Science: Assessment Frameworks-at-a-Glance and Colorado Content Model Standards

1. Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.
2. Physical Science: Students know and understand common properties, forms, and changes in matter and energy.
3. 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.
4. Earth and Space: Students know and understand the processes and interactions of earth's systems and the structure and dynamics of earth and other objects in space.
5. Students know and understand interrelationships among science, technology, and human activity and how they can affect the world.
6. Students understand that science involves a particular way of knowing and understand common connections among scientific disciplines.

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1. Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.

--Rationale

In everyday life, we find ourselves gathering and evaluating information (data), noting and wondering about patterns and regularities, devising and testing possible explanations for how things work, and discussing ideas with others. These characteristically human activities mirror in many ways how scientists think and work. Scientific investigation (inquiry) often begins with a question or problem and usually ends with further questions to investigate. Such investigations may include long-term field studies and are not limited to direct experimentation in a lab setting. They involve the identification and control of variables. Inquiry in the science classroom helps students develop a useful base of scientific knowledge, communicated in increasingly mathematical and conceptual ways as they progress through school. In addition, scientific inquiry stimulates student interest, motivation, and creativity. Designing and conducting investigations encourages students to interpret, analyze, and evaluate what is known, how we know it, and how scientific questions are answered. The knowledge and skills related to scientific inquiry enable students to understand how science works, and are powerful ways for students to build their understanding of the scientific facts, principles, concepts, and applications that are described in the other science content standards, particularly standards two, three, and four. To comprehend the world around them, students need opportunities to pursue questions that are relevant to them and to learn how to conduct scientific investigations. Some scientific inquiries can only be investigated by the use of models since actual events are not repeatable.

Development of Scientific Inquiry

These paragraphs explain how scientific inquiry is developed in grades K-10.

GRADES K-4	GRADES 5-8	GRADES 9-10
	Note: Assumes foundational skills and understandings from grades K-4.	**Note: Assumes foundational skills and understandings from grades 5-8.**
Student scientific investigations at this level should be based on direct observation of concrete examples of scientific phenomena. Students should use appropriate simple devices to gather data, observe and recognize patterns in data, recognize when a data set matches an investigation and be able to communicate the reason an investigation was conducted.	Student scientific investigations at this level should be based on direct observation of examples of scientific phenomena and making inferences based on the results of the experiment. Students should evaluate both the explanations and procedures they use in an investigation. They should infer the purpose of an investigation from its process and develop an investigation that is well-connected to a testable prediction/hypothesis. This includes identifying and controlling important variables, using appropriate tools to gather and report data and using multiple trials to confirm results. Further students should explain for a specific investigation, the choice of tools, measurement units, the relationship among variables and whether a conclusion is supported by the data.	Student scientific investigations at this level should strive to synthesize patterns in scientific inquiry and build conceptual models of scientific phenomena and make inferences based on the results of the investigation. Students should evaluate both the explanations and procedures they use in an investigation. They should identify what data sets for a specific investigation should look like and what sources of error to be considered as conceptual models are built.

Assessment Frameworks

For the 5th Grade Science CSAP, what students know and are able to do includes:	For the 8th Grade Science CSAP, what students know and are able to do includes:	For the 10th Grade Science CSAP, what students know and are able to do includes:
1.a Asking questions and stating predictions (hypotheses) that can be addressed through a scientific investigation. *(examples not limited to:)* ▪ Given a description of an investigation, identify the question or problem statement being explored. ▪ Given a description of an investigation, tell what you think will happen and why. ▪ Given a situation, dilemma, or observation, identify a scientific question that could be investigated.	**1.a Identifying and evaluating alternative explanations and procedures.** *(examples not limited to:)* ▪ Design a process/procedure including appropriate variables, constants, and controls to investigate a scientific question (in a chart, table, graph or qualitative observations). ▪ State two or more reasonable explanations for the data from an investigation.	**1.a Asking questions and stating hypotheses, using prior scientific knowledge to help guide their development.** *(examples not limited to:)* ▪ Write a testable scientific question or problem based on a given scenario. ▪ Write a testable statement or hypothesis using an "If, Then" statement or other format based on a given scenario.
1.b Selecting and using simple devices to gather data related to an investigation *(for example, length, volume, and mass measuring instruments, thermometers, watches, magnifiers, microscopes, calculators and computers)*. *(examples not limited to:)* ▪ Identify appropriate tools for use in a given investigation such as recording temperature, length and width, volume or mass in metric units.	**1.b Using examples to demonstrate that scientific ideas are used to explain previous observations and to predict future events *(for example, plate tectonics and future earthquake activity)*.** *(examples not limited to:)* ▪ Predict a possible pattern or future event from scientific data (in a chart, table, graph, or qualitative observations).	**1.b Creating and defending a written plan of action for a scientific investigation.** *(examples not limited to:)* ▪ Critique a procedure to address a given problem or scenario that includes a single variable and proper constants or controls. ▪ Critique and revise a written plan of action/investigation based on a first set of previously collected data. ▪ Given a science scenario, identify the necessity for multiple trials, the constants and necessary controls.
1.c Using data based on observations to construct a reasonable explanation. *(examples not limited to:)* ▪ Given a simple data table or graph, select or construct a reasonable explanation based on the evidence provided.	**1.c Asking questions and stating hypotheses that lead to different types of scientific investigations *(for example, experimentation, collecting specimens, constructing models, researching scientific literature)*.** *(examples not limited to:)* ▪ Select appropriate methods (experimentation, collecting specimens, constructing models, researching scientific literature) to answer a scientific question. ▪ Given a situation/dilemma/issue, write a scientific question to frame an investigation. ▪ Identify a question that could have motivated the collection of the data. ▪ Select a question that can be answered by a scientific investigation. ▪ Write a hypothesis that matches a given question using an "If, Then" statement or other format.	**1.c Selecting and using appropriate technologies to gather, process, and analyze data and to report information related to an investigation.** *(examples not limited to:)* ▪ Given a hypothesis and data, decide if the evidence justifies the conclusion. ▪ Given sets of graphs representing experimental results, identify the graph that best represents the data. ▪ Given sets of experimental results in metric units that include unexpected data, graph the data. ▪ Given sets of experimental results that include unexpected data, formulate conclusions and state relationships based on the data.
1.d Communicating about investigations and explanations. *(examples not limited to:)* ▪ Given a scientific question, identify data that would need to be collected to answer the question. ▪ Given a question and a set of data, select a graph that best displays the data.	**1.d Creating a written plan for an investigation.** *(examples not limited to:)* ▪ Identify the evidence you need to collect in order to answer a certain scientific question. ▪ Given a question or hypothesis, write or critique an investigative process/procedure. ▪ Identify the data that you would collect and the conditions that remain constant in a scientific investigation. ▪ Explain why multiple trials or large sample sizes improve the confidence in or accuracy of results from an investigation. ▪ Identifies multiple trials or large sample sizes as a means of improving the confidence in or accuracy of results from an experiment.	**1.d Identifying major sources of error or uncertainty within an investigation *(for example, particular measuring devices and experimental procedures)*.** *(examples not limited to:)* ▪ Given sets of experimental results in metric units that include unexpected data, identify sources of error that might explain the unexpected data points. ▪ Given sets of experimental results that include unexpected data, suggest a means of revising an experiment to determine the source/cause of the unexpected result.
	1.e Using appropriate tools, technologies and measurement units to gather and organize data. *(examples not limited to:)* ▪ Determine the volume, mass, or dimensions of an object or substance. ▪ Select appropriate tools and metric measurement units to gather data given an experimental procedure. ▪ Organize data appropriately into tables, charts, and/or graphs given the hypothesis and procedure/design process of a scientific investigation. ▪ Given a set of data, construct a graph. ▪ Given a question and a set of data, select a graph that best displays the data.	**1.e Constructing and revising scientific explanations and models, using evidence, logic, and experiments that include identifying and controlling variables.** *(examples not limited to:)* ▪ Given a set of data, determine which model best matches the data. ▪ Given two explanations for a finding, determine which best matches data.
		1.f Communicating and evaluating scientific thinking that lead to particular conclusions. *(examples not limited to:)* ▪ Identifies strengths and weaknesses in conclusions.

Standard 1 Framework Continued---

	1.f Interpreting and evaluating data in order to formulate conclusions. *(examples not limited to:)* ▪ Given a question and a set of data, select a graph that best displays the data. ▪ Describe the relationships between two variables (e.g., time and temperature) in a given scientific investigation based on a given data table, chart or graph. ▪ Given data in a table or graph, describe whether or not the data supports a given hypothesis. Use evidence from that data table chart or graph to back up conclusions or explain why the hypothesis should be rejected. ▪ Given a data table or graph and hypothesis, generate new questions to investigate based on results given. **1.g Communicating results of their investigations in appropriate ways *(for example written reports, graphic displays, oral presentations)*.** *(examples not limited to:)* ▪ Given a question and a set of data, select a graph that best displays the data. **1.h Using metric units in measuring, calculating, and reporting results.** *(examples not limited to:)* ▪ Use an illustration of a graduated cylinder, gram scale or metric ruler to determine the volume in milliliters, mass in grams or dimensions in centimeters of an illustrated object. ▪ Describe data using appropriate metric units. **1.i Explaining that scientific investigations sometimes result in unexpected findings that lead to new questions and more investigations.** *(examples not limited to:)* ▪ Given data in a table or graph that does not support a given hypothesis, explain why the hypothesis should be rejected. ▪ Given data in a table or graph that does not support a given hypothesis, identify another question that could be investigated. **1.j Giving examples of how collaboration can be useful in solving scientific problems and sharing findings.** *(examples not limited to:)* ▪ Identify ways collaboration can be useful in solving scientific problems and advancing scientific knowledge. ▪ Given several scientific problems (e.g. making a map of the earth's interior; exploring the surface of Venus; learning the structure of an atom; finding out how DNA works; learning what causes a new disease), choose one problem and explain how scientists from at least two different areas (e.g. biology, chemistry) might have contributed to solving it.	**1.g Recognizing and analyzing alternative explanations and models.** *(examples not limited to:)* ▪ Given alternative explanations and models, identifies strengths and weaknesses in each. **1.h Explaining the differences between a scientific theory and a scientific hypothesis.** *(examples not limited to:)* ▪ Identify characteristics that distinguish a scientific hypothesis from a scientific theory (and scientific law).

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2.1 Students know that matter has characteristic properties, which are related to its composition and structure.
2.2 Students know that energy appears in different forms; and can move (be transferred) and change (be transformed).
2.3 Students understand that interactions can produce changes in a system, although the total quantities of matter and energy remain unchanged.
3. 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.
4. Earth and Space 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.
5. Students know and understand interrelationships among science, technology, and human activity and how they can affect the world.
6. Students understand that science involves a particular way of knowing and understand common connections among scientific disciplines.

2.1 Students know that matter has characteristic properties, which are related to its composition and structure.

--Rationale

By working with physical objects, students can build an understanding of similarities and differences in the properties of matter. The experiences help students understand common properties such as hardness, strength, color, shape, and states of matter (solid, liquid, and gaseous). Knowledge of observable properties of matter and its structure and composition is helpful in considering matter's varied uses, availability, and limitations in our world.

Development of Concepts of Matter

These paragraphs explain how the concepts of characteristic properties and their relationship to the compositions and structure of matter are developed in grades K-10. The bold print emphasizes the processes and concepts developed in each grade level interval.

GRADES K-4	GRADES 5-8	GRADES 9-10
The study of physical science in grades K-4 involves students working with common materials. They are asked **to make direct observations and direct measurements**. Based on these observations, students are asked **to classify** objects and **propose methods** of separation. The classroom activities require **manipulation** of the objects and **investigating** their physical characteristics. These observation skills and experiences are necessary for the more sophisticated measurements, analyses, and model building required in middle and high school.	In grades 5-8, students move from observations of objects to **comparing** objects based on their physical and chemical properties, to **designing experiments** to measure these properties, and to utilizing the properties to **separate mixtures**. Students also begin to develop the concepts of atoms and molecules as a **model** to classify and describe matter and its properties.	At the high school level, students will extend their skills to **predicting properties** using the Periodic Table. The sophistication in **using a model to describe and explain** properties and composition of matter is also expanded from the expectation in middle school. The expectation for **experimental skills** also increases as students are asked to separate substances based on chemical and physical properties. Finally, students are asked to **utilize word and chemical equations** to communicate about changes in the composition and structure of matter.

Assessment Frameworks

For the 5th Grade Science CSAP, what students know and are able to do includes:

2.1.a Examining, describing, classifying, and comparing tangible objects in terms of common physical properties *(for example, state of matter, size, shape, texture, flexibility, color)*.
(examples not limited to:)
- Describe the properties used to classify a collection of objects by using shape, size, texture, flexibility, heavy or light, and color.
- Classifying a substance as a solid, liquid, or gas.
- Identify which state of matter can maintain its own shape, maintain the shape of the container, and which can expand to fill a container fully.

2.1.b Measuring common physical properties of objects (*for example, length, mass, volume, temperature)*.
- Uses a thermometer to measure temperature.
- Uses a metric ruler to measure.

2.1.c Creating mixtures and separating them based on differences in properties *(for example, salt and sand, iron filings and soil, oil and water)*.
(examples not limited to:)
- Separate a mixture of two substances based on differences in a physical property (e.g., iron filings and soil (magnetism), oil and water (density), red beans and white beans (color).

