1-2)
- d. Use multiple resources – including print, electronic, and human – to locate information about different sources of renewable and nonrenewable energy (DOK 1-2)

**21<sup>st</sup> Century Skills and Readiness Competencies**

**Inquiry Questions:**

1. How do we know that energy exists within a system such as in an electrical circuit?
2. How can heat be transferred from one object to another?

**Relevance and Application:**

1. There are multiple energy sources, both renewable and nonrenewable.
2. Energy can be used or stored. For example, it can be stored in a battery and then used when running a portable media player such as an iPod.
3. Transportation, manufacturing, and technology are driven by energy.

**Nature of Science:**

1. Ask testable questions about energy, make a falsifiable hypothesis and design an inquiry based method of finding the answer, collect data, and form a conclusion. (DOK 2-4)
2. Understand that models are developed to explain and predict phenomena that cannot be directly observed. (DOK 1)
3. Critically evaluate models of energy, identifying the strengths and weaknesses of the model in representing what happens in the real world. (DOK 2-3)
4. Create plans to decrease electrical energy use for one week and evaluate the results. (DOK 2-4)

## 2. Life Science

Students know and understand the characteristics and structure of living things, the processes of life and how living things interact with each other and their environment.

### **Prepared Graduates**

The preschool through twelfth-grade concepts and skills that all students who complete the Colorado education system must master to ensure their success in a postsecondary and workforce setting.

#### **Prepared Graduate Competencies in the Life Science standard:**

- Analyze the relationship between structure and function in living systems at a variety of organizational levels, and recognize living systems' dependence on natural selection
- Explain and illustrate with examples how living systems interact with the biotic and abiotic environment
- Analyze how various organisms grow, develop, and differentiate during their lifetimes based on an interplay between genetics and their environment
- Explain how biological evolution accounts for the unity and diversity of living organisms

**Content Area: Science**  
**Standard: 2. Life Science**

**Prepared Graduates:**

- Analyze how various organisms grow, develop, and differentiate during their lifetimes based on an interplay between genetics and their environment

**Grade Level Expectation: Fourth Grade**

**Concepts and skills students master:**

1. All living things share similar characteristics, but they also have differences that can be described and classified

**Evidence Outcomes**

**Students can:**

- a. Use evidence to develop a scientific explanation of what plants and animals need to survive (DOK 1-3)
- b. Use evidence to develop a scientific explanation for similarities and/or differences among different organisms (species) (DOK 1-3)
- c. Analyze and interpret data representing variation in a trait (DOK 1-2)
- d. Examine, evaluate, question, and ethically use information from a variety of sources and media to investigate questions about characteristics of living things (DOK 1-2)

**21<sup>st</sup> Century Skills and Readiness Competencies**

**Inquiry Questions:**

1. How have classification systems changed over time?
2. How are individuals in a related species similar and different?

**Relevance and Application:**

1. Human beings have use technology in order to survive in a variety of climates, such as heating and air conditioning.

**Nature of Science:**

1. Understand that all scientific knowledge is subject to new findings and that the presence of reproducible results yields a scientific theory. (DOK 1)
2. Evaluate and provide feedback on evidence used by others to justify how they classified organisms. (DOK 2-3)

**Content Area: Science**  
**Standard: 2. Life Science**

**Prepared Graduates:**

- Explain how biological evolution accounts for the unity and diversity of living organisms

**Grade Level Expectation: Fourth Grade**

**Concepts and skills students master:**

2. Comparing fossils to each other or to living organisms reveals features of prehistoric environments and provides information about organisms today

**Evidence Outcomes**

**Students can:**

- a. Use evidence to develop a scientific explanation for:
  1. What fossils tell us about a prehistoric environment
  2. What conclusions can be drawn from similarities between fossil evidence and living organisms (DOK 1-3)
- b. Analyze and interpret data to generate evidence about the prehistoric environment (DOK 1-2)
- c. Evaluate whether reasoning and conclusions about given fossils are supported by evidence (DOK 1-3)
- d. Use computer simulations that model and recreate past environments for study and entertainment (DOK 1-2)