For the 8th Grade Science CSAP, what students know and are able to do includes:

2.1.a Examining, describing, comparing, measuring, and classifying objects based on common physical and chemical properties *(for example, states of matter, mass, volume, electrical charge, temperature, density, boiling points, pH, magnetism, solubility)*.
(examples not limited to:)
- Distinguish between physical (e.g., density, states of matter--solid, liquid, gas, and plasma, magnetism, hardness, melting point, boiling point, solubility) and chemical properties (e.g., flammability, pH, chemical reactivity).
- Describe and compare substances using physical properties.
- Describe and compare substances using chemical properties.
- Distinguish between physical and chemical changes.
- Use appropriate tools, and metric measurement units to gather data about an object's characteristics (e.g., metric ruler (mm, cm), thermometer (Celsius), graduated cylinder (mL), balance (g), stopwatch (s). (For example, given the volume, mass and formula be able to calculate density).

2.1.b Separating mixtures of substances based on their properties *(for example, solubility, boiling points, magnetic properties, densities)*.
(examples not limited to:)
- Separate a mixture based on differences in physical properties (e.g., solubility, color, particle size, magnetic properties, and density).

2.1.c Classifying and describing matter in terms of elements, compounds, mixtures, atoms, and molecules (*for example, copper is an element, water is a compound, air is a mixture)*.
(examples not limited to:)
- Describe matter using the following terms: atoms (proton, neutrons, and electrons), elements, compounds, molecules, and mixtures.
- Given a list of common substances and/or common formulas, classify matter using the following terms: elements, compounds, and mixtures.

2.1.d Developing simple models to explain observed properties of matter *(for example, using a particle model to account for the solubility of a substance)*.
(examples not limited to:)
- Use a particle model to explain observed properties of matter (e.g., comparing solid, liquid, and gases; solubility of a substance, evaporation and condensation; comparing densities).

For the 10th Grade Science CSAP, what students know and are able to do includes:

2.1.a Examining, describing, measuring, classifying, and predicting common properties of substances *(for example, electrical charge, chemical reactivity, acidity, electrical conductivity, radioactivity, relationships in the periodic table)*.
(examples not limited to:)
- Identify substances based on a characteristic property (e.g., chemical reactivity, pH, density, state of matter, boiling point, melting point, magnetism, solubility).
- Describe metals or non-metals in terms of state of matter, luster, ductility, brittleness, malleability, and conductivity.
- Use Periodic Table to identify an element and its properties.

2.1.b Describing and explaining properties and composition of samples of matter using models *(for example, atomic and molecular structure, the periodic table)*.
(examples not limited to:)
- Compare and contrast the Bohr model with the modern atomic theory.
- Use a simple model in describing the elemental composition of a molecule (e.g., water molecule with one hydrogen and two oxygen atoms, or carbon dioxide with one carbon and two oxygen atoms).
- Use a model to describe the differences in the kinetic energy of the states of matter (e.g., solid, liquid, gas, plasma).

2.1.c Separating substances based on their chemical and physical properties (*for example, color, solubility, chemical reactivity, melting point, boiling point*).
(examples not limited to:)
- Separate a mixture based on differences in physical properties (e.g., color, solubility, melting point, boiling point, magnetic properties, density, particle size).

2.1.d Using word and chemical equations to relate observed changes in matter to its composition and structure.
(examples not limited to:)
- Given a simple chemical equation, identify the reactants and products.
- Given a balanced chemical equation, verify the conservation of the number of atoms and the conservation of mass in the reactants and products.
- Using the periodic table, identify the elements and number proportions making up a simple compound (e.g., H_2O is 2 Hydrogen atoms:1 Oxygen atom).

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2.2 Students know that energy appears in different forms; and can move (be transferred) and change (be transformed).

--Rationale

Energy is a central concept in science because all physical interactions involve changes in energy. Students need to understand that all physical events involve transferring energy or changing one form of energy into another. When a transformation of energy takes place, some of it is likely to appear as heat. Knowledge of forms of energy, its transfer and transformation, is essential to interpreting, explaining, predicting, and influencing change in our world.

Development of Concepts of Energy

These paragraphs explain how the concept of energy forms and their transfer and transformation are developed in grades K-10.
The bold print emphasizes the processes and concepts developed in each grade level interval.

GRADES K-4	GRADES 5-8	GRADES 9-10
Students in grades K-4 begin to link observations of changes with the concept of energy. They **identify names** for different types of energy and **describe the effect** energy has on objects. Students **observe changes** and **measure** the position, and simple physical and chemical properties of objects associated with energy transfer or transformation. The students then **present this information** in simple diagrams and charts to compare effects.	In grades 5-8, students are asked to **make measurements** associated with energy transfer and transformation. By examining physical situations (real or pictured) students **identify energy forms**, **link changes** that occur based on energy transfer, and **describe the relationship** between measurable quantities that change due to an energy transformation.	In grades 9-10, students are asked to **make qualitative and quantitative measurements and predictions** associated with energy transfer and transformation. By examining physical situations (real or pictured) students build on their identification of energy forms, to **predict changes** that occur based on energy transfer, and **calculate potential kinetic energy quantities** to show that energy is conserved.

Assessment Frameworks

For the 5th Grade Science CSAP, what students know and are able to do includes:	For the 8th Grade Science CSAP, what students know and are able to do includes:	For the 10th Grade Science CSAP, what students know and are able to do includes:
2.2.a Recognizing that energy *(for example, light, heat, motion, sound, mechanical)* can affect common objects and is involved in common events. *(examples not limited to:)* ▪ Identify different types of energy forms (e.g., light, heat, sound, motion). ▪ Match an energy form to a common event (e.g., flashlight-light, fire-heat, ball bouncing-motion, musical instrument-sound). **2.2.b Making observations and gathering data on quantities associated with energy, movement, and change *(for example, distances for a bean launcher, time for a melting ice cube)*.** *(examples not limited to:)* ▪ Observe and collect data on quantities associated with energy forms (e.g., measure distance an object moved, measure time it take for ice to melt, measure temperature of objects). **2.2.c Comparing quantities associated with energy movement and change by constructing simple diagrams or charts (for example, graph of launch distances, chart of melting time).** *(examples not limited to:)* ▪ Perform simple energy transfer experiments and construct a chart/graph displaying data (measure distance traveled with different numbers of winds of a toy; measure differences in temperature on light/dark surfaces).	**2.2.a Measuring quantities associated with energy forms *(for example, temperature, mass, speed, distance, electrical charge, current, voltage)*.** *(examples not limited to:)* ▪ Identify different types of energy forms (e.g., light, heat, sound, kinetic, electrical, chemical, ▪ mechanical- potential and kinetic). ▪ Quantify energy forms (e.g., temperature change before and after heating a liquid; measure voltage through wires; temperature change caused by light shining on a surface; distance a rubber band travels when it is stretched; distance an object travels after acted on with different forces). **2.2.b Describing qualitative and quantitative relationships, using data and observations and graphs, associated with energy transfer or energy transformation *(for example, speed of object vs. height of ramp; length of string vs. pitch of sound; electric current vs. volume of gas produced in electrolysis, with length of time kept constant)*.** *(examples not limited to:)* ▪ Using graphs, observations, and data, compare the potential energy and kinetic energy within a system at various locations or times (e.g., roller coaster, waterfall).	**2.2.a Identifying, measuring, calculating, and analyzing quantitative relationships involved with energy forms *(for example, heat transfer in a system involving mass, specific heat, and change in temperature of matter)*.** *(examples not limited to:)* ▪ Identify that all energy can be considered to be kinetic energy (energy of motion), potential energy (stored energy), or energy contained by a field, such as electromagnetic waves. ▪ Identify that potential energy is stored energy and is associated with gravitational or electrical force, mechanical position, or chemical composition. **2.2.b Identifying, measuring, calculating and analyzing qualitative and quantitative relationships associated with energy transfer or energy transformation *(for example, changes in temperature, velocity, potential energy, kinetic energy, conduction, convection, radiation, voltage, current)*.** *(examples not limited to:)* ▪ Describe heat as a form of energy transfer. ▪ Differentiate between specific heat and heat capacity. ▪ Compare and contrast conduction, convection, and radiation. ▪ Use Ohm's Law to calculate quantities of electrical energy and conservation of energy for a situation, given appropriate equations, constants, and variable data including voltage, current, and resistance.

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2.3 Students understand that interactions can produce changes in a system, although the total quantities of matter and energy remain unchanged.
--Rationale

Interactions between matter and energy account for changes observed in everyday events. Understanding how matter and energy interact extends students' knowledge of the physical world and allows them to monitor and explain a wide variety of changes and to predict future physical and chemical changes. Students gain both a practical and conceptual understanding of the laws of conservation of matter and energy.

Development of Concepts Regarding Systems **These paragraphs explain how the concepts of matter and energy conservation are developed in grades K-10.** **The bold print emphasizes the processes and concepts developed in each grade level interval.**		
GRADES K-4	**GRADES 5-8**	**GRADES 9-10**
In grades K-4, students develop the concept of a system by **observing** and **describing** parts of a system and changes in a system. Students can then **predict** changes in a system when it experiences an external influence. Students **show** these energy changes in pictures, graphs, and words. These skills serve as the foundation for developing the ideas of matter and energy conservation.	In grades 5-8, students **identify** and **classify** factors causing change within a system. This provides the basis for **predicting** changes when matter experiences an external force or energy transfer. Students specifically utilize the concept of conservation of mass in **describing** chemical reactions and phase changes. Also, following the application of a force, students **measure** distance and time, **calculate** speed and potential and kinetic energy. Students also calculate power from changes in energy.	In grades 9-10, students **describe** and **explain** physical and chemical changes using conservation of matter and energy. This is also done using chemical and nuclear equations. They **calculate** mass and mechanical energy in systems. Students need to **describe** chemical changes in words and symbols, and to describe and physical interactions in words. Finally, students need to **use models** to describe changes in properties of a substance, and then use models to **explain** the results.

Assessment Frameworks		
For the 5th Grade Science CSAP, what students know and are able to do includes:	**For the 8th Grade Science CSAP, what students know and are able to do includes:**	**For the 10th Grade Science CSAP, what students know and are able to do includes:**
2.3.a Observing and describing parts of system (for example, water in a closed jar, water in an open jar, a plant terrarium). *(examples not limited to:)* ▪ Identify the parts of a simple system and how the parts go together (water in a closed jar, water in an open jar, balloon filled with air, balloon filled with water, a battery, wires and a light bulb). **2.3.b Describing an observed change *(for example, a melting ice cube, crystal growth, burning candle, physical breakage*) in terms of starting conditions, type of change, and ending conditions, using words, diagrams, or graphs.** *(examples not limited to:)* ▪ Predict in words or pictures what happens to a system over time (e.g., water evaporates from an open jar). **2.3.c Predicting what changes and what remains unchanged when matter experiences an external influence *(for example, a push or pull, addition or removal of heat, division of clay into pieces, melting an changing a ball of clay to a flattened shape), ice cube.*** *(examples not limited to:)* ▪ Given a scenario involving a change due to an external influence, predict how things will change or not change.	**2.3.a Identifying and classifying factors causing change within a system *(for example, force, light, heat).*** *(examples not limited to:)* ▪ Identify cause and effect pairs involved in changes associated with a system (e.g., heating and cooling causes changes in some of the properties of materials; pushing and pulling an object affect the motion of the object; changes in pressure affect gases; changing the position of a mirror alters the path direction of light). ▪ Given a before and after picture, describe what might have caused the change. **2.3.b Identifying and predicting what will change and what will remain unchanged when matter experiences an external force or energy change *(for example, boiling a liquid; comparing the force, distance, and work involved in simple machines).*** *(examples not limited to:)* ▪ Predict the changes in motion of an object when a force is applied (e.g., moves faster or slower, changes direction). ▪ Given a particular system, predict what change will happen if the system undergoes a change in energy (e.g., a solid melts when heat is applied). ▪ Given a simple machine (lever, pulley, inclined plane) predict what will happen if there is a change in the system (e.g., changing the angle of an inclined plane, changes in placement of levers, fulcrum, adding a pulley). **2.3.c Observing and gathering data to support the concept of conservation of mass within a closed system *(for example, precipitation reaction, forming mixtures, gas production).*** *(examples not limited to:)* ▪ Given a physical change in a closed system, describe why the mass does not change. ▪ Predict resulting data based on the concept of "conservation of mass." **2.3.d Describing, measuring (*for example, temperature, mass, volume, melting point of a substance*) and calculating quantities before and after a chemical or physical change within a system *(for example, temperature change, mass change, specific heat).*** *(examples not limited to:)* ▪ Given measurements of properties of a substance before and after a chemical or physical change, explain changes that took place (e.g., temperature, mass, volume, solubility). ▪ Predict what will happen to the temperature of a substance as it is heated versus when it changes phase (e.g. phase changes). **2.3.e Describing, measuring (*for example, time, distance, mass, force*) and calculating quantities that characterize moving objects and their interactions within a system *(for example, force, velocity, acceleration, potential energy, kinetic energy).*** *(examples not limited to:)* ▪ Given measurements of time and distance for objects that are moving in a straight line, relate distance and time in words and graphs. ▪ Identify the points at which a moving object has the most potential and/or kinetic energy (e.g., pendulum swing, falling objects). ▪ Calculate the work done/power required to change an object's motion.	**2.3.a Identifying, describing, and explaining physical and chemical changes involving the conservation of matter and energy *(for example, oscillating pendulum/spring, chemical reactions, nuclear reactions).*** *(examples not limited to:)* ▪ Describe a balanced chemical equation in terms of conservation of matter and energy. ▪ Describe the interchange of potential and kinetic energy in a motion (e.g. oscillation of a spring or pendulum, movement of a roller coaster). ▪ Describe the attractive forces that holds different atoms or ions together ▪ in substances (e.g. ionic and covalent bonds). **2.3.b Observing, measuring, and calculating quantities to demonstrate conservation of matter and energy in chemical changes *(for example, acid-base, precipitation, oxidation- reduction reactions),* and physical interactions of matter *(for example, force, work, power).*** *(examples not limited to:)* ▪ Given the masses of the other components in a simple chemical reaction, calculate the molar mass of either a reactant or product. ▪ Given Newton's Second Law (F=ma), calculate the force, mass, or acceleration of a object. **2.3.c Describing and predicting chemical changes *(for example, combustion, simple chemical reactions),* and physical interactions of matter (*for example, velocity, force, work, power), using word or symbolic equations).*** *(examples not limited to:)* ▪ Given the reactants in a simple combustion, combination, single replacement or double replacement reaction, predict the products. ▪ Apply Newton's third Law given different situations. **2.3.d Describing and explaining physical interactions of matter using conceptual models *(for example, conservation laws of matter and energy, particle model of gaseous behavior).*** *(examples not limited to:)* ▪ Describe the properties of a substance as a system changes using a model (e.g., diffusion, osmosis, collision of objects). ▪ Use the particle model of gases to explain the relationships among pressure, volume, temperature.

Science: Assessment Frameworks-at-a-Glance and Colorado Content Model Standards

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2. Physical Science: Students know and understand common properties, forms, and changes in matter and energy.
3. **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.**
   - **3.1 Students know and understand the characteristics of living things, the diversity of life, and how living things interact with each other and with their environment.**
   - 3.2 Students know and understand interrelationships of matter and energy in living systems.
   - 3.3 Students know and understand how the human body functions, factors that influence its structures and functions, and how these structures and functions compare with those of other organisms.
   - 3.4 Students know and understand how organisms change over time in terms of biological evolution and genetics.
4. Earth and Space 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.
5. Students know and understand interrelationships among science, technology, and human activity and how they can affect the world.
6. Students understand that science involves a particular way of knowing and understand common connections among scientific disciplines.

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

--Rationale

As a result of their study of a variety of organisms and where they live, students gain a better understanding of their world. Students have a natural curiosity about life and the great diversity of organisms. Their curiosity leads to the study of organisms and how the organisms interact with the world. Through the study of similarities and differences of organisms, students learn the importance of classification as a tool used by scientists. In their future as citizens, students will need to think about and make decisions about the diversity and extinction of organisms in their communities and the world.

Development of Concepts of Living Things and Diversity of Life

These paragraphs explain how the characteristics of living things, diversity of life, and how living things interact with each other and their environment as they develop in grades K–10. The bold print emphasizes the processes and concepts developed in each grade level interval.

GRADES K-4	GRADES 5-8	GRADES 9-10
Living and Non-living	**Classification of living things, their basic needs, and interactions**	**Interactions and equilibrium of ecosystems**
The study of living and non living things in grades K-4 is based on students **observing** through their senses. They observe and gain experience with living and nonliving things at their school and in their neighborhood. Their focus is on classifying a variety of organisms and describing their basic needs and interactions. Classroom activities emphasize **concrete models** and **direct observation**. These concepts and experiences are the building blocks that prepare students for using classification systems in middle school, and explaining a variety of classification systems in high school.	In grades 5-8, students move from observing the living and non living at the K-4 level to **explaining** the interaction and interdependence of living and nonliving components within ecosystems. Students use classification systems based on the structure of organisms. They are able to **describe** how an environment's ability to provide food, water, space, and essential nutrients determines carrying capacity. Students will **create and interpret models and diagrams** food chains and food webs. They will understand the importance of plant and animal adaptations. Students are introduced to ecosystems in preparation for more analytical approaches in high school.	As students progress into high school, they will begin to use data in a more critical and analytical way. Students analyze data collected to **synthesize concepts** fundamental to ecosystems. Students will compare the strengths and weaknesses of **conceptual/mathematical models**, and be able to use models appropriately. These concepts include the dynamic equilibrium of ecosystems. In addition, students will develop their own perspectives on the result of human action on an ecosystem.

Assessment Frameworks

For the 5th Grade Science CSAP, what students know and are able to do includes:

3.1.a Distinguishing living from nonliving things.
(examples not limited to:)
- Given a list of objects, identify each as living or nonliving.

3.1.b Classifying a variety of organisms according to selected characteristics *(for example, backbone vs. no backbone).*
(examples not limited to:)
- Sort living organisms as plant or animal.
- Group organisms by a physical characteristic. [e.g., body covering, body support (bone, shell, exoskeleton, leaf structure) insects, fish, mammal, bird].

3.1.c Describing the basic needs *(for example, food, water, air, shelter, space*) of an organism.
(examples not limited to:)
- Name the basic needs of all animals (e.g., food, water, air, shelter, space).
- Communicate examples of shelters and tell about the types of animals that might use them.
- Explain that all types of animals have the same basic needs but differ in what they use to meet those needs (e.g., caterpillars eat leaves, robins eat worms).
- Name the basic needs of all plants (e.g., light, water, air).

3.1.d Giving examples of how organisms interact with each other and with nonliving parts of their habitat.
(examples not limited to:)
- Give examples of how a particular animal uses plants and other animals in its habitat to meet its needs.
- Describe examples of predator-prey relationships (i.e., of one animal type eating another).
- Describe how plants depend on animals (e.g., carry pollen or to disperse seeds).
- Describe how plants and animals depend on non-living parts of their habitat.

For the 8th Grade Science CSAP, what students know and are able to do includes:

3.1.a Constructing and using classification systems based on the structure of organisms.
(examples not limited to:)
- List physical characteristics of an animal that could be useful for identification.
- Select and use one characteristic to sort a group of plants or animals.
- Sort a group of organisms based on their function in an ecosystem (e.g., producers, consumers, or decomposers).
- Sort animals into two groups, vertebrates and invertebrates.
- Sort organisms by their physical characteristics (e.g., plant or animal; vertebrates or invertebrates).
- Using an identification key, classify organisms by multiple characteristics.

3.1.b Describing the importance of plant and animal adaptations, including local examples.
(examples not limited to:)
- Given an example, explain how a characteristic of an organism might be important for the survival of that organism.

3.1.c Creating and interpreting food chains and food webs.
(examples not limited to:)
- Draw a food web that includes the sun.
- Explain that the arrows on a food web represent the flow of energy.
- Compare and contrast concepts of food chains and food webs; include producers, consumers, and decomposers.

3.1.d Explaining the interaction and interdependence of nonliving and living components within ecosystems.
(examples not limited to:)
- Name examples of nonliving a biotic component of an ecosystem (e.g., climate, light, H_2O nutrients, fire).
- Describe examples of nonliving characteristics of the local environment.
- Explain how the nonliving characteristic of an environment has affected the types of plants and animals that live there.

3.1.e Describing how an environment's ability to provide food, water, space, and essential nutrients determines carrying capacity.
(examples not limited to:)
- Name the basic needs of all animals—food, water, oxygen, and the right environmental conditions (e.g., temperature, shelter, space).
- Describe several factors that could limit the size of an animal population.
- Describe the relationship of population and carrying capacity.
- Name the basic needs of all plants, light, water, temperature, and carbon dioxide.
- Describe the sequence of events that happen if one of the basic needs (e.g., light, water, other environmental conditions) are not met.

For the 10th Grade Science CSAP, what students know and are able to do includes:

3.1.a Using and producing a variety of classification systems for organisms (*for example, the five-kingdom classification, classification based on behavior).*
(examples not limited to:)
- Classify organisms into kingdoms.
- Sort the same group of organisms in two different ways.
- Recognize that classification schemes can be based on characteristics other than physical traits (e.g., DNA, behavior, function).
- Create a classification system to identify an organism (e.g., dichotomous key, genus/species).
- Compare classification systems to identify an organism.

3.1.b Predicting and describing the interactions of populations and ecosystems.
(examples not limited to:)
- Explain how factors can limit a species ability to survive in a particular environment.
- Use the data in a graph to decide if a population has reached its carrying capacity.
- Use the data in a graph to predict future population levels.
- Identify/analyze/draw a food web showing energy transfer.
- Differentiate the roles of producers, consumers and decomposers in an ecosystem in the recycling of matter.

3.1.c Explaining how adaptations (*for example, structure, behavior*) of an organism determine its niche (role) in the environment.
(examples not limited to:)
- Describe how characteristics (e.g., structural, behavioral, chemical) of an organism improves the chances of that organism's survival.

3.1.d Explaining how changes in an ecosystem can affect biodiversity and how biodiversity contributes to an ecosystem's stability.
(examples not limited to:)
- Explain the impact, particularly noxious weeds have on the native plants and animals.

3.1.e Analyzing the dynamic equilibrium of ecosystems, including interactions among living & nonliving components (*for example, tropical deforestation is linked to decreased global precipitation; Mount St. Helen's eruption had impact on the local ecosystem).*
(examples not limited to:)
- Describe why water is a basic need for all life forms and for each cell in a multi-cellular organism.
- Predict a series of changes that might result from a particular interaction (e.g., a deer walking across damp ground).
- Given a human action in an ecosystem, describe a range of changes that could result including microscopic impacts as well as the obvious visible changes.
- Describe environmental impact/issues that result from a recreational activity (e.g., backpacking, mountain biking, snowmobiling, rock climbing).
- Predict what will happen if a component of an ecosystem is removed.
- Use numbers to illustrate how, over generations, population size affects family size.
- Graph and interpret data that shows the change in population size over time.
- Use numbers to illustrate how over generations, populations size affects family size.

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   3.3 Students know and understand how the human body functions, factors that influence its structures and functions, and how these structures and functions compare with those of other organisms.
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4. Earth and Space 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.
5. Students know and understand interrelationships among science, technology, and human activity and how they can affect the world.
6. Students understand that science involves a particular way of knowing and understand common connections among scientific disciplines.

3.2 Students know and understand interrelationships of matter and energy in living systems.

--Rationale

From experience, students know that they must eat food to live. As a result of their study of energy movement (transfer) and change (transformation) in living organisms, students understand that the sun is the primary and ultimate source of energy for living organisms. They learn why a constant input of matter and energy is critical for life. Photosynthetic organisms are critical to all organisms and need to be maintained. If one or more components are altered in an ecosystem, all other components are affected. Through studying the interrelationships of organisms, students learn that they can have a critical impact on other organisms.

Development of Concepts of Living Systems

These paragraphs explain how concepts about the interrelationships of matter and energy in living systems develop in grades K–10.
The bold print emphasizes the processes and concepts developed in each grade level interval.

GRADES K-4	GRADES 5-8	GRADES 9-10
Food Chains	**Food Webs, and basic life process**	**Flow of Energy and life processes**
The study of living systems in grades K-4 is based on students **observing** through their senses. They observe and gain experience with living systems at their school and in their neighborhood. They recognize that green plants need energy from sunlight and various raw materials to live and animals consume plants and other organisms to live. They recognize the interrelationship between organisms by tracing the flow of energy in a food chain. Classroom activities emphasize **concrete models** and **direct observation**. These concepts and experiences are the building blocks that prepare students for explaining basic life processes in middle school and their comparison in high school.	In grades 5-8, students move from observing to **explaining the processes** of living systems. Students **describe the basic process** of photosynthesis and respiration and their importance to life. They **compare and contrast** food webs within and between different ecosystems. They **describe** ways that organisms get food and matter to their cells. They **explain** the recycling of materials by determining the pathway of a substance that is important for life. They **describ**e the role of organisms in the decomposition of organisms and the recycling of dead organisms. Students are introduced to basic life processes in preparation for more analytical approaches in high school.	As students progress into high school, they will **analyze** living systems. They **compare and contrast** the processes of photosynthesis and respiration. They **explain** how simple molecules can be built and broken down. They will understand how energy is used in maintenance, repair, growth, and development. They also describe the cycling of matter and the movement and change of energy through the ecosystem. Students will compare the strengths and weaknesses of **conceptual models** and be able to use models appropriately.