**21<sup>st</sup> Century Skills and Readiness Competencies**

**Inquiry Questions:**

1. What are some things fossils can't tell us?
2. What conditions would most likely lead to something becoming a fossil?

**Relevance and Application:**

1. Computers are used to model and recreate past environments for study and entertainment.

**Nature of Science:**

1. Ask testable questions about past environments. (DOK 2)
2. Make predictions about past environments based on fossil evidence. (DOK 2)
3. Recognize that different interpretations of evidence are possible. (DOK 1)

**Content Area: Science**  
**Standard: 2. Life Science**

**Prepared Graduates:**

- Explain and illustrate with examples how living systems interact with the biotic and abiotic environment

**Grade Level Expectation: Fourth Grade**

**Concepts and skills students master:**

3. There is interaction and interdependence between and among living and nonliving components of ecosystems

**Evidence Outcomes**

**Students can:**

- a. Use evidence to develop a scientific explanation on how organisms adapt to their habitat (DOK 1-3)
- b. Identify the components that make a habitat type unique (DOK 1)
- c. Compare and contrast different habitat types (DOK 2)
- d. Create and evaluate models of the flow of nonliving components or resources through an ecosystem (DOK 2-3)
- e. Make a plan to positively impact a local ecosystem (DOK 2-4)
- f. Examine, evaluate, question, and ethically use information from a variety of sources and media to investigate endangered habitats (DOK 1-2)

**21<sup>st</sup> Century Skills and Readiness Competencies**

**Inquiry Questions:**

1. How are resources shared among organisms in a specific ecosystem or habitat?
2. How do nonliving components of an ecosystem influence living components?
3. What would happen if the Sun's energy no longer reached Earth?
4. What would happen if water were removed from an ecosystem?

**Relevance and Application:**

1. Humans can have positive and negative impacts on an ecosystem.
2. Nonliving components are cycled and recycled through ecosystems and need to be protected and conserved.

**Nature of Science:**

1. Understand that models are developed to explain and predict natural phenomena that cannot be directly observed because they happen over long periods of time. (DOK 1)
2. Evaluate models that show interactions between living and nonliving components of ecosystems, identifying the strengths and weaknesses of the model in representing what happens in the real world. (DOK 2-3)

# 3. Earth Systems Science

Students know and understand the processes and interactions of Earth's systems and the structure and dynamics of Earth and other objects in space.

**Prepared Graduates:**

The preschool through twelfth-grade concepts and skills that all students who complete the Colorado education system must master to ensure their success in a postsecondary and workforce setting.

**Prepared Graduate Competencies in the Earth Systems Science standard:**

- Describe and interpret how Earth's geologic history and place in space are relevant to our understanding of the processes that have shaped our planet
- Evaluate evidence that Earth's geosphere, atmosphere, hydrosphere, and biosphere interact as a complex system
- Describe how humans are dependent on the diversity of resources provided by Earth and Sun

**Content Area: Science**

**Standard: 3. Earth Systems Science**

**Prepared Graduates:**

- Describe and interpret how Earth's geologic history and place in space are relevant to our understanding of the processes that have shaped our planet

**Grade Level Expectation: Fourth Grade**

**Concepts and skills students master:**

1. Earth is part of the solar system, which includes the Sun, Moon, and other bodies that orbit the Sun in predictable patterns that lead to observable paths of objects in the sky as seen from Earth

**Evidence Outcomes**

**Students can:**

- a. Gather, analyze, and interpret data about components of the solar system (DOK 1-2)
- b. Utilize direct and indirect evidence to investigate the components of the solar system (DOK 1-2)
- c. Gather, analyze, and interpret data about the Sunrise and Sunset, and Moon movements and phases (DOK 1-2)
- d. Develop a scientific explanation regarding relationships of the components of the solar system (DOK 1-3)

**21<sup>st</sup> Century Skills and Readiness Competencies**

**Inquiry Questions:**

1. What are the patterns of movement for the Sun and Moon across the sky?
2. How does Earth compare to other objects orbiting the Sun?
3. How do we study the solar system?

**Relevance and Application:**

1. Space exploration has produced data to answer questions about the solar system.
2. Comets are observable objects seen from Earth which provide scientists data about the solar system.
3. Orbits in a predictable pattern in space influence season's on Earth.

**Nature of Science:**

1. Understand that models are developed to explain and predict natural phenomena that cannot be directly observed because they happen over long periods of time. (DOK 1)
2. Critically evaluate models of the solar system, identifying the strengths and weaknesses of the model in representing what happens in the real solar system. (DOK 2-3)

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