Assessment Frameworks

For the 5th Grade Science CSAP, what students know and are able to do includes:	For the 8th Grade Science CSAP, what students know and are able to do includes:	For the 10th Grade Science CSAP, what students know and are able to do includes:
3.2.a Recognizing that green plants need energy from sunlight and various raw materials to live, and animals consume plants and other organisms to live. *(examples not limited to:)* ▪ Group animals based on the types of food they eat (e.g., herbivores, carnivores, omnivores). ▪ Know that animals use food for growth as well as for energy. ▪ Describe what happens to an animal when it does not get enough food. ▪ Describe what happens to a plant when it does not get its basic need of light.	**3.2.a Describing the basic processes of photosynthesis and respiration and their importance to life *(for example, set up a terrarium or aquarium and make changes such as blocking out light).*** *(examples not limited to:)* ▪ Explain that photosynthesis is the process by which plants convert light energy to stored chemical energy, and identify the raw materials and products of photosynthesis. ▪ Describe what happens to a plant when it doesn't get light. ▪ Provide evidence that plants use the carbon from carbon dioxide, not soil, for gain in mass to produce leaves, roots, and all the other parts of a plant. ▪ Describe that most cells use oxygen to break down sugar for energy and release carbon dioxide during cellular respiration. ▪ Describe the results of photosynthesis and cellular respiration. ▪ Identify where the carbons and oxygen come from in the carbon dioxide produced during cellular respiration.	**3.2.a Comparing and contrasting the processes of photosynthesis and respiration *(for example, in terms of energy and products*).** *(examples not limited to:)* ▪ Describe the role of the sun in the production of simple sugar/glucose. ▪ Determine the number of sugar molecules that could be produced from a given number of carbon dioxide molecules. ▪ Provide examples when plants produce carbon dioxide and require oxygen (e.g., germinating seed). ▪ Explain the relationship between respiration and food (e.g., carbohydrates, fats, proteins). ▪ Understand cellular respiration, the use of oxygen, and identify anaerobic respiration. ▪ Provide evidence that our cells produce heat.
3.2.b Recognizing the interrelationships of organisms by tracing the flow of matter and energy in a food chain. *(examples not limited to:)* ▪ Organize the sun, a plant, and two appropriate animals into a food chain. ▪ Describe the source of food for each organism in a food chain. ▪ Predict what would happen if one organism were removed from a food chain.	**3.2.b Comparing and contrasting food webs with-in and between different ecosystems *(for example, grasslands, tundra, marine*) and predict the consequences of disrupting one of the organisms in a food web.** *(examples not limited to:)* ▪ Predict consequences that result from the introduction of a new organism into an existing food web. ▪ Predict consequences that result from the removal of an organism from a food web.	**3.2.b Explaining how simple molecules can be built into larger molecules within organisms *(for example, amino acids serve as building blocks of proteins; carbon dioxide and water are the basic materials for building sugars through photosynthesis).*** *(examples not limited to:)* ▪ Identify the elements that make up fats, sugars, amino acids and nucleic acids. ▪ Realize that a each protein is a specific sequence of amino acids. ▪ Compare the structure of organic molecules (e.g., proteins, carbohydrates, lipids, nucleic acids). ▪ Explain how organisms gain in biomass.
	3.2.c Describing ways (*for example, digestion, transport of nutrients by circulatory system*) that multi-cellular organisms get food and other matter to their cells. *(examples not limited to:)* ▪ Describe the role of the digestive, respiratory, and circulatory systems in getting food, water, and oxygen to cells. ▪ Describe the types of things that have to happen to food before it can be used by a cell. ▪ Describe the role of the circulatory system in delivering food and oxygen to cells and removing waste products. ▪ Describe the role of the respiratory system in exchanging gases with the blood.	**3.2.c Explaining how large molecules (*for example, starch, protein) are broken down into smaller molecules, serving as an energy source or as basic building blocks in organisms.*** *(examples not limited to:)* ▪ Describe the main functions of protein, carbohydrate, and fat (e.g., the functions of enzymes as a type of protein). ▪ Explain how a cell gets rid of carbons, nitrogens, hydrogens, and oxygens that result from the break down of larger molecules.
	3.2.d Explaining the recycling of materials by determining a pathway of a substance that is important for life *(for example, trace water through an ecosystem)* *(examples not limited to:)* ▪ Describe how carbon moves back and forth between plants and animals. ▪ Describe the role of plants and animals in the water cycle.	**3.2.d Explaining how energy is used in the maintenance, repair, growth, & development of tissues (*for example, in the production of new skin cells requires energy)*** *(examples not limited to:)* ▪ Give examples of cell types in the human body that are continually being replaced. ▪ Explain why cells in a grown individual still would need to divide. ▪ Explain the reason for increased breathing rate produced during exercise.
	3.2.e Describing the role of organisms in the decomposition and recycling of dead organisms (e.g., bacteria's role in the decomposition and recycling of matter from a dead animal). *(examples not limited to:)* ▪ Describe how the appearance of an object changes as it decomposes. ▪ Identify organisms that play a role in the final steps of decomposition. ▪ List several factors that affect the rate of decomposition (e.g., bacteria, fungi, temperature, humidity).	**3.2.e Describing the cycling of matter and the movement and change of energy through the ecosystem (e.g., some energy dissipates as heat as it is transferred through a food web).** *(examples not limited to:)* ▪ Explain the reason for the decrease in available energy from level to level in a food chain. ▪ Contrast the flow of energy with cycling of matter as they move through an ecosystem.

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6. Students understand that science involves a particular way of knowing and understand common connections among scientific disciplines.

3.3 Students know and understand how the human body functions, factors that influence its structures and functions, and how these structures and functions compare with those of other organisms.

--Rationale

Students are interested in learning about their bodies and how they relate biologically to other forms of life. The study of structure and function, body organization, growth and development, and maintenance of other organisms enhances students' understanding of human development, health, and disease. Knowledge of these areas can assist students in making informed choices regarding nutrition, exercise, and other factors that influence how their body functions.

Development of Concepts of Body Systems

These paragraphs describe human body systems and how they compare to those of other organisms as they are developed in K-10.
The bold print emphasizes the processes and concepts developed in each grade level interval.

GRADES K-4	GRADES 5-8	GRADES 9-10
Basic Body Systems	**Basic Interactions of Body Systems**	**Relationships of Body Systems**
The study of human body systems in grades K-4 is based on students **gathering information** about human systems and nutrition, and by **observing life cycles**. They describe the main functions of the body systems. They learn the basic food requirements for good health. They will **observe** the stages and life cycles of various organisms. These concepts and experiences are the building blocks that prepare middle school students for understanding how these systems interact and compare to other organisms.	In grades 5-8, students broaden their focus from describing basic systems to understanding their interactions. They **describe the observable components** and functions of a cell. They are able to **compare and contrast** the basic structures and functions of different types of cells. They describe and compare the growth and development of several organisms. They **describe the interactions** of the structures and functions of the human body systems. They are able to distinguish the difference between non-communicable and communicable diseases. These experiences provide the background needed in high school to examine the body systems in depth at various levels.	As students progress into high school, they begin to use information about organisms in a more critical and analytical way. Students describe cellular organelles and their functions. They are able to **differentiate** between levels of organization and their roles in the whole organism. They are able to **explain** human body functions in terms of interacting organ systems composed of specialized structures that maintain or restore health. They **compare and contrast** characteristics of, and treatment for, various types of medical problems. Students use examples to explain the relationship of structure and function in organisms. They **understand the patterns and processes** of reproduction and development in several organisms.

Assessment Frameworks

For the 5th Grade Science CSAP, what students know and are able to do includes:

3.3.a Describing human body systems *(for example, digestive, respiratory, circulatory, skeletal, muscular).*
(examples not limited to:)
- Identify the senses.
- Describe each sense (e.g., touch tells us about size, shape, texture).
- Recognize that the human body is composed of systems.
- Given a model or diagram, locate the body systems.
- Describe the main functions of human body systems (skeletal system provides protection and support, muscular system allows us to move, and digestive system allows us to meet our need for food and water).

3.3.b Describing the basic food requirements for humans as summarized in the nutrition pyramid.
(examples not limited to:)
- Using the current nutritional guidelines, describe the basic food requirements for humans.
- Give a description of a healthy meal and classify the foods into their food groups.
- Name examples of foods that are high in sugar but low in important nutrients.
- Identify that the foods we eat come from carbohydrates, fats, and/or proteins.
- Identify foods that are likely to be high in fat.
- Identify foods that are likely to be good sources of fiber.

3.3.c Describing life cycles of selected organisms *(for example, frog, chicken, butterfly, radish, bean plant).*
(examples not limited to:)
- Explain what is meant by the term life cycle (e.g., a plant starts from a seed and produces seeds to start new plants, human's stages of life) and understand that similar organisms go through similar life stages.
- Observe and draw several types of seeds.
- Sequence pictures that show stages in the growth of a plant from a seed and describe changes that take place as a plant grows.
- Describe the stages of an insect's life cycle (e.g., egg, larva, and pupa, adult).

For the 8th Grade Science CSAP, what students know and are able to do includes:

3.3.a Describing the observable components and functions of a cell *(for example, cell membrane, nucleus, cytoplasm, chloroplasts; movement of molecules into and out of cells).*
(examples not limited to:)
- Identify that living things are made up of cells.
- Give examples of organisms that are made up of single cells and multi-cellular organisms.
- Explain that small molecules (e.g., carbon dioxide, oxygen, water) can move in and out of a cell through a cell membrane.

3.3.b Comparing & contrasting the basic structures & functions of different types of cells *(for example, single-celled organisms in pond water, Elodea, onion cell, human cheek cell).*
(examples not limited to:)
- Recognize several cell types (muscle cells, red blood cells, sperm, egg, nerve).
- Recognize a single cell when looking at a prepared microscope slide or at a photographic image of a slide.
- Distinguish between an animal cell and a plant cell.

3.3.c Describing the growth and development of several organisms *(for example, embryonic development of a vertebrate).*
(examples not limited to:)
- Describe the life stages of vertebrates beginning with a sperm and egg (e.g., human, chick, frog.), and invertebrates (e.g., complete metamorphosis and incomplete metamorphosis).
- Explain the term life cycle, and give examples.
- Compare and contrast how a human fetus and a bird in an egg meet their needs for food, water, and oxygen.

3.3.d Describing the structures and functions of human body systems.
(examples not limited to:)
- Describe the main functions of the following systems: skeletal, muscular, digestive, circulatory, respiratory, nervous, and reproductive.
- Identify the locations of major organs in body systems.
- Explain how organ structures support the function of the system.
- Explain how body systems interact and depend on each other.
- Recognize that humans have systems to meet their basic needs (e.g., food, water, oxygen, and the right environmental conditions).
- Describe ways that individuals might differ with respect to internal characteristics (e.g., the size of their bones, the size of their hearts, the number of cavities in their teeth, near-sighted or not, blood type, resting heart rate).

3.3.e Describing and give examples of non-communicable diseases and communicable diseases *(for example, heart disease, chicken pox).*
(examples not limited to:)
- Sort medical problems into communicable and non-communicable groups and give examples of each.
- Identify that contagious diseases are caused by microorganisms.
- Distinguish between two types of microorganisms (e.g., bacteria, viruses) that can cause disease.

For the 10th Grade Science CSAP, what students know and are able to do includes:

3.3.a Describing cellular organelles and their function *(for example, the relationship of ribosome's to protein synthesis; the relationship of mitochondria to energy transformation).*
(examples not limited to:)
- Identify major cell organelles.
- Compare and contrast main organelles/structures of plant and animal cells (e.g., chloroplast and cell wall).
- Describe the structure and function of all organelles.
- Indicate nucleic acids are located within animal and plant cells.

3.3.b Differentiating among levels of organization (cells, tissues, organs) and their roles within the whole organism.
(examples not limited to:)
- Explain how the levels of organization work together to form an organism.

3.3.c Explaining human body functions in terms of interacting organ systems composed of specialized structures that maintain or restore health *(for example, mechanisms involved in homeostasis, such as feedback in the endocrine system).*
(examples not limited to:)
- Describe how homeostasis is a characteristic of life (e.g., maintenance of body temperature, fluid balance).
- Describe the structure and function of body system relationships.
- Describe the function of the immune system in restoring health.

3.3.d Comparing and contrasting characteristics of and treatments for various types of medical problems (*for example, accidental, infectious, genetic).*
(examples not limited to:)
- Distinguish among and give examples of environmentally caused, infectious, and genetic disorders in terms of transmission and treatment.
- Describe the effects of antibiotics on microorganisms.
- Explain how vaccines help to prevent contraction of a disease.
- Explain the role of protein in DNA synthesis.
- Discuss some benefits of genetic counseling to determine family history of genetic disorders and diseases.

3.3.e Using examples to explain the relationship of structure and function in organisms.
(examples not limited to:)
- Use the examples of cell organelles, or cell structure, or organ structure, or system to explain its relationship to the organisms' role in the environment.

3.3.f Describing the pattern and process of reproduction and development in several organisms (*for example, earthworm, chicken, human).*
(examples not limited to:)
- Distinguish between various reproductive patterns and development in organisms (e.g., metamorphosis, hermaphroditic, life cycles, and egg laying).
- Compare the advantages and disadvantages of asexual and sexual reproduction.
- Describe how the mother's system meets the basic needs of a developing fetus.

Science: Assessment Frameworks-at-a-Glance and Colorado Content Model Standards

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2. Physical Science: Students know and understand common properties, forms, and changes in matter and energy.
3. **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.**
   - 3.1 Students know and understand the characteristics of living things, the diversity of life, and how living things interact with each other and with their environment.
   - 3.2 Students know and understand interrelationships of matter and energy in living systems.
   - 3.3 Students know and understand how the human body functions, factors that influence its structures and functions, and how these structures and functions compare with those of other organisms.
   - **3.4 Students know and understand how organisms change over time in terms of biological evolution and genetics.**
4. Earth and Space 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.
5. Students know and understand interrelationships among science, technology, and human activity and how they can affect the world.
6. Students understand that science involves a particular way of knowing and understand common connections among scientific disciplines.

3.4 Students know and understand how organisms change over time in terms of biological evolution and genetics.

--Rationale

Students study the scientific concept of biological evolution -- the changes in populations of organisms through time-- in order to understand diversity and relatedness within the living world. Inquiries into evolution explain the ways in which natural processes produce life's diversity. These studies help students understand that evolution is the major unifying concept in the biological sciences and that it explains a wide variety of observations that can be made about the living world. In particular, students see that the study of evolution initiates questions about biodiversity, adaptation, genetics, mutations, the geological record, and the observed unity at molecular and whole-organism levels. This content standard does not define any student expectations related to the origin of life.

Development of Changes in Organisms

These paragraphs explain differences in organisms, heredity, and the role of DNA in genetics as these concepts are developed in grades K-10.
The bold print emphasizes the processes and concepts developed in each grade level interval.

GRADES K-4	GRADES 5-8	GRADES 9-10
Differences in Organisms	**Basic Heredity**	**Heredity and DNA**
The study of the differences among organisms in grades K-4 is based on student **observation**. Students **identify characteristics** that are common to all individuals of a species. Students recognize that there are **differences in appearance** among individuals of the same population or group. They identify characteristics of plants and animals that allow them to live in specific environments. They are able to describe examples of extinct organisms based on fossil evidence. These concepts and experiences are the building blocks that prepare middle school students for understanding the basic concepts of heredity.	In grades 5-8, students broaden their focus to the study of basic heredity. They describe the **purpose of body and sex cell division**. They understand the role of chromosomes and genes in heredity. They **describe evidence** that reveals changes or constancy in groups of organisms over geologic time. These experiences provide the background needed in high school to more thoroughly understand heredity.	As students progress into high school, they begin **applying** their **conceptual understanding** of heredity to current research in a more critical and analytical way. They are **comparing and contrasting** the purpose and process of cell division and the production of sex cells. Students are able to give examples to show how some traits can be inherited while others are due to the interaction of genes and the environment. They describe how DNA serves as the vehicle for genetic continuity and the source of genetic diversity upon which natural selection can act. They understand how mutation, natural selection, and reproductive isolation can lead to new species and explain the planet's biodiversity. They analyze how variation within a population improves the chances that a species will survive under new environmental conditions. Students are able to describe the general structure and function of the gene and its role in heredity and protein synthesis.

Assessment Frameworks

For the 5th Grade Science CSAP, what students know and are able to do includes:

3.4.a Identifying characteristics that are common to all individuals of a species (*for example, offspring resemble their parents).*
(examples not limited to:)
- List characteristics that are common to all animals of a specific species (e.g., offspring resemble parents).
- Identify the adult insects in a group based on characteristics (e.g., 6 legs, 3 body sections, and two antennae.).
- Observe and draw a plant, labeling roots, leaves, and stem.
- List characteristics that are common to plants of the same kind (e.g., offspring resemble parent).

3.4.b Recognizing that there are differences in appearance among individuals of the same population or group.
(examples not limited to:)
- Observe and describe ways that plants or animals of the same population and life stage look different.

3.4.c Identifying characteristics of plants and animals that allow them to live in specific environments.
(examples not limited to:)
- Identify modifications animals have in order to eat certain foods (e.g., match types of teeth with types of food).
- Identify modifications plants have in order to survive (e.g., a desert cactus has spines and a waxy coat).

3.4.d Describing examples of extinct organisms based on fossil evidence *(for example, dinosaurs).*
(examples not limited to:)
- Identify fossils as the reason we know that dinosaurs ever existed.
- Tell why an animal may become extinct.
- c. Distinguish between extinct and imaginary animals (e.g., dinosaurs and dragons).

For the 8th Grade Science CSAP, what students know and are able to do includes:

3.4.a Describing the purpose of body cell division and sex cell division.
(examples not limited to:)
- Interpret a sketch of the chromosomes in the cells that form when a parent cell divides by either mitosis division or by meiosis division.
- List several types of cells that undergo body cell division (e.g.,. skin cells, blood cells, cells that line the mouth).
- Describe why the body needs to make new cells.
- Explain what would happen to the chromosome number if an egg and sperm formed by body cell division instead of by sex cell division.
- Identify the number of chromosomes that are in a human cell of a particular type (e.g., skin, sperm, muscle, egg).

3.4.b Describing the role of chromosomes and genes in heredity *(for example, genes control traits, while chromosomes are made up of many genes).*
(examples not limited to:)
- Describe why a child inherits half its genes from one parent and half from the other.
- Predict and explain the sex of an unborn baby whether or not the sex of the siblings is known.
- Show the relationship between cells, chromosomes, and genes.
- Explain why offspring are not identical to either parent.
- Distinguish between dominant and recessive genes.

3.4.c Describing evidence that reveals changes or constancy in groups of organisms over geologic time.
(examples not limited to:)
- Explain the difference between the terms extinct and endangered.
- Name organisms that lived at the time of the dinosaurs and still exist today.
- Describe how organisms have changed over time based on fossil records.

For the 10th Grade Science CSAP, what students know and are able to do includes:

3.4.a Comparing and contrasting the purpose and process of cell division (mitosis) with the production of sex cells (meiosis).
(examples not limited to:)
- When given a diagram, compare and contrast the purpose and process of mitosis with meiosis.

3.4.b Giving examples to show how some traits can be inherited while others are due to the interaction of genes and the environment (*for example, skin cancer triggered by overexposure to sunlight or contact with chemical carcinogens).*
(examples not limited to:)
- Explain how data from twin studies are used to help understand which traits are genetic and which have an environmental contribution.

3.4.c Describing how DNA serves as the vehicle for genetic continuity and the source of genetic diversity upon which natural selection can act.
(examples not limited to:)
- Describe DNA replication and how it relates to genetic continuity.
- Explain the significance of a mutation and its relationship to genetic diversity.
- Describe and give an example of how natural selection and existing variation in a population lead to the development of new species and the diversity of life on earth.

3.4.d Describing how mutation, natural selection, and reproductive isolation can lead to new species and explain the planet's biodiversity.
(examples not limited to:)
- Distinguish between mutations that are not likely to be noticed, those that would affect only the individual carrying the mutation, and those that can be passed on to future generations.

3.4.e Explaining why variation within a population improves the chances that the species will survive under new environmental conditions.
(examples not limited to:)
- Explain variations in a population of organisms.
- Give an example of how variations in a population can improve the chance of survival for the population if there are changes in the environment.

3.4.f Describing the general structure and function of the gene (DNA) and its role in heredity and protein synthesis *(for example, replication of DNA, the role of RNA in protein synthesis).*
(examples not limited to:)
- Draw or use a model to show the relationship among chromosomes, genes, and DNA.
- Explain what is meant by the term 'genetic code.
- Explain the general role of DNA in protein synthesis.
- Explain the relationship among DNA, genes, proteins, and traits.

3.4.g Calculating the probability that an individual will inherit a particular single gene trait *(for example, calculate the probability of offspring inheriting cystic fibrosis when both parents are carriers) for the disease.*
(examples not limited to:)
- Use an example to show why it is possible for an offspring to look different from either parent.
- Describe a child's characteristics when the child's gene pairs are known using a chart as a reference.
- Predict the offspring's gene pairs when the characteristics are known.
- Show the possible outcomes of a cross when the parents' gene pairs are known.

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   - **4.1 Students know and understand the composition of earth, its history, and the natural processes that shape it.**
   - 4.2 Students know and understand the general characteristics of the atmosphere and fundamental processes of weather.
   - 4.3 Students know major sources of water, its uses, importance, and cyclic patterns of movement through the environment.
   - 4.4 Students know the structure of the solar system, composition and interactions of objects in the universe, and how space is explored.
5. Students know and understand interrelationships among science, technology, and human activity and how they can affect the world.
6. Students understand that science involves a particular way of knowing and understand common connections among scientific disciplines.

4.1 Students know and understand the composition of earth, its history, and the natural processes that shape it.

--Rationale

By studying earth, its composition, history, and the processes that shape it, students gain a better understanding of the planet on which they live. Landforms, resources, and natural events such as; earthquakes, flooding, and volcanic eruptions affect the location of population centers. Life throughout geologic time has been, and continues to be, affected by changes that occur at a varying rate on earth's surface. Knowledge of the structure and composition of the earth provides a basis for making informed decisions. Understanding geologic events, such as earthquakes and volcanic eruptions, allows students to make responsible choices, evaluate the consequences, and predict the impact of future occurrences.

Development of Earth Concepts

These paragraphs explain how geologic concepts develop in grades K-10.
The bold print emphasizes the processes and concepts developed in each grade level interval.

GRADES K-4
Earth Materials

The study of earth materials in grades K-4 is based on students **observing** and **recognizing patterns** in earth materials and features of earth's surface through their senses. They observe and gain experience with earth materials such as soil, rocks, and fossils at their school and in their neighborhood. They explore events that cause change and create landforms such as mountains, rivers, and plains. Their focus is on surface processes such as weathering and erosion rather than processes beneath earth's surface. Classroom activities emphasize **concrete models** and **direct observation**. These concepts and experiences are the building blocks that prepare students for explaining the rock cycle in middle school and plate tectonics in high school.

GRADES 5-8
Rock Cycle

In grades 5-8, students move from observing earth materials and surface features at the K-4 level to **inferring** and **explaining the processes** that cause and change these phenomena. As students study the rock cycle, they explain how rocks are changed from one kind to another. As they study fossils, they explain how a fossil is formed from a buried plant or animal and thus how fossils provide evidence about past life forms. Students examine different rocks and the relationship of rocks to minerals, soils, and fossils. They refine classification skills and **develop explanations** of the processes that transform these materials in terms of a sequence of events (e.g., weathering, erosion, deposition, and cementation). Students use **cause-and-effect reasoning** as they consider not only the effects on earth's surface of events such as volcanic eruptions and stream erosion, but also how these events change the surface. Students are introduced to plate tectonics and earth history through a variety of models in preparation for more analytical approaches in high school.

GRADES 9-10
Plate Tectonics and Earth History

As students progress into high school, they will begin to use data in a more critical and analytical way. Students analyze data collected by a variety of instruments to **synthesize patterns** fundamental to concepts in plate tectonics and earth history. Students will compare the strengths and weaknesses of **conceptual models**, and be able to use models appropriately. These concepts include the composition and structure of the earth's interior; surface features; natural events and the risks posed by these events; and evidence for a dynamic earth that has evolved over time. In addition, students will develop their own perspectives on natural resource exploration, development, and consumption.

Assessment Frameworks

For the 5th Grade Science CSAP, what students know and are able to do includes:

4.1.a Describing different types and uses of earth materials *(for example, rocks, soil, minerals);*
(examples not limited to:)
- Identify rocks and soils and where they are found.
- Describe rocks and soils using properties (e.g., color, size, shape, and texture).
- Describe ways we use earth materials in everyday life.

4.1.b Recognizing that fossils are evidence of past life;
- Identify a fossil as a once-living plant or animal (e.g., leaf, shell, bone).
- Explain that fossils are found in rocks.

4.1.c Identifying major features of earth's surface *(for example, mountains, rivers, plains, hills, oceans, plateaus);*
(examples not limited to:)
- Identify surface features from pictures (e.g., mountains, rivers, plains, hills, oceans, plateaus).

4.1.d Describing natural processes that change earth's surface *(for example, weathering, erosion, mountain building, volcanic activity)*;
(examples not limited to:)
- Distinguish between weathering and erosion.
- Describe two processes that cause rocks to weather (e.g., freeze/thaw cycles, wind, rain).
- Describe two ways that rocks and sand are eroded (e.g. water, wind).
- Explain how features on the earth's surface (e.g. canyons, valleys, sand dunes, sandbars) are formed by erosion and deposition.

4.1.e Recognizing that humans are affected by natural events *(for example, earthquakes, volcanoes, floods).*
(examples not limited to:)
- Explain how people are affected when rivers flood.

For the 8th Grade Science CSAP, what students know and are able to do includes:

4.1.a Explaining how minerals, rocks, and soils form;
(examples not limited to:)
- Identify one of the common rock-forming minerals given a data chart of characteristic properties (e.g. quartz, feldspar, hornblende, calcite, mica).
- Identify a type of rock (igneous, sedimentary, and metamorphic) based on observable characteristics.
- Describe how igneous, sedimentary, or metamorphic rocks form.
- Describe the processes by which one rock can become another rock (i.e. the rock cycle).
- Describe how soils form and how weathering contributes to soil formation.
- Explain how weathering and erosion change a rock's shape and size to form sediments (pebbles, sand, silt, clay).
- Explain the relationships between rocks, minerals, and soil.

4.1.b Explaining how fossils are formed and used as evidence to indicate that life has changed through time;
(examples not limited to:)
- Describe methods of fossil formation.
- Explain why bones and teeth are more commonly preserved as fossils, and more likely to occur in sedimentary rocks.
- Describe how fossil evidence can be linked to environmental conditions of the past.

4.1.c Modeling natural processes that shape earth's surface *(for example, weathering, erosion, mountain building, volcanic activity)*; and
(examples not limited to:)
- Name two landforms created primarily by erosion and explain their formation.
- Name two landforms created primarily by deposition and explain their formation.
- Explain the relationship between magma, igneous rocks, and volcanoes.
- Explain why the earth's surface is always building up in some places and wearing down in others (e.g., erosion and deposition).

4.1.d Explaining the distribution and causes of natural events *(for example, earthquakes, volcanoes, landslides).*
(examples not limited to:)
- Identify a pattern of natural events as corresponding with surface features (e.g. volcanoes and earthquakes with plate boundaries; landslides with mountain ranges).
- Explain the relationship between volcanoes and plate boundaries.

For the 10th Grade Science CSAP, what students know and are able to do includes:

4.1.a Describing the composition and structure of earth's interior;
(examples not limited to:)
- List the 4 main layers (crust, mantle, outer core, inner core) of the earth and describe two characteristics of each layer.
- Use seismic data to support the idea that the earth is composed of layers.
- Describe the processes by which one rock can become another rock with respect to plate tectonics (e.g. melting of ocean crust into magma at a subduction zone).

4.1.b Using the theory of plate tectonics to explain relationships among earthquakes, volcanoes, mid-ocean ridges, and deep-sea trenches;
(examples not limited to:)
- Relate the patterns of earthquakes, volcanoes, and landforms on a world map to each other and to (hypothetical) plate boundaries.
- Given a hypothetical plate boundary situation (convergent, etc.), predict the features formed and associated events that result from plate motion.
- Explain how plate boundary features identify major crustal plates and their motions.
- Use plate tectonics as an example of how scientists develop and modify theories over time.
- Analyze temperature and density data from earth's interior to evaluate a possible cause of plate motion.

4.1.c Using evidence *(for example, fossils, rock layers, ice cores, radiometric dating)* to investigate how earth has changed or remained constant over short and long periods of time *(for example, Mount St. Helens' eruption)*;
(examples not limited to:)
- Explain how earth's surface has changed over time by interpreting a geologic cross section.
- Interpret a series of diagrams to determine erosional and depositional environments.
- Relate erosional and depositional environments to kinetic energy.
- Use uniformitarianism to explain the correlation between a present and a past environment.
- Correlate rock layers, fossils, and other data to determine relative age.
- Interpret data about radioactivity to determine absolute age.
- Use a geologic time scale to interpret earth's history.

4.1.d Evaluating the feasibility of predicting and controlling natural events *(for example, earthquakes, floods, landslides)*; and
(examples not limited to:)
- Interpret geologic data (e.g., topographic or hazard maps, aerial photos, etc.) to identify levels of risk in a given area.
- Formulate a mitigation plan for an area of high risk.

4.1.e Analyzing the costs, benefits, and consequences of natural resource exploration, development, and consumption.
(examples not limited to:)
- Identify the sequence of events (exploration, extraction, refinement, reclamation) for bringing an earth material to market.
- Identify and support costs, benefits, and consequences (e.g., economic, environmental, and social) to developing a resource when given a scenario.
- Identify the criteria that distinguish a renewable and non-renewable resource.
- Analyze data about the effect of resource consumption on resource reserves to draw conclusions about sustainable use.

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   - **4.2 Students know and understand the general characteristics of the atmosphere and fundamental processes of weather.**
   - 4.3 Students know major sources of water, its uses, importance, and cyclic patterns of movement through the environment.
   - 4.4 Students know the structure of the solar system, composition and interactions of objects in the universe, and how space is explored.
5. Students know and understand interrelationships among science, technology, and human activity and how they can affect the world.
6. Students understand that science involves a particular way of knowing and understand common connections among scientific disciplines.

4.2 Students know and understand the general characteristics of the atmosphere and fundamental processes of weather.

--Rationale

Our earth's atmosphere is vital to life. The sun and atmosphere affect every aspect of our lives, including work productivity, food supply, energy use, transportation, recreation, environmental quality, and human health and safety. Weather related choices we make range from selecting appropriate clothing to more complex situations, including preparing for and responding to hazardous weather. Preparedness and response to weather conditions require knowledge of how energy transfer influences atmospheric changes. The more we know about weather, the greater the chances that we will make informed decisions concerning its impact.

Development of Concepts of Atmosphere and Weather

These paragraphs explain how concepts in meteorology develop in grades K-10. The bold print emphasizes the processes and concepts developed in each grade level interval.

GRADES K-4 Local Weather Patterns	GRADES 5-8 Atmosphere and Regional Weather	GRADES 9-10 Global Weather and Climate
The study of weather in grades K-4 is based on students **observing** concrete changes in weather conditions, such as clouds, temperature, and precipitation, with their senses and simple tools. Students will **collect data** and look for seasonal and daily **patterns**. Using these observations and collected data, students will recognize how weather affects their daily activities, and that the sun is the primary source of energy. These concepts and experiences are the building blocks that prepare students for explaining local and regional weather patterns in later grades.	In grades 5-8, students move from observing the sky and weather patterns to **inferring** and **explaining the processes** that cause and change these phenomena. As students study weather patterns, they begin to understand and describe the layers and composition of earth's atmosphere. Classroom activities include **observing, measuring, graphing,** and **analyzing** local and regional weather patterns and looking at weather data to describe weather changes. Students understand how location (latitude, elevation) affects weather. Students are able to explain that much of earth's weather is a result of solar activity and transfer of energy through conduction, convection, and radiation. Students use this knowledge to explain local weather fronts and explain weather in other regions.	As students progress into high school, they begin to use data in a more critical and analytical way. Students analyze multiple data sets collected regionally and globally to **synthesize patterns** in weather and climate, and apply **conceptual models** to explain these patterns. Students relate these patterns to energy transfer within the atmosphere and between the atmosphere and oceans. Students relate regional patterns in weather to global patterns. In addition, students develop their own perspectives on issues such as human impact on climate and the effects of weather on human populations.

Assessment Frameworks

For the 5th Grade Science CSAP, what students know and are able to do includes:	For the 8th Grade Science CSAP, what students know and are able to do includes:	For the 10th Grade Science CSAP, what students know and are able to do includes:
4.2.a Recognizing that the sun is a principal source of earth's heat and light. *(examples not limited to:)* ▪ Describe how the temperature and amount of light are different in a sunny and shady place. ▪ Describe how the temperature and amount of light are different in the day and at night. ▪ Explain why the temperature and amount of light are different from day to night. ▪ Identify the sun as the main source of our heat and light. **4.2.b Recognizing how our daily activities are affected by the weather *(for example, type of clothing, travel plans, recreational activity)*.** *(examples not limited to:)* ▪ Describe what to wear outdoors given a specific weather condition. ▪ Identify an outdoor activity that is appropriate for a given weather condition. **4.2.c Describing existing weather conditions by collecting and recording weather data *(for example, temperature, precipitation, amount of cloud cover)*.** *(examples not limited to:)* ▪ Use a table of weather data (temperature, precipitation, cloud cover) to tell what the weather was on a particular day. ▪ Make a bar graph of daily temperature data. ▪ Interpret a bar graph of temperature or precipitation data to identify the weather at a certain time. ▪ Describe the weather conditions that are typical of different seasons in Colorado.	**4.2.a Describing the basic composition, properties, and structure of the atmosphere *(for example, the range and distribution of temperature and pressure in the troposphere and stratosphere)*.** *(examples not limited to:)* ▪ Identify the main components of air (nitrogen, oxygen, carbon dioxide, water, inert gases). ▪ Interpret evidence that air takes up space and has mass. ▪ Describe the relationship between altitude and air pressure. ▪ Describe the relationship between altitude and temperature. **4.2.b Observing, measuring, and recording changes in weather conditions *(for example, humidity, temperature, air pressure, cloud types, wind, precipitation*).** *(examples not limited to:)* ▪ Use data tables to compare weather conditions in various locations. ▪ Create and/or analyze a line graph to interpret weather changes over time. **4.2.c Explaining how atmospheric circulation is driven by solar heating *(for example, the transfer of energy by radiation, convection, conduction)*.** *(examples not limited to:)* ▪ Explain why the poles receive less solar energy than the equator. ▪ Explain that as air is heated it becomes less dense and rises. ▪ Explain that the sun heats the earth via radiation that in turn heats the atmosphere via conduction and convection. ▪ Interpret a diagram to show how water and land surfaces heat differently thus producing winds. ▪ Identify convection as a driving force for localized weather phenomena such as winds and storms. **4.2.d Describing large scale and local weather systems *(for example, fronts, air masses, storms)*.** *(examples not limited to:)* ▪ Use several pieces of evidence (cloud observations, weather maps) to show that weather systems generally move from west to east in the United States. ▪ Relate changes in local weather to the general motion of regional air masses. ▪ Identify a front as a boundary between air masses of different temperatures.	**4.2.a Analyzing the structure of, and changes in, the atmosphere, and its significance for life on earth.** *(examples not limited to:)* ▪ Given a diagram of the layers of the atmosphere, describe how they differ. ▪ Identify the troposphere as the layer where human activities and weather take place. ▪ Identify how the composition and properties of different layers of the atmosphere affect life on earth. ▪ Correlate data that show changes in atmospheric composition to effects on living organisms. **4.2.b Explaining and analyzing general weather patterns by collecting, plotting, and interpreting data.** *(examples not limited to:)* ▪ Interpret weather maps to describe large-scale weather events. ▪ Identify relationships between two weather variables given a graph of each variable over time. ▪ Relate changes in weather variables to actual weather conditions. **4.2.c Describing how energy transfer within the atmosphere influences weather *(for example, the role of conduction, radiation, convection, and heat of condensation in clouds, precipitation, winds, storms)*.** *(examples not limited to:)* ▪ Describe the transfer of heat energy within and between the oceans, continents, and atmosphere. ▪ Analyze a diagram to explain the relationship between differential solar heating and wind patterns. ▪ Explain how a cloud forms as moist air rises. **4.2.d Investigating and explaining the occurrence and effects of storms on human populations and the environment.** *(examples not limited to:)* ▪ Interpret maps to relate location to risk of severe weather (tornadoes, flood, hail, lightning, and blizzard). ▪ Interpret data to correlate time of year to frequency of severe weather. ▪ Describe the effects of severe weather (tornadoes, flood, hail, lightning, and blizzard) on a population and the surrounding environment. **4.2.e Describing and explaining factors that may influence weather and climate *(for example, proximity to oceans, prevailing winds, and fossil fuel burning, volcanic eruptions)*.** *(examples not limited to:)* ▪ Compare and describe weather conditions at two locations, then explain how differences in local weather conditions are dependent on oceans, latitude, and elevation. ▪ Analyze graphical data to identify relationship between changes in atmospheric CO_2 levels and climate changes over time. ▪ Identify processes, such as burning fossil fuels and volcanic eruptions that increase atmospheric CO_2.

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   - 4.4 Students know the structure of the solar system, composition and interactions of objects in the universe, and how space is explored.
5. Students know and understand interrelationships among science, technology, and human activity and how they can affect the world.
6. Students understand that science involves a particular way of knowing and understand common connections among scientific disciplines.

4.3 Students know major sources of water, its uses, importance, and cyclic patterns of movement through the environment.

--Rationale

The world's water is vital to life. Both subtle and wholesale changes in earth's water can have profound effects on human existence. In order to preserve both the water and quantity of water for daily living, wise management of water resources is crucial. As the population and economies of the world grow, water becomes an even more important political and economic issue. Knowing the properties of water, its influences on weather, and its availability is necessary for understanding its importance to life. Knowledge of earth's oceans is important for an understanding of how they affect weather, climate, and life. It is important to understand the circulation of water because the amount of water on earth is finite.

Development of Water Concepts

These paragraphs explain how concepts in water develop in grades K–10. The bold print emphasizes the processes and concepts developed in each grade level interval.

GRADES K-4	GRADES 5-8	GRADES 9-10
Water Sources – Rivers, Lakes and Oceans The study of water in grades K-4 is based on students **observing** and **recognizing characteristics** of water. Students observe with their senses water as a liquid and as a solid and **compare** two states of water. Students are introduced to water vapor as they **observe** water evaporating in the sunlight. They identify observable sources of water (rivers, lakes, and oceans) and tell how each source is important in everyday life. These experiences are the building blocks that prepare students for further study of the water cycle in middle grades.	**The Water Cycle** In grades 5-8, students expand their focus from local bodies and personal uses of water to regional water sources and the processes by which water is transported and transformed. They **investigate** the distinctive physical properties of water in different states and understand and **infer** how these properties determine the behavior of water on earth and its special role in supporting life. Students then apply this physical understanding as they **examine** different reservoirs of liquid, solid, and gaseous water found in the natural environment, including glaciers, oceans, lakes, streams, atmospheric water vapor, and clouds. They examine the transformation and transport of water through processes in the water cycle, such as evaporation of surface water, condensation in the atmosphere to form precipitation, and formation of clouds. These experiences prepare students to examine in high school the complex interactions of water with other parts of the earth system.	**The Hydrosphere** As students progress into high school, they begin to use data in a more critical way. Students **analyze** multiple data sets collected regionally and globally to **synthesize patterns** between water and earth systems and apply **conceptual models** to explain these patterns. Students relate these patterns to the water cycle. Students analyze scenarios where costs, benefits, and consequences determine water management decisions. In addition, students develop their own perspectives on issues concerning water resources management and human impact on water quality.

Assessment Frameworks

For the 5th Grade Science CSAP, what students know and are able to do includes:	For the 8th Grade Science CSAP, what students know and are able to do includes:	For the 10th Grade Science CSAP, what students know and are able to do includes:
4.3.a Identifying major sources of water *(for example, oceans, glaciers, rivers, groundwater, and atmosphere)*. *(examples not limited to:)* ▪ Recognize that water exists in many different places and forms. ▪ Distinguish between freshwater and saltwater. ▪ Identify fresh water sources (glaciers, lakes, streams, precipitation) and salt water sources (seas, oceans). **4.3.b Identifying and describing the states (solid, liquid, gaseous) in which water can be found on earth.** *(examples not limited to:)* ▪ Describe ways that ice, snow, and water are the same and ways that they differ. ▪ Identify the state of water present given an example (ocean, air/atmosphere, snow, glacier, stream, lake). ▪ Describe conditions in which water would be found in its various states. **4.3.c Recognizing the importance and uses of water *(for example, drinking, washing, irrigating)*.** *(examples not limited to:)* ▪ Identify water as a basic need of both plants and animals. ▪ Identify uses of water in daily activities. ▪ Give examples of how water can affect the surface of the earth. ▪ Describe a drought and its effects.	**4.3.a Investigating and comparing the properties and behavior of water in its solid, liquid, and gaseous states.** *(examples not limited to:)* ▪ Describe physical characteristics of water in each of its states. ▪ Describe the change in volume when water changes from one state of matter to another. ▪ Use a particle model to describe the different states of matter (solid, liquid, gas) of water. ▪ Provide evidence that water does not disappear when it evaporates. **4.3.b Describing the distribution and circulation of the world's water through oceans, glaciers, rivers, groundwater, and the atmosphere.** *(examples not limited to:)* ▪ Interpret an illustration of the water cycle. ▪ Explain the processes and relationships that connect elements of the water cycle. ▪ Describe conditions that affect the rates of evaporation and condensation. ▪ Explain the relationship that groundwater has in the water cycle. **4.3.c Describing the composition and physical characteristics of oceans *(for example, currents, waves, features of the ocean floor, and salinity)*.** *(examples not limited to:)* ▪ Predict effects of changes in salinity on the physical characteristics of water. ▪ Compare similarities and differences of fresh water and salt water. ▪ Describe causes and characteristics of ocean currents.	**4.3.a Identifying and explaining factors that influence the quality of water needed to sustain life.** *(examples not limited to:)* ▪ Analyze a scenario to identify risks and costs of water pollution. ▪ Identify sources of pollution that affect water quality. ▪ Suggest methods of mitigating water pollution. **4.3.b Identifying and analyzing the costs, benefits, and consequences of using water resources.** *(examples not limited to:)* ▪ Suggest consequences of a drought on human populations, forests, wildlife, crops and livestock. ▪ Analyze the importance of the snow pack for Colorado's water supply. ▪ Analyze a scenario that identifies the costs, benefits, and consequences of developing a water resource. **4.3.c Explaining interactions between water and other earth systems *(for example, the biosphere, lithosphere, and atmosphere)*.** *(examples not limited to:)* ▪ Predict the effects of changes in ocean level as caused by changes in the size of polar ice caps. ▪ Predict the impact on climate of increased or decreased water content in the atmosphere. **4.3.d Explaining interrelationships between the circulation of oceans and weather and climate.** *(examples not limited to:)* ▪ Predict the effects in ocean current changes on weather and climate (for example, the Gulf Stream and western Europe, El Niño and La Niña).

Science: Assessment Frameworks-at-a-Glance and Colorado Content Model Standards

1. Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.
2. Physical Science: Students know and understand common properties, forms, and changes in matter and energy.
3. 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.
4. **Earth and Space 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.**
   - 4.1 Students know and understand the composition of earth, its history, and the natural processes that shape it.
   - 4.2 Students know and understand the general characteristics of the atmosphere and fundamental processes of weather.
   - 4.3 Students know major sources of water, its uses, importance, and cyclic patterns of movement through the environment.
   - **4.4 Students know the structure of the solar system, composition and interactions of objects in the universe, and how space is explored.**
5. Students know and understand interrelationships among science, technology, and human activity and how they can affect the world.
6. Students understand that science involves a particular way of knowing and understand common connections among scientific disciplines.

4.4 Students know the structure of the solar system, composition and interactions of objects in the universe, and how space is explored.

--Rationale

Observing the sky has always fascinated human cultures and civilizations. These observations resulted in the development of ways to measure and predict natural phenomena. All bodies in space, including earth, are influenced by forces acting throughout the solar system and the universe. Studying the universe enhances our understanding of earth's origins, its place in the universe, and its future. Much of what we know about earth's atmosphere and our solar system are due to space exploration. Modern society benefits from many of the technological advances developed for space exploration, including robotics, telecommunications, satellites, and miniaturized components used in computers and other electronic devices. Knowledge of the universe and past space exploration enables people to make informed decisions about the future of space.

Development of Solar System Concepts and Concepts of the Universe

These paragraphs explain how concepts in space science develop in grades K–10.
The bold print emphasizes the processes and concepts developed in each grade level interval.

GRADES K-4 Day and Night Sky	GRADES 5-8 Solar System	GRADES 9-10 The Stars and Universe
The study of space science in grades K-4 is based on students **observing and recognizing patterns** in the day and night sky. They observe the sun in the day sky and learn that it provides earth with heat and light. Students learn that the motion and position of the earth relative to the sun result in day, night, and seasons. They observe the moon in both the day and night sky and recognize that the shape of the lit moon changes over one month. Students begin to observe daily, monthly, and yearly patterns associated with the earth, moon, and sun. Students recognize that the earth is one planet within the solar system and that humans have explored space. These concepts and experiences are the building blocks that prepare middle school students for explaining the effects of the motions of the earth-moon-sun system, and how earth compares to other planets in the solar system.	In grades 5-8, students broaden their focus from earth to the solar system. Students observe objects in the sky and **build models to link their observations** to the motions of the earth and moon in relation to the sun. As they construct these models, they develop the ability to alternate perspectives between the view we observe from earth and a view from space of earth's position in the solar system. They use these models to explain human time units—days, months, seasons, years—in terms of astronomical motions. As they compare the earth to other planets, they develop scale models of the solar system. They investigate techniques that humans use to explore and understand space. These experiences provide the background needed in high school to examine the universe beyond the solar system.	As students progress into high school, they begin to use data and scale in a more critical and analytical way. Students understand how electromagnetic radiation collected from stars helps us know what stars are composed of and how far away they are from earth. Students compare the scale of the solar system to galaxies and the universe, and they begin to examine theories about the formation of the universe. Students **use conceptual models** to explain the relationship of our solar system to distant stars and galaxies.

Assessment Frameworks

For the 5th Grade Science CSAP, what students know and are able to do includes:

4.4.a Describing what can be readily observed by the unaided eye in the daytime and nighttime sky *(for example, the sun, moon, planets, stars, and constellations)*.
(examples not limited to:)
- Distinguish between objects in the earth's atmosphere (birds, planes, clouds) and in space.
- Identify and name objects that can be seen in the night sky compared with those seen during the day.
- Recognize that the moon's apparent shape changes over time.
- Describe the apparent change in position of the sun throughout a day.

4.4.b Describing the motion of the earth in relation to the sun, including the concepts of day, night and year.
(examples not limited to:)
- Describe that the side of earth facing the sun experiences daylight.
- Indicate the location of the sun on a drawing that shows an object and its shadow.
- Explain how changes in a shadow can be used to understand the apparent motion of the sun.

4.4.c Recognizing the characteristics of seasons.
(examples not limited to:)
- Compare the length of daylight in summer and winter.

4.4.d Identifying basic components of the solar system *(for example, sun, planets, and moons)*.
(examples not limited to:)
- Describe the solar system as consisting of the sun, the earth and its moon, and other planets.
- Know that the planets, including earth, orbit the sun.
- Name two other planets.

4.4.e Describing a space exploration event such as a manned or unmanned space mission.
(examples not limited to:)
- Know that astronauts have landed on the moon and explored its surface.
- Know that space probes, but not astronauts, have gone to other planets.

For the 8th Grade Science CSAP, what students know and are able to do includes:

4.4.a Describing the basic components, composition, size, and theories of origin of the solar system.
(examples not limited to:)
- Describe the parts and motions of the solar system (planets, sun, moons, asteroids, comets).
- Distinguish objects in the solar system from those outside it.
- Compare and contrast the sun and a planet.
- Compare and contrast the moon with the earth.
- Describe how craters are formed on the surface of the moon and other bodies.

4.4.b Explaining the effects of relative motion and positions of the sun, earth, and moon *(for example, seasons, eclipses, moon phases, tides)*.
(examples not limited to:)
- Sequence pictures of phases of the moon and explain why the moon appears to change shape.
- Draw a sketch that shows the position of the sun, earth, and moon to explain the new and full moons.
- Explain solar and lunar eclipses.
- Explain how gravity affects the movement of the sun, earth, and moon.
- Use a model to show how the earth rotates with respect to the sun resulting in day and night.
- Use a model to show how the earth orbits the sun resulting in a year.

4.4.c Comparing earth to other planets *(for example, size, composition, relative distance from the sun)*.
(examples not limited to:)
- Name the planets in order from the sun.
- Identify a planet given several key characteristics.
- Show relative size of planets given a scale to use.
- Show the relative distances between planets given a scale to use.
- List several ways that earth differs from the other planets.

4.4.d Identifying technology needed to explore space *(for example, telescopes, spectroscopes, spacecraft, and life support systems)*.
(examples not limited to:)
- Name tools used to explore space (telescope, lunar module, rover, and shuttle) and tell how each is used.
- Describe some of the challenges that must be overcome during space exploration.
- Explain how tools are useful in exploring space (e.g., a telescope magnifies objects in space).
- Explain the destination and purpose of a recent space exploration event.

For the 10th Grade Science CSAP, what students know and are able to do includes:

4.4.a Explaining the causes of and modeling the varied lengths of days, seasons, and phases of the moon.
(examples not limited to:)
- Interpret a diagram of earth orbiting the sun to explain why Colorado has summer when farthest from the sun.
- Explain why the moon goes through phases.
- Explain why the earth doesn't have a lunar eclipse every month.

4.4.b Describing the effect of gravitation on the motions observed in the solar system and beyond.
(examples not limited to:)
- Explain why the sun and the planets are a "system."
- Distinguish and justify the difference between objects in our solar system and objects not in our solar system.
- Describe the relationship among a solar system, a galaxy, and the universe.

4.4.c Describing electromagnetic radiation produced by the sun and other stars (*for example, X-ray, ultraviolet, infrared, radio)*.
(examples not limited to:)
- Identify and describe several parts of the electromagnetic spectrum (e.g., x-rays, visible light, radio waves).
- Explain how electromagnetic radiation is used as a tool in astronomy.
- Describe unique objects in space (e.g., galaxies, nebulae, black holes, comets that can be identified from spectral analysis).

4.4.d Comparing the sun with other stars *(for example, size, color, temperature)*.
(examples not limited to:)
- Interpret data on a Hertzsprung-Russell diagram.
- Use a Hertzsprung-Russell diagram to compare characteristics of our sun with other stars (e.g., Rigel, Betelgeuse, Sirius, and Alpha Centauri).
- Compare and contrast stars of various size, color, temperature, and age, given a data table.
- Explain how solar phenomena (solar flares, sunspots, solar wind) affect the earth.

4.4.e Identifying and describing the everyday impact of recent space technology *(for example, more sophisticated computers, remote sensing, medical imaging)*.
(examples not limited to:)
- Analyze the benefits (e.g., aerospace jobs, Velcro™, microwave ovens) and consequences (e.g., monetary cost of missions, space trash, and loss of life) of space exploration.
- Explain why astronauts have not traveled to other planets.
- Analyze a scenario of an asteroid or comet impacting earth.

Science: Assessment Frameworks-at-a-Glance and Colorado Content Model Standards

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4. Earth and Space: Students know and understand the processes and interactions of earth's systems and the structure and dynamics of earth and other objects in space.
5. **Students know and understand interrelationships among science, technology, and human activity and how they can affect the world.**
6. Students understand that science involves a particular way of knowing and understand common connections among scientific disciplines.

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5. Students know and understand interrelationships among science, technology, and human activity and how they can affect the world.

--Rationale

Our world is shaped in many ways by scientific advances, technology (involving applications of science), and human activity. Science and technology provide useful connections between the natural world and the designed world. Since the invention of stone tools, technological applications have provided, and will continue to provide, humans the ability to modify their environment. Because scientific advances and technology affect all of earth's living and non-living systems, it is vital that students understand the interrelationships of science, technology, and human activity.

Development of Concepts Regarding the Interrelationships Among Science, Technology and Human Activity

These paragraphs explain the K-10 conceptual development of the use and application of science and technology in managing the natural and designed world.

GRADES K-4	GRADES 5-8	GRADES 9-10
Students in grades K-4 begin to learn the variety of natural and energy resources and their uses. They also gain a basic understanding of responsible resource management practices. Furthermore, these students begin to understand how raw materials and resources are modified and used to create technological applications that better our world and create careers in science and technology.	In grades 5-8 students progress from the identification of earth's resources to classifying them into natural and energy resources based on their source and use. They begin to understand the scope of human use of these resources and the difference between renewable and nonrenewable natural and energy resources. In addition, these students begin to evaluate the impact of new technologies on our world, both positive and negative. This includes matching a community program with a technological solution. Finally, they begin to understand the many ways technology is used in the workplace.	By grade 10 students are able to analyze the significance of developing and using technology or resources. They are able to consider the affects on human activity including economic, health, recreational, social, and environmental. Moreover, they are able to distinguish between science and technology and describe how they are different yet interdependent. They can more thoroughly describe how different technologies are used in different professions.

Assessment Frameworks

For the 5th Grade Science CSAP, what students know and are able to do includes:

5.a Recognizing the diversity of resources provided by the earth and sun *(for example, soil, fuels, minerals, medicines, food).*
(examples not limited to:)
- Identify some of earth's natural resources such as plants, land, rocks/minerals, water, and animals.
- Recognize uses of natural resources. (e.g., fuels to heat home, plants for home construction, rocks for building roads, land for crops, water to drink)
- Recognize responsible management of natural resources such as recycling, reusing, trash disposal, and water conservation.
- Identify some of earth's natural energy resources such as coal, wind, water, nuclear, oil, geothermal, and solar.

5.b Inventing a device that addresses an everyday problem (or task) and communicating the problem, (or task) design, and solution.
(examples not limited to:)
- Given a simple everyday problem or task, match it with a scientific or technological solution.

5.c Describing resource-related activities in which they could participate that can benefit their communities *(for example recycling, water conservation).*
(examples not limited to:)
- Given a common community resource issue, describe an activity that would help solve the issue. (e.g., waste disposal – recycling; energy availability - energy conservation and efficiency; water availability and water conservation).

5.d Identifying careers that use science and technology.
(examples not limited to:)
- Given a specific technology, identify a career that makes primary use of that technology.

For the 8th Grade Science CSAP, what students know and are able to do includes:

5.a Investigating and describing the extent of human uses of renewable and nonrenewable resources *(for example, forests, fossil fuels).*
(examples not limited to:)
- Distinguish between renewable (e.g., solar, wind, biomass, geothermal, water) and nonrenewable energy resources (e.g., coal, oil, natural gas). (Biomass encompasses fuels from biological sources such as wood, ethanol, and landfill gas).
- Identify positive and negative consequences of using renewable and nonrenewable energy resources. (e.g., solar → nonpolluting but expensive to manufacture; coal → plentiful but requires additional pollution controls; wind → nonpolluting but intermittent; oil → inexpensive but in limited supply).
- Describe sustainable uses of natural resources (e.g., logging practices, that preserve the health and biodiversity of forests; agricultural practices that ensure preservation of soil resources; water storage, conservation, and treatment practices that ensure the continued availability of clean fresh water) and describe the methods of maintaining the health of natural environments by managing human use and impacts.
- Recognize common uses of some of earth's natural energy resources. (e.g., coal and nuclear used for electricity, solar radiation used for heating, hydroelectric used for electricity, natural gas used for heating, oil and biomass made into fuels).

5.b Describing the advantages and disadvantages that might accompany the introduction of a new technology *(for example, mountain bikes, cellular telephones, pagers).*
(examples not limited to:)
- Given a new technology, identify its advantages and/or disadvantages. (e.g., titanium used for stronger bikes but has high cost; the computer age uses less paper but requires more electricity and metal wiring).
- Recognize that technologies often have drawbacks as well as benefits. A technology that helps some people or organisms may hurt others.

5.c Describing how the use of technology can help solve an individual or community problem *(for example, using catalytic converters on autos to help reduce air pollution).*
(examples not limited to:)
- Given a common individual or community problem, describe an activity that would help solve the problem. (e.g., waste disposal –recycling; energy availability - energy efficiency and distributed renewable energy; water availability - efficient appliances and waste water uses; sickness - extracting medicines from plants).

5.d Describing how people use science and technology in their professions.
(examples not limited to:)
- Describe specific scientific and/or technological uses in a profession.

For the 10th Grade Science CSAP, what students know and are able to do includes:

5.a Analyzing benefits, limitations, costs and consequences involved in using technology or resources *(for example, x-rays, agricultural chemicals, natural gas reserves*).
(examples not limited to:)
- Given an example of a technological advance in a specific scientific discipline identify benefits, limitations, costs, and consequences of implementing the technology.
- Compare the negative and positive consequences of using technology in the development and utilization of natural resources (economic, health, recreational, social, and environmental).
- Compare the negative and positive consequences of using renewable energy and of using non-renewable energy (economic, health, recreational, social, and environmental).

5.b Analyzing how the introduction of a new technology has affected or could affect human activity *(for example, invention of the telescope, application of modern telecommunications).*
(examples not limited to:)
- Given an example of a technological advance in a specific scientific discipline, describe the affect of the technology on human activity.
- Describe how the technological solution to one problem can create another, possibly worse problem.

5.c Demonstrating the interrelationships between science and technology (*for example, building a bridge, designing a better running shoe).*
(examples not limited to:)
- Given an example of a technological advance in a specific scientific discipline identify how science affects the technology and how the technology affects science.

5.d Explaining the use of technology in an occupation.
- Given an example of a technological advance in a specific scientific discipline, describe how the technology is used in careers and occupations.
- Describe how a new technology may develop new careers and additional new technologies.

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4. Earth and Space: Students know and understand the processes and interactions of earth's systems and the structure and dynamics of earth and other objects in space.
5. Students know and understand interrelationships among science, technology, and human activity and how they can affect the world.
6. **Students understand that science involves a particular way of knowing and understand common connections among scientific disciplines.**

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6. Students understand that science involves a particular way of knowing and understand common connections among scientific disciplines.

--*Rationale*

Human societies have long asked questions about, observed and collected data on, and offered explanations for natural phenomena. Scientific evidence and knowledge are distinguished from other ways of knowing and other bodies of knowledge in terms of the criteria that must be met. These criteria include the use of empirical standards and rules of evidence, a logical structure, rational thought, questioning, and openness to criticism. Scientific disciplines differ from one another in what is studied, techniques used, and outcomes sought. They share a common purpose—to explain and predict events and phenomena—and offer strategies to solve defined problems. Scientific knowledge is dynamic. Although some scientific theories have withstood the test of time and are still used, other knowledge claims have been altered by new scientific evidence. Change, continuity, and stability are characteristic features of science.

Although acquiring scientific knowledge of laws, concepts, and theories is central to learning science, it does not necessarily lead to an understanding of how science itself works. Students need to understand that science works by weaving different aspects of science together so that they reinforce one another. To bring coherence to seemingly diverse sets of ideas or facts involving natural phenomena, scientific themes such as change, systems, models, and organization are highly useful. Themes can encompass and connect large quantities of basic data and evidence in science and can be used to integrate science with other disciplines.

Development of Concepts Regarding the Connections Among Scientific Disciplines **These paragraphs explain how an understanding of science as a unique way of knowing develops in K-10.**		
GRADES K-4	**GRADES 5-8**	**GRADES 9-10**
The study of the Nature of Science in grades K-4 focuses on students recognizing that science is based on evidence. Scientists learn about the world through observation and the collection of evidence. Students will recognize several themes and processes (e.g. cycles and systems; evidence and explanation) that recur in all scientific disciplines. Students will understand scientists repeat experiments and compare their findings with findings from other scientists to confirm their results.	The study of the Nature of Science in grades 5-8 focuses on students recognizing how ideas change in science. As scientists make observations and collect additional evidence, their explanations of the natural world are confirmed or modified. Students will identify themes and processes (e.g., cycles, systems, models, change, constancy, and measurement) that cross all scientific disciplines. Students will understand scientists from all disciplines share their investigative process, data and results so they can be evaluated by others.	The study of the Nature of Science in grades 9-10 focuses on students distinguishing between science and other ways of understanding the world. Students will know science relies on empirical standards and evidence free of bias or opinion, a logical structure, rational thought, questioning, and openness to criticism. Students will recognize how scientific knowledge has grown and changed over time through testing, revising, and occasionally discarding theories. Students know how advances in one scientific discipline affect other disciplines. Students will identify common themes and processes (e.g., form and function, systems, equilibrium, change over time) that cross all scientific disciplines.

Assessment Frameworks		
For the 5th Grade Science CSAP, what students know and are able to do includes:	**For the 8th Grade Science CSAP, what students know and are able to do includes:**	**For the 10th Grade Science CSAP, what students know and are able to do includes:**
6.a Recognizing that when a science experiment is repeated with the same conditions, the experiment generally works that same way. *(examples not limited to:)* ▪ Explain why scientist repeat experiments under the same conditions.	**6.a Explaining why a controlled experiment must have comparable results when repeated.** *(examples not limited to:)* ▪ Explain how repeating a controlled experiment leads to comparable results. (See 1.d) ▪ Recognize when comparisons of evidence, collected by others, between experimental results are not fair because some conditions were not kept the same.	**6.a Evaluating print and visual media for scientific evidence, bias, or opinion.** *(examples not limited to:)* ▪ Given an article interpreting scientific data, determine if the conclusion of the author is supported by the data and/or if bias or opinion is present in the article. ▪ Identify the potential bias based on the source (for example an environmental group or an industrial group).
6.b Comparing knowledge gained from direct experience to knowledge gained indirectly *(for example collecting data about height of students in their class and comparing the results to similar data collected in another class or school).* *(examples not limited to:)* ▪ Compare their own observations with those reported by others and recognize that both similar and dissimilar evidence helps us learn about the natural world (e.g., contributes to scientific knowledge). ▪ Describe how observations/ evidence collected by scientists or others who lived long ago (e.g., several generations ago) could be used today to contribute to your understanding (e.g., of changes in the landscape, trees, tools).	**6.b Giving examples of how scientific knowledge changes as new knowledge is acquired and previous ideas are modified *(for example new knowledge through space exploration).*** *(examples not limited to:)* ▪ Give an example of how scientific knowledge has changed over time. ▪ Explain why scientific knowledge changes over time. ▪ Distinguish between hypothesis, theory and law. ▪ Explain that scientific knowledge relies on evidence. ▪ Identify connections between science disciplines (for example chemistry to biology, chemistry to geology, physics to astronomy). ▪ Recognize that there are basic themes found in all science disciplines (e.g., systems, cycles, change).	**6.b Explaining that the scientific way of knowing uses a critique and consensus process *(for example, peer review, openness to criticism, logical arguments, skepticism).*** *(examples not limited to:)* ▪ Given a scenario explain why a critique and consensus process is important.
6.c Identifying observable patterns and changes in their lives and predicting future events based on those patterns (*for example, seasonal weather patterns).* *(examples not limited to:)* ▪ Recognize that repeating events are the basis of pattern and cycles. ▪ Using an illustration of a natural cycle or pattern, predict one event or stage based on another. ▪ Recognize that parts that make up a cycle or pattern are interrelated. ▪ Describe how the parts of a cycle or pattern are interrelated.	**6.c Describing contributions to the advancement of science made by people in different cultures and at different times in history.** *(examples not limited to:)* ▪ Recognize the concept of multicultural contributions to the advancement of science over time.	**6.c Using graphs, equations, or other models to analyze systems involving change and constancy *(for example comparing the geologic time scale to shorter time frames).*** *(examples not limited to:)* ▪ *See Standard 1*
6.d Describing and comparing the components and interrelationships of a simple system *(for example, tracing the continuous flow of water through an aquarium, filter, and pump).* *(examples not limited to:)* ▪ Recognize that a system is made up of parts that are dependent upon each other, and that a change in one part will affect the system.	**6.d Identifying, comparing, and predicting variables and conditions related to change *(for example, climate, population, motion).*** *(examples not limited to:)* ▪ Identify the variables or conditions that cause change in a system. ▪ Describe how the variables or conditions impact the system. ▪ Predict, identify and explain factors that would cause a change in system. Explain the change.	**6.d Analyzing and comparing models of cyclic change as used within and among scientific disciplines *(for example water cycle, circular motion, sound waves, and weather cycles).*** *(examples not limited to:)* ▪ Analyze common characteristics of cycles in nature, such as: • *Recycling of matter/energy* • *Conservation of matter/energy* • *Sustainable (ongoing) and Natural* • *Representative of a closed system* • *Required interdependence of the parts* • *Requires energy input*
6.e Comparing a model with what it represents *(for example, map of a school to the actual school, model of earth to the earth itself).* *(examples not limited to:)* ▪ Given an illustration of a model identify what it likely represents.	**6.e Identifying and illustrating natural cycles within systems *(for example, water, planetary motion, geological changes, climate).*** *(examples not limited to:)* ▪ Identify a natural cycle within a given system. (e.g., life cycle rock cycle, cycles in planetary motion, tides, seasonal cycles).	**6.e Identifying and predicting cause-effect relationships within a system** *(examples not limited to:)* ▪ Describe naturally occurring earth systems and predict the outcome when one component of the systems is changed. Suggest alternative trade-offs, decisions, and/or designs of systems.
	6.f Using a model to predict change *(for example computer simulation, video sequence, stream table).* *(examples not limited to:)* ▪ Use a model to predict change. ▪ Explain why models are used to understand processes and change.	**6.f Identifying and describing the dynamics of natural systems *(for example, weather systems, ecological systems, body systems).*** *(examples not limited to:)* ▪ Understand the major attributes of systems such as: • *The properties of a system are different from the properties of its component parts* • *The properties of a system appear due to interaction of the parts* • *The system responds to large and small disturbances in different ways* • *Different aspects of a system change over time while others remain the same*
		6.g Identifying and testing a model to analyze systems involving change and constancy (*for example, mathematical expression for gas behavior, constructing a closed ecosystem such as an aquarium).* *(examples not limited to:)* ▪ Given a model, analyze and interpret the model.
		6.h Explaining an exponential model *(for example, pH scale, population growth, Richter scale).* *(examples not limited to:)* ▪ Identify an example graph of an exponential model.
		6.i Refining a hypothesis based on an accumulation of data over time (*for example, Alvarez's theory on dinosaur extinction).* *(examples not limited to:)* ▪ Recognize that scientific knowledge constantly changes as information and technology changes. Suggest an alternative way of explaining a set of data.

Science: Assessment Frameworks-at-a-Glance and Colorado Content Model Standards

This section identifies examples of additional knowledge and abilities to promote science development for students continuing their science education beyond the CSAP measured standards.	
	10th Grade and Beyond
Standard 1: Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.	• Design and Complete an advanced scientific investigation – either individually or as part of a student team that extends over several days or weeks. • Continue to practice and apply inquiry skills as they extend their understanding of science content through further study.
Standard 2: Physical Science: Students know and understand common properties, forms, and changes in matter and energy.	• Relate their prior knowledge and understanding of properties of matter to observable characteristics of material and emerging technologies (*for example, semiconductors, superconductors, photovoltaics, ceramics*). • Model quantitative aspects of chemical and physical interactions (*for example, rates of reactions, stoichiometry, electromagnetic phenomena, statics and dynamics, electrochemistry*). • Apply knowledge and understanding of chemical and physical interactions to explore factors that influence or govern change (*for example, equilibrium constants, kinetics, thermodynamics*). • Distinguish among different types of constancy (*for example, static and dynamic equilibrium, symmetry, uniform/accelerated motion*) and different types of change (*for example, qualitative and quantitative trends, cyclic change, chaotic change*).
Standard 3: 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.	• Describe how, over long periods of time, ecosystems can remain stable and, if altered by factors such as climatic change, return to stability. • Explain specializations that allow different types of cells to perform different functions. • Describe how balance (*homeostasis*) is maintained within an organism when its environment is altered (*for example, the relationship between blood glucose level and insulin production; carbon dioxide and oxygen balance in the body*). • Describe the role of gene mutations that result in uncontrolled cell division (*for example, cancer*). • Explain the role of exposure to certain factors (*for example, chemical, biological, radiation*) that may increase the rate of mutation, and therefore the incidence of cancer and other diseases. • Determine the degree of kinship between organisms or species from estimations of the similarity of their nucleic acid sequences, which often closely match classifications based on anatomical similarities. • Explain how the rate of environmental change may exceed the capacity of organisms to respond to change, leading to the extinction of species.
Standard 4: Earth and Space 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.	• Explain relationships and interactions between living things and Earth systems (*for example, the atmosphere, geosphere, and hydrosphere*). • Predict possible climatic changes and their effects based on past and present climatic data. • Identify and predict natural hazards, using historical data. • Describe the life cycle of a star. • Describe evidence that supports past and current scientific theories of the origin of the universe.
Standard 5: Students know and understand interrelationships among science, technology, and human activity and how they can affect the world.	• Apply their knowledge and understanding of chemical and physical interactions to explain present and anticipated technologies (*for example, lasers, ultrasound, superconducting materials, photocopy machines*). • Explore the scientific and technological aspects of contemporary problems (*for example, issues related to nutrition, air quality, natural resources*).
Standard 6: Students understand that science involves a particular way of knowing and understand common connections among scientific disciplines.	• Relate small-scale phenomena to large-scale properties (*for example, intermolecular forces related to physical properties*). • Trace the development of an invention, theory, or discovery to demonstrate the dynamic nature of science.